Ph.D. Thesis

An Inquiry into Causes of Regional Disparities in Economic Growth across Indian States

by

Sanghamitra Bandyopadhyay

London School of Economics and Political Science
University of London

2002

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346

Abstract

This thesis documents some stylised facts of what sustains unequal economic growth across Indian states over the period 1965-1997. It documents the dynamics of the convergence of incomes across the Indian states by tracking the evolution of the entire income distribution over 1965-97, instead of using standard regression and time series analyses. This approach, known in the literature as the distribution dynamics approach, reveals patterns of catch-up, which remain obscured in standard parametric approaches.

The findings document a decline in disparities in the late sixties, with a subsequent increase in inequality in the seventies, eighties, and nineties. This is accompanied by the polarisation of the income distribution into two convergence clubs, one at around 125% of the national average, and at 50% of the national average. The latter half of the thesis tries to explain these stylised facts using both non-parametric and parametric techniques. The distribution dynamics reveal that the disparate distribution of infrastructure – both economic and social – strongly explains the formation of the lower income club. Fiscal deficits seem to partially explain club formation at the higher income levels. Standard panel regression analyses reveal that education, especially primary education, is associated with better growth performances. Macroeconomic stability is also associated with higher growth., while political instability and the lack of political governance is found to be negatively associated with growth too.

Such findings have interesting implications for economic policy. The distribution dynamics reveal that an all-encompassing "global" policy for all states may not be appropriate – cohesive forces governing the formation of the two convergence clubs are different, hence, states belonging to different clubs require specific policies to address unequal growth performances. In terms of policy content, basic infrastructure, such as health, education, transport, and political governance require the most attention in the lower income states, while for higher income states, macroeconomic stability and political governance, seem to be the more important.

Acknowledgements

I humbly thank my supervisors, Danny Quah and Diana Weinhold, for inspiring me and guiding me through the process of conceiving and writing the thesis. I am immensely grateful to Henry Overman for being my "informal supervisor" and for introducing me to distribution dynamics. I am grateful to Ashwani Saith and John Harriss for guiding my work in the first year of my doctoral studies.

I thank the Economic and Social Research Council, UK and the London School of Economics for funding my doctoral studies. I am very grateful to the Aristomene Varoudakis and Marie Ange-Veganzones, OECD, Paris, and Shahrokh Fardoust., World Bank, Washington DC, for providing me with data for this project.

I also thank Abhijit Banerjee, Jean Paul Dréze, Shahrokh Fardoust, Ben Fine, Martin Ravallion for many insightful comments on the thesis. I am indebted to the administrative staff of both Development Studies and Economics departments, LSE for bearing with all my mundane scholarly needs. Last, but not the least, I thank my parents and friends for their invaluable encouragement and support.

I dedicate this thesis to my parents.

Table of Contents

1. Chapter 1: Introduction 12 - 49

1.1 Introduction

1.1.1 The main conclusions of the thesis - in brief 16

1.1.2 Organisation of the thesis 18

1.2 The Indian Problem and Existing Empirical Work on Convergence across Indian states.

1.2.1 Previous Empirical Work on Convergence of Growth across India 22

1.3 Approaches to studying convergence: the theoretical and empirical debate 25

1.3.1 Empirical Approaches to Convergence: The Traditional Approaches: Cross Section Regression Approach 26

1.3.2 Time Series Methods 34

1.3.3 Panel Data Techniques 34

1.4 What is Distribution Dynamics? 35

1.4.1 Explaining existing disparities, or the lack of convergence 37

1.4.2 Conditioning, in distribution dynamics 38

1.5 Conclusion 38

2. Chapter 2: Regional Distribution Dynamics of GDPs across Indian states: 1965-1997 48-67

2.1 Introduction 48

2.2 Distribution Dynamics 50

2.2.1 Random Fields and the Random Element 52

2.2.2 Models of Intra-distribution Churning/ Mixing 53

2.3 What has been happening to the inter-state income distribution in India? 56

2.3.1 A Preliminary Look 56

2.3.2 Intra-distributional dynamics 61

2.4 Further Dynamics 63

2.5 Conclusion 67

3. Chapter 3: Regional Distribution Dynamics of GDPs across Indian states: Role of Infrastructure 105-162

3.1 Introduction 105
3.2 Conditioning: Non parametric results 107
3.2.1 What to look for in the stochastic kernels? 110
3.2.2 Conditioning on physical neighbours 112
3.2.3 Conditioning on sectoral composition of State Domestic Product 112
3.2.4 Conditioning on infrastructure 114
3.2.5 Conditioning on State Development Expenditure 117
3.2.6 Conditioning on Education 119
3.2.7 Discrete version of the stochastic kernels : Using transition probability matrices 121
3.3 Conditioning with parametric specifications 122
3.3.1 Accounting for potential endogeneity bias 127
3.4 Implications for Public Investment Policy 129
3.5 Conclusion 131

4. Chapter 4: Regional Distribution Dynamics of GDPs across Indian states: Role of Macroeconomic Stability and Political Governance 163-188

4.1 Introduction 163
4.2 The Macro-economic Crisis in India in the Nineties 169
4.3 Cross country empirical literature on growth and convergence and the role of macroeconomic stability and political governance 169
4.3.1 Role of Macroeconomic stability 169
4.3.2 Institutions and Governance 171
4.4 Empirical Analysis 173
4.4.1 Description of data 172
4.4.2 Non-parametric results: the Distribution Dynamics Approach 175
4.4.3 Obtaining the conditional distribution 176
4.4.4 The Results 177
4.4.5 Transition probability matrices 178

4.4.6 Panel Regression (Parametric) Results 179
4.4.7 Long run effects of fiscal indices and governance – 1961 – 1998 187
4.5 Conclusion 188

5. Chapter 5: Conclusion 213
5.1 What are the main contributions of this project? 218
5.2 What is not done in this thesis? 219
5.3 What policy conclusions can one derive from the empirical findings? 224

Bibliography 227-240

List of Tables and Figures

Chapter 1: Introduction.

Table 1. Growth rates (per cent) of the Fourteen Largest Indian States 42

Table 2 India and High Growth East Asia: A Comparison 43

Table 3: India and Sub-Saharan Africa: Some Selected Comparisons (1991) Adult Literacy Rate Comparisons 44

Table 4. India and Sub-Saharan Africa: Some Selected Comparisons (1991) Infant Mortality Rate Comparisons. 45

Fig 1a. Sigma Convergence 1965-80 46

Fig 1b. Sigma Convergence 1981-97. 47

Chapter 2: Regional distribution Dynamics of GDPs across Indian states: 1965-1997.

Table 1: Inter-State (per capita) income dynamics, 1965-88, First Order transition matrix, Time stationary 74

Table 2a: Inter-State (per capita) income dynamics, 1965-70; First Order transition matrix, Time stationary 75

Table 2b: Inter-State relative (per capita) income dynamics, 1971-80; First Order transition matrix, Time stationary 76

Table 2c: Inter-State relative (per capita) income dynamics, 1981-87, First Order transition matrix, Time stationary 77

Table 2c: Inter-State relative (per capita) income dynamics, 1988-97, First Order transition matrix, Time stationary 78

Fig.1: Relative GDP per capita of Indian States : 1965-1988 79

Fig.2 Indian inter-state spatial dynamics of GDP per capita: 1965, 1970, 1977,1988 80
Fig.3a and b: Tukey Boxplots, relative per capita incomes across Indian states 81-82
Fig.4a and b: Cross profile dynamics across Indian States 83-84
Fig.5a.i: Relative Income Dynamics across Indian States, 1 year horizon, 1965-87 85
Fig 5a.ii: Relative Income Dynamics Across Indian States, 1 year horizon, Contour Plot, 1965-87. 86
Fig. 5b.i: Relative Income Dynamics across Indian States, 5 year horizon, 1965-84 87
Fig 5b.ii: Relative Income Dynamics across Indian States, 5 year horizon, Contour Plot, 1965-84. 88
Fig5c.i: Relative Income Dynamics across Indian States, 1 year horizon, 1965-70. 89
Fig5c.ii: Relative Income Dynamics across Indian States, 1 year horizon, 1965-70, Contour Plot 90
Fig. 5d.i: Relative Income Dynamics across Indian States, 1year horizon,1971-80 91
Fig. 5d.ii: Relative Income Dynamics across Indian States, 1 year horizon
1971-80, Contour Plot 92
Fig. 5e.i: Relative Income Dynamics across Indian States, 1 year horizon, 1981-87 93
Fig. 5e.ii: Relative Income Dynamics across Indian States, 1 year horizon, 1981-87, contour 94
Fig 5fi. Relative Income Dynamics across Indian states, 1 year horizon, 1988-97 95
Fig 5f ii Relative Income Dynamics across Indian states, 1 year horizon, 1988-97, contour 96

Fig. 5g.i: Relative Income Dynamics across Indian States, 5 year horizon,1965-70 97
Fig. 5g.ii: Relative Income Dynamics across Indian States, 5 year horizon, 1965-1970, Contour Plot 98
Fig. 5h.i: Relative Income Dynamics across Indian States, 5 year horizon, 1970-75 99
Fig. 5h.ii: Relative Income Dynamics across Indian States, 5 year horizon, 1970-75, Contour Plot 100
Fig. 5j.i: Relative Income Dynamics across Indian States, 5 year horizon, 1978-83 101
Fig. 5j.ii: Relative Income Dynamics across Indian States, 5 year horizon, 1978-83, contour. 102

Chapter 3: Regional Distribution Dynamics of GDPs across Indian states: Role of Infrastructure.

Table 1. Results of Factor Analysis and Factor Loadings 138

Table 2. Conditioning regressions (two sided projections) of growth rates on State development expenditure (real) 139

Table 3a. Inter-state conditioning on neighbours, transition matrix. 140

Table 3b. Inter-state conditioning on state domestic product, transition matrix 140

Table 3c. Interstate conditioning on infrastructure, transition matrix 141

Table 3d. Inter-state conditioning on state development expenditure, transition matrix "

Table 3e. Inter-state conditioning on education, transition matrix. 142

Table 4. Panel Regressions. 143

Table 5. Infrastructure Equations. 144

Table 6. Public Sector Share in Real GDP (totals and by sectors of activity, in percentage) 145

Table 7. Share of Infrastructure in Public Investment 146

Fig1a. Relative income dynamics across Indian States, 1 year horizon: 1965-70 147

Fig1b. Relative income dynamics across Indian States, 1 year horizon: 1971-80 148

Fig1c. Relative income dynamics across Indian States, 1 year horizon: 1981-88 149

Fig1d. Relative income dynamics across Indian States, 1 year horizon: 1989-96 150

Fig 2a and b. Benchmark Stochastic Kernels 151

Fig 3a Relative per capita incomes across Indian states: Neighbours conditioning. 152

Fig 3b.Relative per capita incomes across Indian states: Neighbours conditioning, contour 153

Fig4a. Relative per capita incomes across Indian states: Composition of State Domestic Product conditioning. 154

Fig4b. Relative per capita incomes across Indian states: Composition of State Domestic Product conditioning, contour. 155

Fig 5. Infrastructure dynamics across Indian states: Contour plot, 1978-1993 156

Fig.6a. Relative per capita incomes across Indian states: Infrastructure conditioning. 157
Fig.6b. Relative per capita incomes across Indian states: Infrastructure conditioning, contour 158
Fig.7a. Relative per capita incomes across Indian states: State development expenditure conditioning 159
Fig7b. Relative per capita incomes across Indian states: State development expenditure conditioning, contour 160
Fig8a. Relative per capita incomes across Indian states: Education conditioning 161
Fig8b. Relative per capita incomes across Indian states: Education conditioning, contour. 162

Chapter 4: Regional Distribution Dynamics of GDPs across Indian states: Role of Macroeconomic Stability and Political Governance.

Table 1. Conditioning regressions (two sided projections) of growth rate capital expenditure 191
Table 2a Inter-state conditioning on capital expenditure, transition matrix 192
Table 2b. Inter-state conditioning on education expenditure, transition matrix 192
Table 2c. Inter-state conditioning on fiscal deficit, transition matrix 193
Table 2d. Inter-state conditioning on inflation, transition matrix 193
Table 2e. Inter-state conditioning on interest expenditure, transition matrix. 194
Table 3. Conditioning panel regressions of growth: 1986-1997 195
Table 4. Conditioning panel regressions of growth: 1986-1997 196
Table 5. Conditioning panel regressions of growth: 1986-1997 197
Table 6. Conditioning panel regressions of growth: 1986-1997 198
Table 7. Conditioning panel regressions of growth: 1986-1998, Averaged panel (for 3 years) 199
Table 8. OLS Conditioning Regressions for sub-periods 1987-91, 1992-95 and 1996-98 200
Table 9. OLS Averaged Conditioning Panel regressions of growth: 1961-1997 201

Fig 1. Sigma convergence 202

Fig 2a. Relative income dynamics across Indian States, 1 year horizon: 1965-70 203
Fig 2b. Relative income dynamics across Indian States, 1 year horizon: 1971-80 204
Fig 2c. Relative income dynamics across Indian States, 1 year horizon: 1981-88 205
Fig 2d. Relative income dynamics across Indian States, 1 year horizon: 1990-96 206
Fig.3ai. Relative per capita incomes across Indian states, Capital Expenditure conditioning. 207
Fig.3aii. Relative per capita incomes across Indian states, Capital Expenditure conditioning, contour. 208
Fig.3bi. Relative per capita incomes across Indian states, Education Expenditure conditioning, 209
Fig.3bii. Relative per capita incomes across Indian states, Education Expenditure conditioning, contour 210
Fig.3ci. Relative per capita incomes across Indian states, Fiscal deficit conditioning. 211
Fig.3cii. Relative per capita incomes across Indian states, Fiscal deficit conditioning, contour 212
Fig.3d. Relative per capita incomes across Indian states, Inflation conditioning. 213
Fig.3e. Relative per capita incomes across Indian states, Interest Expenditure conditioning. 214

Chapter 1

Introduction

Why have some states in India grown rich, while others remained poor? Only few questions have generated a literature with greater fervour than that of the question of economic inequality across individuals and nations. Understanding different patterns of cross country or cross regional growth 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. This study is an attempt to understand what factors sustain unequal economic growth across Indian states.

That regional inequalities of incomes across the Indian states exist has been well documented and studied by many. It is almost common knowledge that the western states are the industrially advanced, while the north-west is agriculturally prosperous. There exist pockets of relative success in agriculture and industry the south and the north, while the north eastern states are yet to excel in either.

Saying that regional inequalities exist is just the starting point - what is of concern is that they continue to persist, particularly so that they do after five decades of concerted state led planning. Such persistent differential development, given widespread inter-state socio-ethnic and political differences risk the unleashing of highly destructive centrifugal political

forces. It is therefore vitally important that policies for containing and counteracting regional disparities are implemented in the early rapid phase of development.

This thesis documents the dynamics of growth and convergence of incomes (real per capita) across Indian states over the period 1965-1998. The framework used addresses a number of specific goals: first, we are interested in the dynamics of equality across incomes across Indian states. In other words, is there any tendency towards equality in the cross section income distribution across the Indian states? If not, what distributional pattern do they exhibit?

Second, if cohesive[1] tendencies were not to obtain, we would like to characterise the possibilities for inter-regional mobility – are there any signs of poorer regions overtaking the rich in the future? Are there any signs of initially rich economies falling behind? These facts are important for policy purposes. Characterising the presence of other distributional patterns, e.g. convergence clubs or stratification, will enable the researcher to identify the economic forces governing their formation and their persistence.

Finally, we are interested in finding what processes serve to generate such income dynamics. We will look at the role of distribution of infrastructure (both social and economic) and that of macroeconomic and political instability in explaining the observed income dynamics.

The investigations undertaken are of empirical nature - it establishes new stylised facts and posits some explanations for these findings using a new empirical methodology in studying convergence – the *distribution dynamics* approach. This approach improves upon existing

econometric approaches to studying cross-country or cross-regional growth in that it is fashioned to essentially describe the dynamics of growth in greater detail – here one would ask: if we do not obtain convergence, what exactly is the distribution pattern and why so? Is growth polarised? Or even stratified? And hence, what implications does it have for policy and how we understand cross country growth? Such concerns are not addressed by existing empirical techniques which only explain average representative behaviour; here one would only ask: do we observe convergence or not? The study, especially in the context of the Indian states, is new – it presents fresh stylised facts of income dynamics, improves upon existing studies of Indian inter-state differentials of economic growth by using a wide range of econometric tools for its investigation and also uses new data sets compiled by the author from various international organisations.

This study follows from the new wave of empirical growth analyses, following the studies of Barro and Sala-i-Martin(1992), Desdoigts(1994), Quah (1993a,1996b, 1996c, 1996d), Nagaraj et al (1998) to name a few. These new studies of income dynamics have made powerful and controversial claims, which have instigated yet further empirical techniques of analysing cross-country income dynamics. The ensuing stylised facts of growth have telling implications for widely accepted theoretical claims. Also, the questions which are addressed in the new empirical growth literature differ from those in earlier empirical works of Kaldor's stylised facts (1963), or of Solow(1957) in a production function accounting exercise. The primary focus is to understand the cross-country patterns of income, rather than explaining only within-country dynamics (i.e. the stability of factor shares - the "great ratios" - within a single economy, or growth exclusively in terms of factor inputs). The new empirical literature also uses auxilliary explanatory factors to explain the stylised facts, as opposed to analysing the production function residual, the norm earlier.

---

[1] By cohesion, we simply mean the tendency towards equality of incomes across the states.

In conceiving convergence, the traditional approach clarifies whether an economy will converge to its own steady state (income) – this, however, is a less interesting notion of convergence. We are interested in a more useful notion of convergence here - convergence as a notion of catch-up. We would like to know how an economy initially within the poorest 10 per cent of the country can catch up with the rest, or will converge within a median 20 per cent. Extant approaches cannot say anything on whether the poorest economies will stagnate, permanently distant from the richest ones – they remain silent on patterns of stratification and polarisation. It has been argued by many, that convergence as a notion of "catch-up" is not useful when studied by standard regression analysis as it captures only representative behaviour, and uninformative, in general, for the dynamics of the distribution of income across countries (Friedman, 1992, Leung and Quah, 1996). Again, while time series analyses accounting for the univariate dynamics, does not utilise the cross section information, the evolution of income dispersion, (say, in terms of the standard deviation), also does not tell us anything about the underlying cross section growth dynamics.

So, how does this new approach improve on existing approaches? Here we examine inter-state income inequalities in terms of the behaviour of the *entire* cross section distribution. When the cross section distribution exhibits tendencies of collapsing to a point mass, one can conclude of tendencies towards convergence. If, on the other hand, it shows tendencies towards limits which have other properties – normality or twin-peakedness, or a continual spreading apart - these too will be revealed. What this approach essentially endeavours is to describe a law of motion of the cross section income distribution over the period of study. Appropriately named, the distribution dynamics approach exposes instances of economies overtaking, or falling behind – it reveals the existence of any intra-distributional mobility.

Finally, this model will allow the researcher to study not just the likelihood, but also the potential causes, of poorer economies becoming richer than those currently rich, and that of the rich regressing to become relatively poor[2].

Methodologically, thus, the distribution dynamics approach, and other approaches incorporating the time series-cross section approaches to studying convergence (Bianchi 1997, Desdoigts 1994, Jones 1997, Lamo 1996 and Quah 1993a, 1996b, 1996c, 1996d) has obvious advantages over and above the existing approaches employed so far. Standard (i.e. beta convergence) regression analysis only considers average or representative behaviour, and says nothing about what happens to the entire distribution (Barro and Sala-i-Martin, 1992, and Bajpai and Sachs, 1996, Cashin and Sahay, 1996, Nagaraj et al., 1998, for the Indian case, among many others). Neither are both beta and sigma convergence analyses able to inform the researcher of any prospects of inter-regional mobility. They are unable to uncover the long run aspects of the evolving distributional pattern. Such is also the case with time series applications to regional analyses (Carlino and Mills, 1993). The distribution dynamics approach goes beyond point estimates of dispersion and unit root analyses to highlight two vital aspects of how a distribution evolves over time – intra-distributional mobility and the long run prospects of the distribution (ergodicity). It encompasses both time series and cross section properties of the data simultaneously and presents itself as an ideal approach for large data sets.

1.1.1 The main conclusions of the thesis - in brief

Starting with the basics, the thesis uncovers the relevant stylised facts of Indian inter-state income distribution over the period 1965-98. Our main finding is that while cohesive

[2] The econometric methodology used in this paper is that conceived by Quah (1993a,1996b, 1996c, 1996d).

tendencies were observed in the late sixties, these were considerably weakened over the following years with increasing diverging tendencies. Strong tendencies are found of the existence of two income clubs, particularly over the later years (1970 onwards to the 1990s). – a low income club at 50 % of the national average, and another at 125% of the national average.

The rest of the thesis attempts to identify a number of factors which explain the observed income dynamics. We find that the distribution of economic and social infrastructure strongly explains the formation of the lower income club. Macroeconomic stability also strongly influences growth performances – fiscal deficits partially explain the formation of the higher income club. Capital expenditure also, to an extent, explains the high income states. Standard parametric (panel) regressions complementing the distribution dynamics results also extensively reveal interesting insights. Some of the factors which do not appear to explain the distribution dynamics, show up as significant factors explaining the lack of convergence under parametric specifications. Of the infrastructural indicators used in the study, extent of irrigation, roads, power consumption in industrial sectors, education (mainly, primary education) and bank deposits show up to be significant determinants of cross-state growth differentials. Of the various macroeconomic indicators, short run results show that fiscal deficits are negatively associated with growth, while the long run results over 1965 -1998 reveal the negative impact of inflation on growth. Political instability is also observed to be negatively correlated with growth in both short and long run horizons. Expenditure on education, particularly over the 1990s is positively correlated with growth, a result in confirmation with that obtained in the cross-country growth literature.

Details of the methodology are elaborated later in the paper.

1.1.2 Organisation of the thesis

The thesis is organised as follows. In this chapter, we lay out the agenda and motivation of this thesis, highlight the drawbacks of extant methods of studying convergence and introduce the distribution dynamics approach. In Chapter 2 we establish new stylised facts using this approach: we find that the distribution dynamics reveals "twin peaks" dynamics; that the income dynamics are characterised by persistence and immobility, polarising the income distribution into two convergence clubs. In Chapter 3, we extend the distribution dynamics approach to test for causal factors in explaining the observed income dynamics, and examine the role of the distribution of infrastructure in explaining the polarisation. In Chapter 4 we will examine the role of macroeconomic stability and political governance. Chapter 5 concludes.

The rest of this chapter is organised as follows. Section 2 reviews the existing literature on convergence of growth and incomes across Indian states. Section 3 reviews the existing theoretical and empirical debate over the approaches to studying convergence of economic growth. Section 4 introduces and briefly describes the distribution dynamics approach. Section 5 concludes.

1.2 The Indian Problem and Existing Empirical Work on Convergence across Indian states.

India's trend growth of 5.8% per annum since 1980 has been the highest outside South East Asia among large developing countries. In 1998-99 alone, India's GDP grew at a rate

of 6%, one of the highest growth rates in the world[3]. Between 1951 and 1996, per capita income more than doubled, food grain production has increased fourfold, and the index of industrial production has gone up 15 times. Despite high aggregate growth, at the state level growth figures have not only differed, but diverged consistently since the late sixties. Table 1 presents the states' growth rates over 1960/1 to 70/1, 1970/1 to 1980/1, 1980-1-1990/1, and 1991-2 – 1996-7. The high income states' average growth per capita (1.8 per cent per annum) was almost greater by 50% of the low income states (1.2 per cent per annum) in the 1960s – by 1997, the difference had widened to a gaping double (3.9 per cent for the high income states as opposed to 2.1 for lower income states). Figure 1 reveals how state incomes have diverged over the period 1965 to 1997: it plots the standard deviation of state incomes per capita, revealing the increasing divergence of economic growth across Indian states. A cursory look at the figures in Table 1 reveals that the general trend is that the rich have remained rich, while the poor have remained poor. States of Punjab, Haryana, Gujarat and Maharashtra continue to top the ranks, while states of Uttar Pradesh, Bihar and Orissa have remained at the bottom. What also characterises the income dynamics is that states with intermediate initial incomes experienced mixed fortunes. Some had a marked improvement in their incomes, while some fell drastically, while still others saw it unchanged.

Such disparate growth performances have also been accompanied by a high, and varied, incidence of poverty. While the overall trend of poverty has been on the decline over the three decades from 62% in 1967-8 to 48% in 1977-78, 38% in 1988-89 and 34% in the

[3] World Bank 2001

1990s[4], they have diverged between states. The proportion of the rural population living in poverty in Bihar (58%) around 1990 was more than triple that of rural Punjab and Haryana (18%), while it was only twice of that of Punjab-Haryana (65% for Bihar as opposed to 32% for Punjab-Haryana) in the 1960s[5]. While states of West Bengal, Kerala and still further Punjab and Haryana, have seen significant reduction in their levels of poverty, states of Rajasthan, Orissa, Assam and Bihar have seen their poverty levels decline only marginally. In comparison, countries of Korea, Thailand and Indonesia, have had substantially higher per capita incomes and social indicators, and considerably lower poverty than India, although the countries had similar per capitas in the 1960s, (detailed in Table 2).

Disparities in growth and poverty are accompanied by wide schisms in the very engines of economic growth across the states. Infrastructure, industry, agriculture, irrigation, roads, telecommunication, provision of credit at both rural and urban levels, health services, education, all widely differ in their distribution across states. States of Punjab, Gujarat and Maharashtra are infrastructurally (broadly speaking) equivalent to that of a middle income group country (like Brazil,) while the poorer states of Rajasthan, Uttar Pradesh and Bihar are infrastructurally similar to that of Bangladesh, Mali and Burkina Faso. Rural areas of states of Bihar and UP have less than 10 per cent of households with electricity, while the richer states of Punjab, Haryana and Himachal Pradesh[6] have over 70 per cent of rural households with electricity. Likewise, there are only between 30-40 hospital beds per million persons available in rural areas of Bihar, Rajasthan and UP, compared to a 1,768 in rural Kerala. Female literacy rates vary from 20% in Rajasthan, 25% in Uttar Pradesh to

[4] Datt 1997. These are figures of rural poverty, as the bulk of the poor (93%) live in rural areas.

[5] Datt and Ravallion 1998

[6] Bihar has less than 6% rural households, while Himachal Pradesh has a staggering 87% of rural households with electricity. Source: Dreze and Sen, 1995

86% in Kerala. It is remarkable that there is no country in Sub-Saharan Africa[7] – or indeed in the world – where adult literacy is as low as in the district of Barmer in Rajasthan, or where the infant mortality rates are as high as in the district of Ganjam in Orissa, elaborated in Tables 3 and 4. Each of these districts have a population larger than Botswana or Namibia, and a combined population of the two is larger than that of Sierra Leone, Nicaragua or Ireland. Even entire states like Uttar Pradesh, with a population larger than Brazil or Russia, do not do better than the worst off among the Sub-Saharan Africa in terms of these basic indicators of quality of life. While India is doing significantly better than, say, Ethiopia or Zaire (now the Democratic Republic of Congo), there are regions within the country, where elementary deprivation is as endemic, if not more severe, as in sub-Saharan Africa. If we add to it the fact that gender bias at death is a substantial problem in India, but not so in sub-Saharan Africa, we see a picture of deprivation that is much less favourable to India than to Africa.

In spite of such intense localised deprivation, the macroeconomic picture is decidedly less feeble, especially so in the nineties. Aggregate economic growth, particularly in the 1990s, has been robust; though much of it is attributed to the success of agricultural prosperity. However, growing fiscal deficits have proven to be a persistent menace to macroeconomic stability - over the period 1987-97, India had one of the largest fiscal deficits in the world, at over 6.2 per cent of the GDP, surpassed only by Brazil, Pakistan and Nigeria. Gross fiscal deficit to GDP ratio of all state governments touched a high of 4.2 per cent in 1998-99[8] – the highest in Indian fiscal history. The macroeconomies of the individual states also widely differ. 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

[7] It is estimated that the bulk of the world's poor live in two regions of the world – Sub-Saharan Africa and South Asia. 46 of the 52 countries afflicted by extreme poverty are in these two regions, by 1991 estimates.

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%. To add to that the central government's 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. In contrast to the fiscal situation, over the recent years, the balance of payments remained comfortable, with a substantial improvement over the 1990s, after an initial crisis in 1990-91.

Such casual empiricism is indicative of the importance of the above-mentioned facts in accounting for disparate economic growth across the Indian states. The thesis will pick up these factors in various chapters and investigate their role in perpetuating differential inter-state growth.

1.2.1 Previous empirical work on convergence of growth across India

Numerous Indian studies document the dynamics of the growth patterns across Indian states. The earlier studies include those of Chaudhury (1966), Nair (1971), Majumdar and Kapur (1980) Rao (1985) and Ghuman and Kaur (1993). All of these studies investigate income trends or movements in the ranking of states according to various criteria, independent of any theoretical framework akin to that of recent studies. Though they use different approaches, much of their results suggest divergent patterns of growth across Indian states. More recent studies, working within the theoretical framework developed with the resurgence of new growth theory document divergent growth across the Indian states, with the exception of a few documenting that of convergence. The bulk of the

[8] World Bank 1999

studies using this approach (Bajpai and Sachs 1996, Cashin and Sahay (1996) Nagaraj et al 1998, Rao Shand and Kalirajan 1999) broadly document a divergence. All of these studies make use of an empirical growth relationship derived by Barro and Sala-i-Martin (1992), which describes the relationship between the growth rate, initial income per capita and the convergence coefficient, derived later in Section 1.3.1b.

Bajpai and Sachs (1996) using standard cross section regressions of growth on initial incomes levels over four sub-periods over 1961 to 1993 with a sample of 19 states, obtain convergence in the sixties, with divergence in the seventies, eighties and nineties. Results are not statistically significant over all periods. For the entire period, there is no convergence observed. Results do improve, though marginally, on inclusion of the share of agriculture in total output as a control variable.

Cashin and Sahay examine the 4 sub-periods between 1961 and 1991, with 10 year intervals for a sample of 20 states. They find evidence of convergence in all 4 sub–periods, though all not statistically significant. Introduction of additional variables controlling for the share of agriculture and manufacturing in total output (proxying for differing steady states) that some, but not all of the estimated coefficients become significant. Weak convergence is concluded over the period as a whole.

Rao, Shand and Kalirajan also run similar cross section regressions and obtain the other extreme result of divergence over the period 1965 to 1994 over all four sub-periods. They however use a different data-set and work with a smaller sample of (14) states. Given the extreme results obtained, it is noteworthy that the authors use a different data set as well.

Nagaraj et al (1998) also presents evidence of divergence over 1970 to 1993, and that of conditional convergence, though they do not break up their time period into sub groups. Their study is more informative, and the first which investigates for conditional convergence using a variety of infrastructural variables; they use panel data for their study. A number of infrastructure indicators, eg. percentage of irrigated land, education, percentage of electrified industries, road density, vehicles etc are used to investigate for conditional convergence.

Though these studies are more informative than earlier studies in that they test for convergence within a theoretical framework, (as opposed to earlier studies observing income trends), it will be argued in this thesis, that the methodology of investigation employed in these studies is uninformative to the end that we are dealing with a lesser interesting notion of convergence. Here convergence pertains to convergence to one's own steady state income, to be elaborated in later sections. We will argue in the following section that investigating for convergence on the basis of the statistical significance of the sign of a single coefficient (i.e. the convergence coefficient), which is in effect, a summary statistic, obscures vital information about the income dynamics, particularly in instances of divergence. If we do not obtain convergence, what exactly do we observe? Do we observe polarization or stratification? And what governs the formation of such convergence clubs? The methodology thus adopted in the thesis, the distribution dynamics approach, endeavours to expose and explain such underlying regularities of the income dynamics which are not revealed in standard techniques for testing for convergence.

1.3 Approaches to studying convergence: the theoretical and empirical debate

The literature on the issue of convergence has generated a lively debate – both theoretical and empirical. The theoretical debate has mainly centred around which school of growth best explains the phenomenon of convergence - the classical school which predicts convergence (or conditional convergence) on the basis of the notion that growth is an exogenously driven process, while the endogenous growth models allow for the continuation, or even the widening of existing product differentials. It is, however, the empirical debate which has generated a wider and more provoking literature, particularly so, that pertaining to the empirical approach which is used to test convergence. The popularly known "cross section regression analysis" approach examines the regression of (averaged) growth rates on initial levels of income across economies. More elaborate techniques involve panel data techniques or pooled data regression to avoid loss of information because of averaging. Another aspect of this approach is to observe the cross section of dispersion of income across the economies, where it is expected that as each economy becomes as rich as the rest, the cross section dispersion will narrow over time. As will be argued later, this approach provides insufficient information, which may even prove to be misleading.

Time series analyses have also been used to study issues of convergence which has entailed testing whether inter-regional disparities have neither unit roots or divulging deterministic time trends. Both of the above approaches have been considered as incomplete in testing for convergence. While time series analysis does not utilise the cross sectional information, the evolution of income dispersion, (say in terms of standard deviation), does not tell us anything about the underlying cross-sectional growth dynamics. An invariant standard deviation could be consistent with a number of situations: one, where the positions of the regions remain invariant over time, but another, where there could be exchange of

positions over time. As the following approach described by Quah (1993a, 1996b, 1996c, 1996d) will document, it is this intra–distributional mobility that remains obscured in both of the above approaches which we set out to highlight with the Indian example.

In the following section we will present the extant approaches to studying convergence and highlight their inadequacies in testing for convergence as a process of "catch-up".

1.3.1 Empirical Approaches to Convergence: The Traditional Approaches

Here we will briefly present the different empirical approaches which have used to study and test for convergence and their drawbacks.

1.3.1 Cross Section Regression Analysis :

There have been two measures of convergence which have been discussed in the literature: beta and sigma convergence. Beta convergence is derived as an empirical counterpart of a property of the Solow growth model. Beta convergence estimation involves regressing the average growth rate of income over time for each economy on the initial level of income (and a number of steady state variables). Economies are said to be converging to a "global" steady state when a negative relationship is observed between the growth rate of income per capita and its initial level of income. The results which have been obtained at world level and even the states of India, are interestingly uniform - a negative and significant estimate of the initial level of income co-efficient, with a rate of convergence of about 2 % over different periods and samples.

The other measure of convergence is that of sigma convergence and is estimated together with beta convergence. Sigma convergence takes place if the measure of dispersion of the real income across economies falls over time.

We shall look at both measures of sigma and beta convergence.

1.3.1b Beta convergence:

Beta convergence is a property of the Solow growth model, which has a neoclassical prooduction function with diminshing returns to capital[9]. Population growth, saving and technological production are taken to be exogenous. The following is expounded in greater detail in Barro (1992)

Consider a Cobb-Douglas production function for an economy i

$$Y(t) = k(t)^{\alpha} (A(t)\, L(t))^{1-\alpha}$$

(1)

where, Y is output , K and L are capital and labour inputs and A is the level of technology and $0<\alpha<1$.

Let L and A grow exogenously at the rates of n and g respectively. Hence.

$L(t) = L(0).\, e^{nt}$, and $A(t) = A(0)\, e^{gt}$. Let $y = Y/AL$ and $k = K/AL$.

[9]See, Barro, 1991; Barro and Sala-i-Martin, 1991, 1992; Mankiw, Romer and Weil, 1992;

The investment equation is given by the following:

$$k = sy(t) - (n + g + \delta).k(t) \qquad (2)$$

, where s is the saving rate and δ is the rate of depreciation.

Capital hence converges to steady state by the following equation:

$$k^* = [s/(n + g + \delta)]^{1/(1-\alpha)}. \qquad (3)$$

Substituting the above into the production function and taking the logarithm, we obtain the steady state income per capita expression.

$$\log(Y/L) = a + gt + (1/1-\alpha)\log(s) - (\alpha/1-\alpha)\log(n + g + \delta) + e, \qquad (4)$$

where $\log[A(0)] = a$ and e , s and e are independent.

The steady state equation reveals that the steady state income of an economy is determined by population growth, and saving rate. Therefore different economies can reach different steady states.

The Solow model prediction of convergence can be summarised by the following equation (by approximating equation 4 about y*)

$$y = \beta[\log(y^*) - \log(y(t))] \qquad (5)$$

, here $(n+g+\delta)(1 - \alpha) = \beta$

Solving the differential equation we have the following:

$$(1/T) \log [y(T)/y(0)] = g + [(1 - e^{\beta T})/T] \log (y^*/y(0)) \quad (6)$$

This is the equation for conditional convergence, where the greater the distance of the initial level of income from the steady state income, the higher the speed at which income approaches its steady state level. Beta is called the convergence co-efficient, greater the value of beta, the higher the speed at which income approaches its steady state level. This steady state income differs across economies and in empirical analysis this cross-economy variation is held fixed.

Testing for convergence in this approach involves estimating a discrete time version of the above equation - where the average rate of growth of income over time for each economy is regressed on the initial level of income. The result of a negative and significant co-efficient of the initial income level is interpreted to represent the tendency of economies to move to a common steady state. On running the regression on the initial level of income and on variables which are hypothesised to determine the steady state, one "conditions" the result of convergence - and the negative and significant co-efficient of the initial income level is said to interpret conditional convergence. Here, the conditioning variables (investment, government expenditure, schooling etc) determine the long run growth or the permanent growth component and the initial income level controls the transitory dynamics.

The drawbacks of beta convergence

There have been a number of criticisms proposed against the validity of the convergence test. There have been criticisms concerning the approach itself, while another set of criticisms regarding assumptions underlying the approach.

The foremost opposition has been to highlight the failure of the concept of beta convergence in being able to account for cross regional performance. The cross section regression analysis, and the concept of beta convergence is based on a model for a "representative" economy, yet is used to make inferences about a cross section of economies. The Solow model as described accounts for how a single economy monotonically converges to its own steady state income level, given that it is disturbed from its original level. This is a single country implication and has nothing to do with different regions approaching each other. Quah (1996 a-e) distinguishes the growth and convergence mechanism very clearly - he argues that while the conventional cross section regression approach may reveal the growth mechanism or the productivity performance of an economy, it is essentially uninformative on the convergence issue.

What also renders the result of beta convergence defunct is that it is a summary statistic derived from a model which ignores the possibility of formation of other distributional patterns - for example convergence clubs, polarisation and stratification. Recent theoretical developments have focused on identifying factors which explain patterns of interaction among groups of economies, and have moved away from a representative economy approach. The emergence of new theories of growth which recognise different patterns of income distribution dynamics e.g. polarisation, club convergence, and stratification, have thus rendered traditional methods (of seeking a significant co-efficient of a regressor which supposedly explains the left hand side variable), defunct. Recent theoretical work in growth concerned phenomena like convergence clubs, polarisation and poverty traps have been

discussed, among many others, by Galor and Zeira (1993) Durlauf (1992), Benabou (1996) Estaban and Ray (1994) and Quah (1996b ,1996d).

.

There are also a number of criticisms of the assumptions underlying the cross section regression analysis. One of the most powerful critiques against the empirics of convergence (both absolute and conditional) has been the underlying assumption of a determinstic trend for the permanent component of income for each economy[10]. It can be shown that the average growth rate is simply the slope of the determinstic trend. This is elaborated in the technical appendix (A)

Quah (1993c) has shown that the assumption of a smooth deterministic trend structure can be misleading under stochastic growth. The very existence of a smooth time trend by fitting linear time trends of log per capita income has been invalidated by Quah (1993c) where he fits linear time trends of the income log per capita over different periods of time. It is clearly found that the data does not reveal any signs of a smooth time trend. [11]

Given all these limitations mentioned above, Quah(1993b) also shows that convergence results based on cross section regressions of average growth rates on initial levels of income and conditioning variables can be consistent with diverging income levels. A negative co-efficient of the initial level of income is essentially uninformative and such a result is, in fact, highly compatible with an entire host of economic scenarios of overtaking and cycles, which are far from the phenomenon of convergence. This is highlighted in Quah (1993b) on Galton's Fallacy.

---

[10] This is assumed in order to justify the usual interpretation of these regressions and such that the average growth rate of the income makes sense.

Galton's fallacy concerns two paradoxical observations: One, that taller than average fathers had sons who were not as much above the average as the fathers themselves; the other - the observed population of male heights continuously displayed significant cross section dispersion. Where this applies to the convergence debate is the following: economies which start off with greater than average income (i.e. the tall fathers) can have future incomes which are below their starting off income level. However, this does not imply that there is a gradual decrease in the extent of dispersion. The reverse argument also holds - a rich country (region, economy etc) may eventually end up much poorer (than average) in the future without a significant change (fall) in the extent of cross section dispersion.

Quah (1993b) also reveals that a non-positive initial income co-efficient holds in a situation where the cross-section distribution is time invariant, and can be negative even if there is divergence.

Other lines of criticism have questioned the estimation of the steady state y* from observed variables. It is posited that the growth and accumulation causal cycle is weaker than that suggested by the Solow model - Cohen (1992) opines that the growth and human capital relationship is invalidated when time invariant country specific factors are included in the regression. A number of studies indicate that the causality relationship of investment to growth is very well the reverse (Blomstrom, Lypsey and Zejan (1993)) and it has also been shown that there may be significant short term macro-economic indicators influencing growth, which are not always robust to the changes in the model specification.

---

[11]Even under such assumptions it has been shown that it is still possible to approximate the time trend by a smooth linear trend if significant economic shocks are found to have occurred at the beginning of the sample

Sigma convergence

The extant approach discussed in the previous section also encompasses measuring the extent of dispersion in the cross section incomes over time - any signs of decreasing cross section dispersion is assumed to be a sign of sigma convergence. Cross section dispersion is measured by the sample standard deviation, σ, and sigma convergence takes place as $\sigma_t \leq \sigma_{t-1}$, for all t. Evidence of sigma convergence in conjunction with that of a negative coefficient of the initial income is supposed to be sufficient to substantiate convergence in this approach.

Sigma convergence is a measure intended to account for the dynamics of the cross section distribution. However, cross section standard deviation being a single point-in-time estimate does little to inform us about the distributional dynamics of the cross section distribution. In particular, it is absolutely uninformative about what happens to intra-distribution mobility. The same standard deviation may be compatible with a distribution where the rankings have considerably changed, or one where a unimodal distribution may have evolved to a bi-modal, or stratified distribution, as shown by Quah (1996b,c,e). Quah's studies reveal that the world distribution has evolved from such a uni-modal distribution to that of a bi-modal distribution - where the polarisation tendencies have persisted over the sample period resulting in convergence clubs.

The traditional approach hence fails as a reliable approach as it mainly relies upon two point statistics which provide insufficient insight into the transitional dynamics.

---

time period.

1.3.2 Time Series Methods

In contrast to the cross section notion of convergence, the existence of random but potentially permanent shocks to per capita income have led researchers to formulate a time series notion notion of convergence. If an economy's log per-capita income possesses a unit root, stochastic convergence is defined as cointegration between two or more such series (Campbell and Mankiw (1989) and Bernaud and Durlauf (1991). Another definition postulates that the log of per capita income of one region relative to that of the economy as a whole is stationary (Carolino and Mills, 1993).[12] Time series evidence suggests that convergence does not hold. While Quah (1990) reveals that there is little evidence of cross-country stochastic convergence among a large set of capitalist economies, Campbell and Mankiw (1989) and Bernaud and Durlauf (1991) have similar story to tell about for OECD economies.

While the time series notion does incorporate what was lacking in the cross section approach, in large cross sections it fails to tell us anything about the dynamics and transition characteristics. The univariate dynamics do not suffice as a study of convergence of economies. What we are interested in is the relative behaviour and cross section mobility or transitional properties which matter the most in analysing convergence.

1.3.3 Panel data techniques

Panel data techniques have also been used to incorporate the time dimension into the cross- section regression analysis. This, however, still remains to inform us about the intra-

[12]Bernaud and Durlauf (1996) have a useful discussion of the relationships between the time series and cross-section notions of convergence.

distribution mobility and also results in inconsistent estimators (Pesaran and Smith 1995 and Canova and Marcet 1995). Panel data techniques apply to data with extensive cross section and time series variation, but they are specific for a particular class of economic problems (Chamberlain 1984). Like ordinary cross section regression, the panel data techniques again only capture the representative economy dynamics and fail to inform us about how the distribution itself evolves over time. Individual-effects panel data methods had been developed to take into account the inconsistency in estimation in regression co-efficients when unobserved heterogeneity is correlated with regressors - they were not designed to naturally provide a picture of how an entire distribution evolves. Existing regression methods average across the entire distribution thus giving us information only on the representative economy.

1.4 What are Distribution Dynamics?

Apart from the studies based on the approaches described above, there has developed a new body of empirical literature which differs from the standard empirical studies in how they conceptualise convergence. They do not follow the standard empirical techniques and recognise that adopting a notion of convergence as a process of homogenisation. The new body of literature suggests that testing for convergence should entail characterising the behaviour of a broad cross section of economies over a long period of time. Thus the traditional approach of testing for convergence is parsimonious and rendered defunct, as this approach does not inform the researcher of other distributional patterns other than convergence, like polarisation and stratification. The recent cross-country empirics by Quah (1993a, 1996b, 1996c, 1996d), Desgoigts 1996, Bianchi 1997 and many based on the methodology adopted by Quah, namely, Larch 1994, Lamo 1996, Nevene and Gouyette

1994, only to name a few, are based on this approach. These studies not only detect tendencies of convergence (or not, as is the case for all), but also identify other distributional patterns of income.

The method of distribution dynamics as a methodology to study convergence, as in Quah (1993a, 1996b,c,e, 1997a,b,c) goes beyond point estimates of dispersion and unit root analyses to highlight two vital aspects of how a distribution evolves over time – intra-distributional mobility (mixing/churning) and the long run prospects of the distribution (ergodicity). It is thus a method by which we can analyse the transitional dynamics of large cross sections of data. This approach encompasses both cross section and time series properties of data simultaneously and presents itself as an ideal approach for large data sets[13]. This approach has revealed empirical regularities such as convergence clubs, polarisation, or stratification – of cross economy interaction that endogenously generates groups of economies; of countries catching up with one another but only within sub-groups (Bernaud and Durlauf 1996, Bianchi 1997, Quah 1997a). Markov chains are used to approximate and estimate the laws of motion of the evolving distribution. The intra-distribution dynamics information is encoded in a transition probability matrix, and the ergodic (or long run) distribution associated with this matrix describes the long term behaviour of the income distribution. Another mathematical model which is used to highlight the transition dynamics is the stochastic kernel - the continuous version of the transition probability matrix. The details of the methodology will be further elaborated in Chapter 2.

[13] Independent of macroeconomic analyses of aggregate growth, the study of distributions and their dynamics has long been a central part of economic analysis, and not just of personal income. Galor and Zeira (1993) explicitly concern personal income distributions. Estaban and Ray (1994), on the other hand, intend their analysis to apply both to people and to entire economies. Others include applications to various other

1.4.1 Explaining existing disparities, or the lack of convergence

How does one investigate for causes underpinning the lack of convergence? A natural extension of the methodology of cross section regression analysis has been to explain the lack of convergence by absorbing heterogeneity using panel data techniques into "individual effects". However such regression methods average across the cross section and thus can only give a picture of the behaviour of the conditional mean, not of the whole distribution. Sweeping out the individual heterogeneities results in leaving unexplained differences across individual countries.

Recent theories in explaining lack of convergence have focused on identifying factors which explain different patterns of economic interaction. They recognise different patterns of income distribution dynamics e.g. polarisation and stratification. Methodologically, the empirical investigations of Quah (1996d, 1997a,c) come closest to the distribution dynamics spirit of the current discussion. Quah (1996d) presents a model where he describes how membership in clubs might be determined endogenously through economic considerations. What determines club membership may be spatial distance, separation in the levels of development, one's trading partners or the sophistication of technological practice (Ben David 1994; Quah 1997a,c). Quah(1997a) proposes a scheme for conditioning whereby one can test for the effects of a number of factors governing club formation. It is this empirical technique which we will implement to identify explanatory factors of the observed income distribution dynamics.

---

economic categories (Atkinson 1995; Cowell, Jenkins, and Litchfield 1996; Loury 1981 Schluter, 1997; Singer and Spilerman, 1976 and Sutton, 1995, among others)

1.4.2 Conditioning, in distribution dynamics

Quah (1997a,c) proposes a simple conditioning methodology where explaining distribution dynamics is conceptually the same as analysing the effects of conditioning under standard panel or cross section regression techniques. Conventional methods of regression analysis, in asking if a factor X explains variable Y entails examining whether E(Y) and E (Y|X) are different, where X is an auxilliary variable. Quah opines that our interest lies far beyond that of comparing their respective expectations - our line of inquiry is to see whether their respective distributions, Y and Y|X are the same, and more importantly, how Y has been transformed into Y|X. How one distribution Y transforms into another Y|X, can be described by an operator mapping one distribution to another. The operator[14] used is the same as that is used to compare distributions across time for our earlier investigations for distribution dynamics across time. Where such a mapping proves particularly useful is that it is possible to observe the explanatory power of an auxiliary factor at specific points of the distribution. Chapters 3 and 4 illustrate the use of a number of auxilliary factors to identify their role in explaining the observed distribution dynamics at various levels of the distribution. For example, infrastructure explains the lack of convergence for the lower income group states, but not so for higher income group states.

1.5 Conclusion

In this chapter we have laid down the main question of investigation and motivation behind this study. A critique of the Indian empirical literature on convergence and that of methodologies for studying convergence have been presented. The theoretical basis to the

[14] The operators used are the stochastic kernel and transition probability matrices.

project, and the new methodology adopted in this thesis, the distribution dynamics approach, has been presented and briefly described.

Appendix:

Codes to the States:

1. Andhra Pradesh (AP)
2. Assam (AS)
3. Bihar (BH)
4. Gujarat (GU)
5. Haryana (HY)
6. Himachal Pradesh
7. Jammu and Kashmir (JK)
8. Karnataka (KT)
9. Kerala (KE)
10. Madhya Pradesh(MP)
11. Maharashtra (MH)
12. Manipur
13. Orissa (OR)
14. Punjab (PN)
15. Rajasthan (RJ)
16. Sikkim
17. Tamil Nadu (TN)
18. Tripura
19. Uttar Pradesh (UP)
20. West Bengal (WB)
21. Arunachal Pradesh
22. Delhi
23. Goa, Daman and Diu
24. Pondicherry

Technical Appendix

(A)

Here we will show that the average growth rate of income is simply the slope of the determinstic trend.

Let each economy's (log) income be $Y_j(t)$, j = 1, 2, ... J , t = 0,....T)

The income can be divided into a permanent and a transitory component, as follows:

$$Y_j(t) = X_{j1}(t) + X_{j0}(t) \text{ , } j = 1,2,...J \text{ , } t = 0,....T. \quad (1)$$

Here, $X_{j1}(t)$ is the permanent component, ie.e the time trend , where $X_{1j}(t) = \alpha_j + \lambda_j(t)$, α and λ are independent of t.

$X_{j0}(t)$ is the transitory component, and $E [X_{j0}(t)]= 0$.

Adding, we have,

$$Y_j(t) = \alpha_j + \lambda_j(t) + X_{j0}(t) \quad (2)$$

$$\Delta Y_j(t) = \lambda_j + \Delta X_{j(0)}t = 0. \quad (3)$$

Given that $EX_{j0}(t) = 0$, we can say that $E \Delta Y_j(t) = E\Delta X_{j1}= \lambda_j$. Hence the growth rate of the economy is the same as that of the permanent component.

Table 1

Growth rates (per cent) of the Fourteen Largest Indian States

States	Growth rate (per cent)			
	1960-1 1970-1	1970-1 1980-1	1980-1 1990-1	1991-2 1996-7
High Income States	**1.8**	**1.6**	**3.2**	**3.9**
Punjab	4.4[a]	2.5	3.3	3.1
Maharashtra	0.5	2.0	3.7	4.4
Haryana	6.4	1.7	3.9	3.2
Gujarat	1.9	0.7	3.3	4.2
West Bengal	-0.1	1.0	2.1	3.2
Middle Income States	**0.9**	**0.8**	**3.0**	**3.2**
Karnataka	2.0	0.6	3.1	3.6
Kerala	1.5	0.8	2.2	3.0
Tamil Nadu	0.4	0.6	4.1	4.3
Andhra Pradesh	1.0	1.0	2.6	2.9
Madhya Pradesh	-0.5	0.8	2.6	2.4
Low Income States	**1.2**	**0.3**	**2.8**	**2.1**
Uttar Pradesh	0.7	0.9	2.6	2.2
Orissa	2.1	1.1	0.9	1.6
Rajasthan	2.2	-1.4	4.7	4.3
Bihar	0.5	0.7	2.6	1.0
Average of 14 states	**1.6**	**0.9**	**3.2**	**3.3**

Source: Author's calculation, years 1960-70 and 1970-80 were calculated using Ozler (1998) and 1980-90 and 1991-96 using World Bank (2000)
A: the figure is for 1965-70

Table 2

India and High Growth East Asia: A Comparison

	GDP per capita PPP $, 1997	Growth per annum, 1970 - 1997	Literacy Rates[b] 1970	1997
India	**1510**	**4.7**	**33.6 (18.1)**	**62.6 (50.0)**
China	3120	10.5[a]	51.7 (35.8)	82.9 (74.5)
Indonesia	3490	6.9	56.3 (44.0)	85.0 (79.5)
Korea	13,580	8.4	86.6 (79.8)	97.2 (95.5)
Malaysia	8190	7.3	58.3 (46.1)	85.6 (81.0)
Thailand	6690	7.5	80.0 (72.7)	94.7 (92.8)

a Data pertains to 1978-97

b Figures in brackets are female literacy rates.

Source: IMF, International Financial Statistics, World Bank, World Development Indicators.

Table 3

India and Sub-Saharan Africa: Some Selected Comparisons (1991)

Adult Literacy Rate Comparisons

Region	Population (millions)	Adult Literacy Rate (female/male)
India	**846.3**	**39/64**
Rajasthan	44.0	20/55
Bihar	86.4	23/52
Uttar Pradesh	139.1	25/56
Barmer (Rajasthan)	**1.4**	**8/37**
Kishanganj (Bihar)	1.0	10/33
Bahraich (UP)	2.8	11/36
Sub-Saharan Africa	**488.9**	**40/63**
Burkina Faso	9.2	10/31
Sierra Leone	4.3	12/35
Benin	4.8	17/35

Source: J.Dreze and A. Sen, India: Economic Development and Social Opportunity (Delhi: OUP, 1995), Table 3.1

Table 4

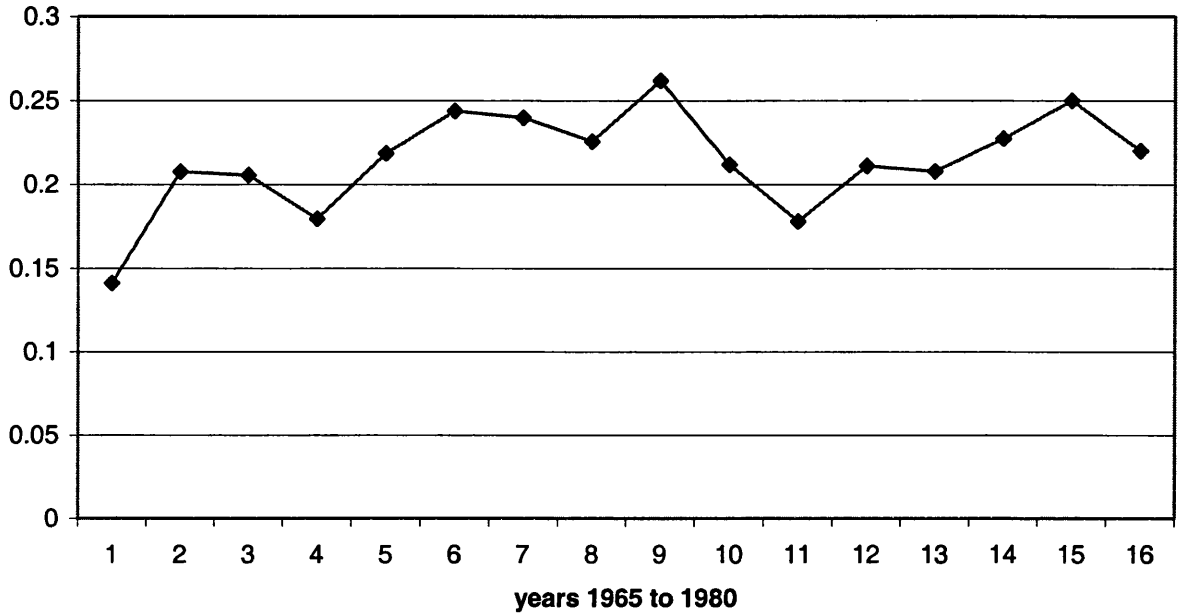
India and Sub-Saharan Africa: Some Selected Comparisons (1991)

Infant Mortality Rate Comparisons

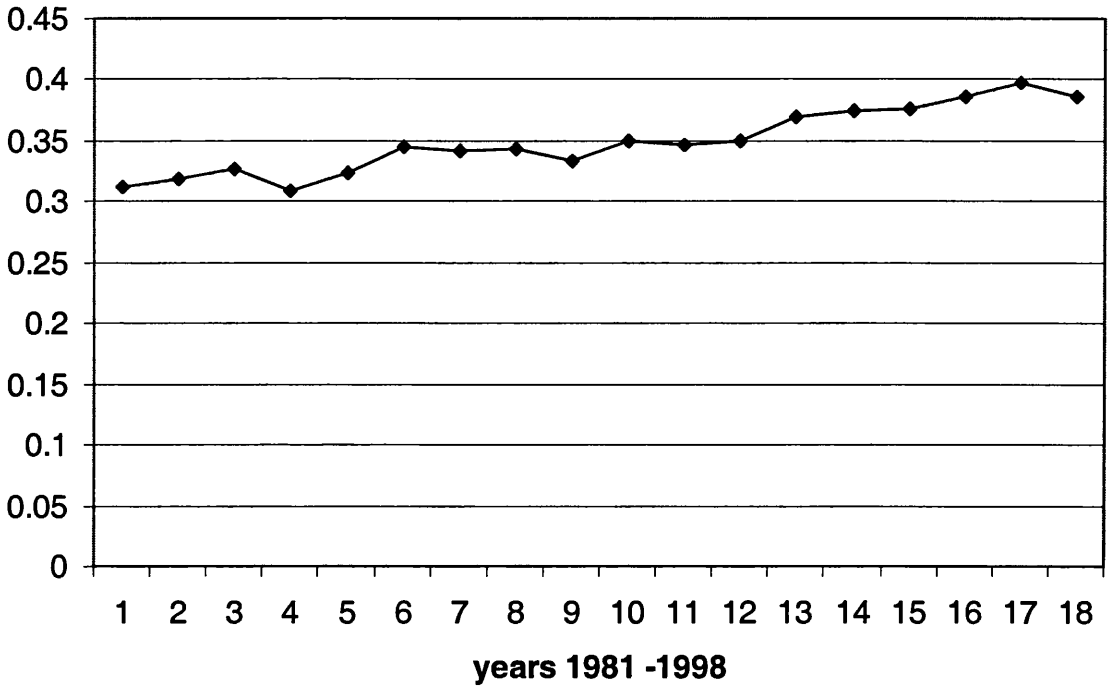
Region	Population (millions)	Infant Mortality Rate (per 1,000 live births)
India	**846.3**	**80**
Orissa	31.7	124
Madhya Pradesh	66.2	117
Uttar Pradesh	139.1	97
Ganjam (Orissa)	3.2	164
Tikamgarh (Madhya Pradesh)	0.9	152
Hardoi (UP)	2.7	129
Sub-Saharan Africa	**488.9**	**104**
Mali	8.7	161
Mozambique	16.1	149
Guinea-Bissau	1.0	148

Source: J.Dreze and A. Sen, India: Economic Development and Social Opportunity (Delhi: OUP, 1995), Table 3.1

Fig 1. Sigma Convergence 1965-80



Sigma Convergence 1981-98



Chapter 2

Regional Distribution Dynamics of GDPs across Indian states – 1965-1997

2.1 Introduction

This chapter documents the dynamics of growth and convergence of incomes (real per capita) across Indian states over the period 1965-1997. The framework we will be using addresses a number of specific goals: first, we are interested in the dynamics of equality across incomes across Indian states. That is, we will investigate for any tendency of equality in the cross section income distribution across the Indian states? If not, what distributional pattern do they exhibit?

Our second goal is to characterise possibilities for inter-regional mobility - if cohesive[15] tendencies were not to obtain, are there any signs of poorer regions overtaking the rich in the future? Are there any signs of initially rich economies falling behind? Such stylised facts enable characterising the presence of other distributional patterns, e.g. convergence clubs or stratification, which in turn are important to identify the economic forces governing their formation and their persistence.

The objectives of this chapter as outlined above, are different from those present in the extant empirical cross-country, or Indian literature – thus, have necessitated going beyond extant techniques of cross section regression or time series econometrics. Standard (i.e. beta convergence) regression analysis only considers average or representative behaviour, and says nothing about what happens to the entire distribution (Barro and Sala-i-Martin, 1992, and Bajpai and Sachs, 1996, Cashin and Sahay, 1996, Nagaraj et al., 1998, for the Indian case). Neither are both beta and sigma convergence analyses able to inform the researcher of any prospects of inter-regional mobility. More so, they are unable to uncover the long run aspects of the evolving distributional pattern. Such is also the case with time series applications to regional analyses (Carlino and Mills 1995).

How does this study improve on extant approaches? In this study we examine inter-state income inequalities in terms of the behaviour of the *entire cross section distribution.* The intention is to observe the evolution of the entire income distribution over time and describe a law of motion of the cross section distribution. If the cross section distribution collapses, or exhibits tendencies of collapsing, to a point mass, one concludes of tendencies towards convergence. On the other hand, tendencies towards limits which have other properties – normality or twin peakedness, or a continual spreading apart – reveal income dynamics which were hitherto obscured under standard techniques of cross section regression or time series approaches of investigating for convergence. The distribution dynamics approach, thus, is distinctly different from other approaches, in that characterises instances of

[15] By cohesion, we simply mean the tendency towards equality of incomes across the States.

intra-distributional mobility - it exposes instances of economies overtaking, or falling behind. As we will later detail in the following chapters, this model will also allow the researcher to study not just the likelihood, but also the potential causes, of poorer economies becoming richer than those currently rich, and that of the rich regressing to become relatively poor[16].

Starting with the basics, this paper uncovers the relevant stylised facts of Indian inter-state income distribution over the period 1965-98. Our main finding is that while cohesive tendencies were observed in the late sixties, these were considerably weakened over the following years with increasing diverging tendencies. Strong tendencies are found of the existence of two income clubs, particularly over the later years (1970s to 1990s).

The rest of the paper is organised as follows. In Section 2 we will introduce the new methodology to be used in this thesis. Section 3 presents preliminary results of the analysis on Indian state level data over the period 1965-98. Section 4 develops further dynamics and Section 5 concludes.

2.2 Distribution Dynamics

The approach of distribution dynamics stems from recent empirical research on patterns of cross-country growth. The focus of research in the new empirical growth literature no longer concerns understanding the behaviour of per capita income or per worker output of a single representative economy but asks questions

[16] The econometric methodology used in this paper is that conceived by Quah (1990-1997).Details of the methodology are elaborated later in the paper.

like, why do some countries grow faster than others. From the perspective of economic growth empirics, the work described in this thesis relates to this research using convergence predictions to distinguish endogenous and neoclassical growth. This new empirical literature is large and helpfully summarised in Barro and Sala-i-Martin 1992, Durlauf and Quah 1996.

What each of the existing techniques of (cross section regression and time series approaches) investigating for convergence fail to inform the researcher is about the *intra-distributional dynamics* of the income distribution and hence, of any other distributional pattern other than convergence. The focus of the new empirics of economic growth research has shifted to understanding the growth dynamics of groups of entire macroeconomies - to understand the patterns of interaction between countries or regions. Such dynamics of cross section income distributions are not revealed by either cross section regression or time series approaches. Convergence regression and sigma convergence cannot reveal the relevant intra-distributional dynamics which would lend insights into any inter-regional patterns of economic interaction. Likewise, time series analyses also fail to shed any light on the cross sectional characteristics of the distribution. These goals have necessitated going beyond the extant technical tools of studying convergence.

In view of the drawbacks presented above, the approach[17] of distribution dynamics to characterising convergence moves away from a singular treatment of cross section regression or a time series approach. The main motivation

[17] See Quah (1996a, b-1997a, b, c). Similar studies which have focused on the behaviour and evolution of the entire distribution have been of Bianchi(1997) where he uses bootstrap estimates to detect multimodality and that of Bernaud and Durlauf(1995), where they identify "multiple regimes" across the economies.

behind this approach is to expose other distributional patterns of income, if convergence were not to obtain. This involves tracking the evolution of the entire income distribution itself over time. Markov chains are used to approximate and estimate the laws of motion of the evolving distribution. 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. Such an approach has revealed empirical regularities such as convergence clubs, or polarisation, or stratification – of cross economy interaction that endogenously generates groups of economies; of countries catching up with one another but only within sub-groups (Bernaud and Durlauf 1996, Bianchi 1997, Quah 1997a).

2.2.1 Random Fields and the Random Element

The distribution dynamics approach is based on treating a single income distribution as a *random element* in a field of income distributions. Figure 1 presents the entire distribution of State income (relative per capita) in India for the period 1965-88. Such structures where both time series and cross section dimensions are large and of equal magnitude are called *random fields* in probability theory. At each point in time, the income distribution is a *random element* in the space of distributions. This approach involves estimating the density function of the income distribution at each point in time and then observing how it evolves over time. These dynamics account for the change in the shape of the distribution and for intra-distributional dynamics which are

notable characteristics of convergence. Another aspect we will be interested in is the dynamics of each state's relative position.

There are two approaches to density estimation, parametric and non-parametric. The former assumes the data to be drawn on one of the known parametric distributions. The task is then to estimate the underlying distribution by estimating the parameters from the data. The non-parametric approach is based on weaker assumptions and does not "fit" a known distribution onto the data – the data itself determines the estimator of the density function. In our analysis, we shall non-parametrically estimate a density function of the given data set as it does not impose a known structure on the distribution, allowing us to detect structures different from parametric forms. Nor does it impose any assumptions about the moments of the density function from which the data are drawn.

There are a number of different methods of non-parametric estimation, of which an excellent account is obtained in Silverman (1986). To study the distribution dynamics of the Indian income distribution, we shall be using transition probability matrices and stochastic kernels to estimate the density function and observe its evolution.

2.2.2 Models of Intra-distribution Churning/ Mixing

The two main models which highlight the distribution dynamics of an income distribution are stochastic kernels and transition probability matrices. Here the

cross section income distribution is seen as a realisation of a random element in the space of distributions. Of the two models, the transition probability matrix is the discrete version, while the stochastic kernel is the continuous version. We present the underlying formal structure of these models as a law of motion of the cross section distribution of income in the technical appendix.

Both stochastic kernels and transition matrices provide an estimate of intra-distributional mobility taking place. In both cases, it is assumed that an economy (in our case, a 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. Such a change in position of an economy in the income distribution is called a transition. Our task is to observe how many such transitions take place in the given time period.

First, what needs to be identified is the position of the economy in the income distribution in the starting period. This is done by dividing the income distribution into "income states". Income states are a range of income levels, say between a fifth and a half of the weighted average of the country. Then we observe how many of the economies which are in an income state say, (0.2, 0.5) in the initial period land up in that very state, or elsewhere. If they do end up in another income state, (for example, in the income range of a half to three quarters of the weighted average income) there is said to mobility. If they end up in the same, there is persistence. We will be interested in the former possibility i.e. of intra-distributional mobility.

In our exercise on India, we have measured these transitions and the results are tabulated in Tables 1 and 2 as *transition probability matrices.* Interpreting the transition matrix is as follows: first, we discretise the space of possible values of income, in r states. For instance, we define the state i = (0.2, 0.5) as one which has regions with an income which lying between 0.2 and 0.5 times the average income of the country. The probabilities obtained, give us the percentages of economies (in our case, Indian states) which given a starting state, have moved on to a different state. So, our row probabilities all add up to 1. Of these, the diagonal of the transition probability matrix is of interest to us. A diagonal with high values indicates higher probabilities of persistence - the likelihood of remaining in a particular state when one starts there. Thus, the smaller the diagonal, the greater intra-distributional mobility there exists.

The transition probability matrix also allows us to take a long run view of the evolution of the income distribution. This is tabulated in the row called the "Ergodic Distribution"

There is, however, a drawback in this measure as the selection of income states is arbitrary - different sets of discretisations may lead to different results. The *stochastic kernel* improves on the transition probability matrix by replacing the discrete income states by a continuum of states. This means that we no longer have a grid of fixed income states, like (0.2 0.5), (0.5 0.75) etc. but allow the states to be all possible intervals of income. This removes the arbitrariness in the discretisation of the states. We now have an infinite number of rows and columns replacing the transition probability matrix. In our exercise on Indian states, such stochastic kernels are presented in Figures 5a*i* –h*i*.

Interpreting the stochastic kernels is as follows. Any slice running parallel to the horizontal axis (i.e. t + k axis) describes a probability density function which describes the transitions from one part of the income distribution to another over k periods. The location of the probability mass will provide us information about the distribution dynamics, and thus about any tendencies of convergence. Concentration of the probability mass along the positive slope indicates persistence in the economies' relative position and therefore low mobility. The opposite, i.e. concentration along the negative slope, would imply overtaking of the economies in their rankings. Concentration of the probability mass parallel to the t + k axis indicates that the probability of being in any state at period t + k is independent of their position in period t – i.e. evidence for low persistence. Finally, convergence is indicated when the probability mass runs parallel to the t axis.

2.3 What has been happening to the inter-state income distribution in India?

2.3.1 A Preliminary Look.

Let us now take a look at the inter-state income distribution of India over the period 1965-1998. The data which has been used for this analysis has been obtained from the World Bank web-site http//www.worldbank.org, compiled by Dutt, Özler, and Ravallion(1996). GDP data for 1989 to 1998 has also been obtained from the World Bank, from a separate dataset, but from same government of India sources. The income

variable we shall be working with in this paper is that of real GDP per capita for each individual state.

Fig.2[18] tracks the real GDP per capita (relative to the all India average) of each Indian state over different time periods. Each of these diagrams emphasise the physical spatial dimension, by plotting each states' income on its physical grid, for each of the years - 1965, 1970, 1980, and 1988. The base of each diagram is formed of the latitude and longitude measurements. The vertical axis graphs per capita GDP (real and relative to the Indian average).

These pictures give us a first hand idea of the dynamic spatial patterns of regional growth across Indian states. Fig.2 reveals the persistent dominance of Punjab and Haryana in the north west, Gujarat and Maharashtra in the west. Punjab already had a per capita income of 270 (in 1990 dollars) in 1965, which increased to 370, increasing by a factor of 34% by 1988, and by another 19% by 1997. Gujarat's and Maharashtra's per capita income had increased from 183 and 196 (in 1990 dollars) to 233 and 303 by a factor of 20% and 27 %, respectively. By comparison, the Indian average per capita GDP (in 1990 dollars) was 153 in 1965 and 195 in 1988 (increasing by 27 %). Hence, Punjab was already almost twice as rich as the Indian average in 1965 and remained so at the end of the period. Maharashtra, Gujarat and Haryana's income per capita have also maintained a per capita of almost twice the Indian average all throughout the period. Averaging, states of Punjab, Haryana, Gujarat,

[18] All graphs and calculations were done using Danny Quah's econometric shell *tSrF*

Maharashtra were at 123%, in 1965 and over 152%, in 1988 of the Indian average[19].

The poorest regions are also evident - Bihar, Orissa in the east, Rajasthan in the west, and Uttar Pradesh in the north have consistently been lying around the lowest per capita GDPs. Bihar, Orissa and Uttar Pradesh and Rajasthan have been at 85% in 1965 and 80% in 1988 of the Indian average. Bihar and Orissa had per capita GDPs of 122 and 121 in 1965 and 122 and 145 in 1988 (in 1990 dollars). Thus over the entire period of study, the income of the richer states has been almost three times that of the poor. Interestingly, while the growth rates of Madhya Pradesh, Assam, Andhra Pradesh, Uttar Pradesh, Orissa, and Bihar, the six poorest states, were all significantly below the national growth rate, they account for more than half of the Indian population.

However, not all that were rich remained rich, and those poor remained poor. West Bengal, notably, with a GDP per capita of 196 in 1965 and 205 (in 1990 dollars) in 1988 fell steeply in its ranking from second to eighth by 1988. Thus, West Bengal teamed with Punjab, Haryana and Maharashtra in the 1960s, but experienced dismal growth over the following years. Again, while the surge of growth in the 1980s benefited the four richest states, it also pushed up Karnataka and Tamil Nadu, whose 1988 per capita income had increased by 21% and 36% over 1980-88.

[19]Author's own calculation. Estimates for following years, i.e. 1989-97 could not be provided in comparison to earlier data as the two data sets for over 1965-88 (Ozler 1988 and World Bank 2000) are found to be incompatible. The stochastic kernels calculated over later years (1989-96) estimated use the second data set.

Summarising - these diagrams reveal information on the dynamic spatial patterns of regional growth in the Indian states. It reveals both persistence and mobility. Some of rich states have remained rich (the richest, Punjab, has retained the highest position all throughout) while a number of poor states have remained poor - Bihar, Uttar Pradesh and Orissa have consistently been the worst performers. There are also high performers who have declined in their performance over the period – West Bengal, others who were poor have picked up over the period, for example, Karnataka. Thus, apart from those consistent performers, there is plenty of evidence of relative successes and failures all across India. Such relative successes and failures are interesting as they have important dynamic dimensions. But, what is more than apparent is that there exists a group of high income states and a group of low income states - there are indications of polarisation of the income distribution.

Looking at the same details, one also observes, over 1965 to 1988 the standard deviation (SD) of per capita income has increased by 192%, while the interquartile range (IQR) has increased by 137%. A significant increase in spread manifests clearly. However, the difference in the extent of increase of the standard deviation and the inter-quartile range has an interesting implication. With an increase in the SD almost double that of the increase in IQR, one can say that much of the spread has been due to some high performers out-performing the rest of the intermediate states (and some low performers remaining relatively stagnant). Cases of Punjab, Haryana and Maharashtra as high performers and Bihar and Orissa as low performers seem to fit into this story. Punjab's and Haryana have had their growth rates almost double over this period, while Bihar and Orissa's growth can be considered as

imperceptible. Here, once again, one could take such dynamics as evidence of polarising tendencies.

A useful way of interpreting the dynamic behaviour of the interquartile range and the standard deviation are Tukey boxplots[20]. In Figures 3a and 3b, each boxplot represents the income distribution of a single year - starting at the top quartile (i.e. 3rd quartile) and ending at the first, with the height representing the inter-quartile range. The middle 50% of the distribution thus lies in the box. The horizontal bar in the box is the median of the income distribution and thus provides us with a measure of location. If the median is located in the middle of the box, the distribution is symmetrical, otherwise skewed. Other observations lying outside the interquartile range lie on the thin lines extending from the boxes on either sides, the two ends known as the upper and lower adjacent values - if the inter-quartile range is r, then the upper adjacent value is the largest income value observed that is no larger than the 3rd quartile plus 1.5 x r, while the lower value is the lowest income observed no smaller than the 1st quartile. Observations which lie beyond this range are located as isolated points outside the thin lines.

Figs.3a and 3b show that though the Indian relative income distribution has fluctuated about its central value, with a particular deterioration in the early seventies, there does not appear to be a great change in the inter-quartile spread, except for 1970, when there was significant spreading out in the middle. Also, what is noticeable in later years is the appearance of upper

[20]The Tukey Box-plot has been extensively used in Quah (1997b) to study income distribution dynamics

outside values, beyond the upper adjacent value. The median of the 1985 distribution lies lower than that in 1965, and skewed towards the bottom tail of the distribution. With little change in the inter-quartile range, the growth in standard deviation thus accounts for most of the spreading taking place in the tails, particularly the upper, as is observed in the box-plots. For the following years, we find the distribution spreading still – this time, the IQR has lengthened too, between years of 1990 and 1997. Thus, the third quartile has pushed further up, and the lower quartile further below, implying a further spreading out of the income distribution.

Thus, our initial look at the income distribution across the Indian States, so far, suggests that the mean and the standard deviation are insufficient in describing the behaviour of the distribution. A preliminary analysis not only reveals that income inequality has increased, but there appears to be some polarising tendencies.

2.3.2 Intra-distributional dynamics

So far we have discussed "snap-shots" of how the income distribution has evolved over time. We will now consider the intra-distribution dynamics. Cross profile graphs are an informative way of looking at our data before any modelling - they describe when economies overtake, fall behind or pull ahead. These graphs rank the regions (in our case, states) according to their relative income per capita in the first year of the sample (1965) and describe how this ranking evolves over time. Figures 4a and b describe the evolution of the rankings of the Indian states over different years: each line refers to a single

year and describes the relative income of the states ordered according to the initial ranking. The larger the income inequality, the steeper they are. Any intra-distributional change in the ranking is manifested as an increase in the choppiness, or the jaggedness of the lines. Such choppiness is referred to as intra-distributional "mixing" or "churning"(Quah, 1997a, b, c) Such "churning" reveals intra-distributional aspects which remain totally obscured when one deals with only the first and second moments.

Fig. 4a presents the cross profiles plots of the Indian (inter-State relative per capita) income distribution over periods 1965, 1975, 1985. What is immediately apparent is the change in choppiness through time in the cross profile plots. We note that the 1965 line is evidently monotonically increasing; it is steeper for the richer states. The following lines are, however, slightly flatter, with the 1985 line looking slightly more steeper than 1975. The increasing choppiness indicates high mobility with regard to the changes in the states' relative positions - the number of peaks in each line indicates that. Not much seems to have changed between 1975 and 1985. This is still so for between 1985 and 1995. Inequality thus appears to be highly persistent between periods 1975-1985 and even more between 1985-1995. Fig 4b. also reveals similar dynamics, over years 1988, 1990, 1995 and 1997. The lines, however, are clearly less choppy than those observed in figure 4a. Intra-distributional mobility appears to be less evident in the 1990s.

The cross-profile plots, hence, reveal characteristics of the intra-distributional mobility, otherwise obscured in traditional approaches. They have given us a first-hand look at the importance of the intra-distributional characteristics and

the dynamic behaviour of the distribution. We are yet, though, not in a position to show any deep underlying regularities of the data. For that we turn to more formal structures to identify signs of intra-distributional mobility.

2.4. Further Dynamics

Looking at such random elements is intuitive and informative for a first hand insight into the dynamics of the distribution. We will now turn to the other two representations of intra-distribution churning - stochastic kernels and transition probability matrices. Modelling the distributions dynamics, both in continuous (stochastic kernels) and discrete (transition probability matrix) versions, lends a detailed insight into the evolution of the income distribution across the Indian states. Figures 5 a-h represent the non-parametric stochastic kernels and their contour plots for relative per capita income of k-year transitions (k = 1, 5).

Figures of 5a.i and 5a.ii over the period 1965-1988 reveal a probability mass running off the positive diagonal, almost parallel to the t-axis with two sharp peaks - this implies that the Indian states have shown a strong tendency of changing their relative position in one year. The peaks at the "head" and the "tail" of the mass suggests tendencies of the low and middle income economies income states experiencing mobility over the period. The contour of the above in Figure 5a.ii reveals these tendencies more clearly - the peaks pertain to two groups of states; one changing positions from less than 50% of the all India average to around 75% of the all India average, while another group at nearly

125% of the all India average to about the average all India level. The contour also reveals the formation of some middle income group States, some of which have remained in their same positions, and some which have improved their relative position.

To obtain a detailed look of the intervening years, we divide the sample period into three sub-sample periods - 1965-70, 1971-80, 1981-88, and 1989-97. The first period was one which reaped the benefits of the successful implementation of the first two Five Year Plans and an agricultural boom, which led to a hike in the overall growth rate. However, to add to the onslaught of a number of droughts (1966-7), the oil shock in the early seventies and following balance of payments problems, the 1970s was plagued by what is commonly termed as the "industrial stagnation phase". This led to a severe set back in economic growth all through the seventies. The early eighties, however, brought an end to that phase and thereafter the Indian growth rate gradually was on the pick up.

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. Over the periods 1965-70, 1971-80, 1981-88 and 1989-97 we observe in Fig. 5c-f 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 contours in Figures 5c.ii., 5d.ii, 5e.ii and 5f.ii reveal 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. Thus, though an overall view of the entire sample period 1965-97 shows some signs

of cohesion, the sub-sample periods, particularly during the later years, have shown the cohesive forces substantially dissipating in influence. The result has been more of that of the rich states forging ahead, with the poor making little progress and a dispersing middle income group.

The longer horizons, over 5 year transitions reinforce these conclusions, in Figures 5f - h, reveal the probability mass running on, or very close to, the positive diagonal, with the distinctive peaks at both ends. However, as the contours in Figures 5f.ii, 5g.ii, 5h.ii are relatively less condensed (though slight), there is some tendency of intra-distributional mobility. The contour for 1965-70 reveals two distinct clusters of states at around 50% of the all India average and another at around 130% of the average. Persistence seems to be stronger at the low income cluster. What appears interesting in this plot is the clear emergence of another middle-income cluster at around the all India average. This disappears in the following plot for 1970-81, where the probability mass is roughly along the main diagonal. Still along the diagonal, the probability mass in the 1981-88 plot reveals the same income clusters, less concentrated and relatively dispersed, showing the early signs of the formation of a middle income group. The overall view holds - persistence of two distinct groups of low and high income groups and a dissipating middle income group. Results for the period 1989-97 reveals more persistence still.

The long run view of whether the economies will converge over the long run is addressed by calculating the transition probability matrices. The results are tabulated in the appendix (Tables 1 and 2). Interpretation of the tables is as follows. Each of the defined states for each table is different, such that each

distribution is uniform at the beginning year of the sample. The first column of the table accounts for the number of transitions over the time period beginning at each state. The following columns present the calculated probabilities of transition from one specified state to another. Like the stochastic kernel, a "heavy" main diagonal is bad news - i.e. indicating persistence.

Table 1 reports results quite similar to those obtained for the stochastic kernel - the values in the main diagonal are around 50%, which indicates that the probability that an economy remains in its own income state is around 50%. The off-diagonal values are those which are indicative of mobility, albeit little. Mobility is evident and obvious for the above average income group. The states with incomes in the first two states reveal some low income states which have forged ahead. We also have an estimator of the long run tendencies, named the ergodic distribution, accounted in the last row of the table. This will give us the long run tendency of an economy to land up in a given income range. The results suggest that over the long run, the probability that an economy lands up in the 4th state is the highest, a little over 40%. What is encouraging is that the lower income groups vanish in the ergodic distribution.

Following tables give us estimates of the transition matrix for the sub-periods. The second period again reveals tendencies of both persistence and mobility, with tendencies of persistence in the lower income group and the high income groups. The probability that the first two income states and last two income states shift anywhere other than their own is zero. Though there are signs of

persistence, there is evidence of some inter-state (income state) movement, again in the high income clusters. This trend continues in the next period.

It is important to remember that as these estimates are based on time stationary transition matrices, it may not be reliable for long time periods for economic structural changes. Hence, the 1965-98 results do not conform with the those of the sub-sample periods.

2.5 Conclusion

This paper documents regional distribution dynamics of Indian inter-state incomes over 1965 to 1998. The distribution dynamics approach moves away from traditional approaches of cross section regressions or time series analyses and tracks the evolution of the entire income distribution. The insights obtained are starkly different from those in recent studies of Bajpai and Sachs (1996) Nagaraj et al (1998) and Rao, Shand and Kalirajan (1999) We find that the dominant cross-state income dynamics are that of persistence and immobility. There are some cohesive tendencies observed in the 1960s, only to dissipate and accentuate polarising tendencies over the following three decades. Our main result is that over the entire period, though there do appear signs of some narrowing in the first period, 1965-70, the periods of 1971-80 and 1980-88, and 1989-97 shows strong signs of persistence and formation of a rich

income group and a poor income group at around 50% and 125% of the national average. The long run view, however, is encouraging in that the polarising tendencies are to weaken over time, with the lower income group vanishing.

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.

Technical Appendix

Here we will present the formal underlying structure for both models highlighting distribution dynamics Let us first consider the continuous version. The model is one for a stochastic process that takes values which are probability measures associated with the cross section distribution. The derivation is taken from Quah (1997a).

Let F_t be the probability measure associated with the cross section distribution. The following probability model holds:

$$F_{t+1} = T^*(F_t, u_t). \qquad (1)$$

Here T* is a mapping operator which maps probability measures in one period (with a disturbance term) to those of another. It encodes information of the intra-distribution dynamics: how income levels grow closer together or further away over successive time periods. Our task is to estimate T* from the observed data set.

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

$$F_{t+s} = T^{*s} . F_t \qquad (2)$$

As s tends to infinity 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.

Handling equation (2) is difficult; hence, the concept of the stochastic kernel was introduced to estimate the long run behaviour of the cross-section distribution[21]. This concept has been used by Quah (1996, 1997) Lamo (1996)

Let us consider the measurable space (**R**, *R*). R is the real line where the realisations of the income fall and R is its Borel sigma algebra. B (**R**, *R*) is the Banach space of finitely additive functions. Let F_{t+1} and F_t be the elements of B that are probability measures in (**R**, *R*). A stochastic kernel is a mapping M : **R** x *R* -> [0, 1], satisfying the following :

(i) $\forall$ a $\in$ **R**, M (a, .) is a probability measure.

(ii) $\forall$ A in *R*, M (., A) is a sigma measurable function.

Then M(a, A) is the probability that the next state period lies in the set A, given that the state now is a.

For any probability measure F on (**R**, *R*) $\forall$ A in R:

$$F_{t+1} = \int M(x, A)\, dFt(x) \qquad (3)$$

[21]See Stokey, Lucas and Prescott (1989) and Silverman (1986)

, where M (., .) is a stochastic kernel, and $F_{t+1}(A) = (T^*F_t)A$. T^* is an operator associated with the stochastic kernel that maps the space of probabilities in itself, (adjoin of the Markov operator associated to M). The above equation (3) measures the probability that the next period state lies in the set A, when the current state is drawn according to the probability measure F_t. F_{t+1} i.e. T^*F_t is the probability measure over the next period state, when Ft is the probability measure over this period. Hence we can consider the T* in the previous equations as being generated by the above differential equation. Our empirical estimation will involve in estimating a stochastic kernel as described above.

Such stochastic kernels though satisfactory as a complete description of transitions, are however, simply point estimates and we are yet to have a fitted model. It is thus not possible to draw inferences and derive long run estimates. However, it is possible for us to infer whether income levels have been converging and diverging. For these computations, we turn to the discrete formulation of the above.

Transition probability matrices

Now let us consider the discrete version. Given that using the stochastic kernel it is not possible for us to draw any inferences about the long run tendencies of the distribution of income, we now turn to a discrete version of the above calculation. Here we calculate T* from the above equation 3 and to compute the values using equation 2. T* is calculated assuming a countable state-space for income levels $Y_t = \{y_{1t}, y_{2t}, ..., y_{rt}\}$. Thus T* is a transition probability matrix Q_t, where

$F_t = Q_t (F_{t-1}, u_t)$

$\mathcal{Q}_t$ encodes information of the short run distribution dynamics and the long run information is summarised by the ergodic distribution - it gives the distribution across states that would be achieved in the long run. Here, convergence is takes place when the ergodic distribution degenerates towards a mass point. The transition matrix and the stochastic kernel together expose the deep underlying short run and long run regularities in the data.

Table1: Inter-State (per capita) income dynamics, 1965-88
First Order transition matrix, Time stationary

(Number)	Upper end point				
	0.640	0.761	0.852	1.019	1.393
5	0.40	0.00	0.40	0.00	0.20
5	0.00	0.40	0.20	0.20	0.20
2	0.00	0.00	0.50	0.00	0.50
4	0.00	0.00	0.25	0.25	0.50
1	0.00	0.00	0.00	1.00	0.00
Ergodic	0.00	0.00	0.22	0.44	0.33

Table2a: Inter-State (per capita) income dynamics, 1965-70
First Order transition matrix, Time stationary

(Number)	Upper end point				
	0.640	0.761	0.852	1.019	1.393
5	0.40	0.00	0.40	0.00	0.20
5	0.00	0.40	0.20	0.20	0.20
2	0.00	0.00	0.50	0.00	0.50
4	0.00	0.00	0.25	0.25	0.50
1	0.00	0.00	0.00	1.00	0.00
Ergodic	0.00	0.00	0.22	0.44	0.33

Table2b: Inter-State relative (per capita) income dynamics, 1971-80
First Order transition matrix, Time stationary

(Number)	Upper end point				
	0.680	0.730	0.795	1.010	1.489
5	0.40	0.60	0.00	0.00	0.00
1	0.00	1.00	0.00	0.00	0.00
3	0.00	0.67	0.33	0.00	0.00
4	0.00	0.00	0.75	0.25	0.00
4	0.00	0.00	0.00	0.50	0.50
Ergodic	0.00	1.00	0.00	0.00	0.00

Table2c: Inter-State relative (per capita) income dynamics, 1981-87
First Order transition matrix, Time stationary

(Number)	Upper end point				
	0.533	0.628	0.795	1.010	1.489
6	0.17	0.50	0.33	0.00	0.00
4	0.00	0.00	0.25	0.75	0.00
3	0.00	0.67	0.33	0.67	0.00
2	0.00	0.00	0.00	0.00	1.00
2	0.00	0.00	0.00	0.00	1.00
Ergodic	0.00	0.00	0.00	0.00	1.00

Table2d: Inter-State relative (per capita) income dynamics, 1988-97
First Order transition matrix, Time stationary

(Number)	Upper end point				
	0.141	0.207	0.241	0.412	0.464
6	1.00	0.00	0.00	0.00	0.00
4	0.00	1.00	0.00	0.00	0.00
3	0.00	0.00	1.00	0.00	0.00
2	0.00	0.00	0.00	0.67	0.33
2	0.00	0.00	0.00	0.50	0.50
Ergodic	1.00	0.00	0.00	0.00	0.00

Fig.1: Relative GDP per capita of Indian States 1965-1988

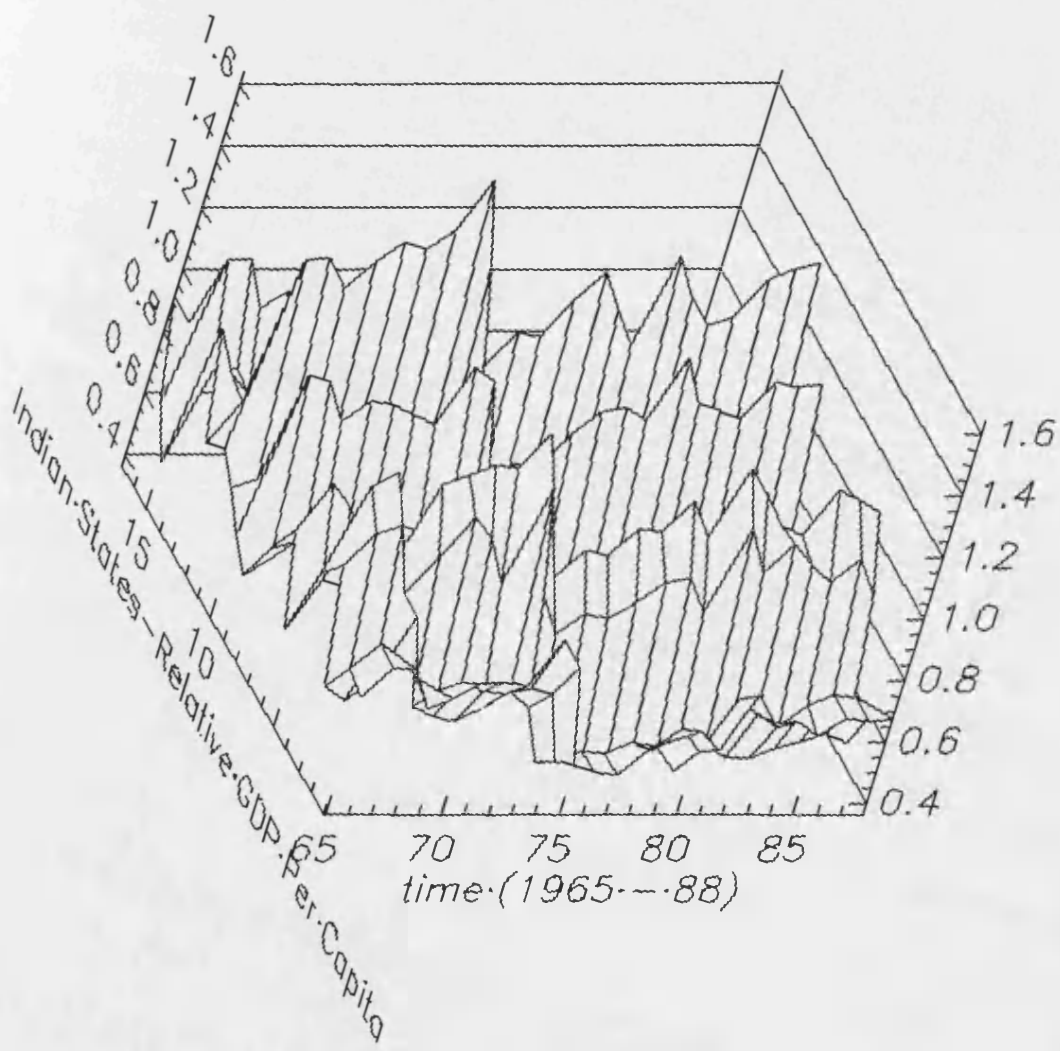
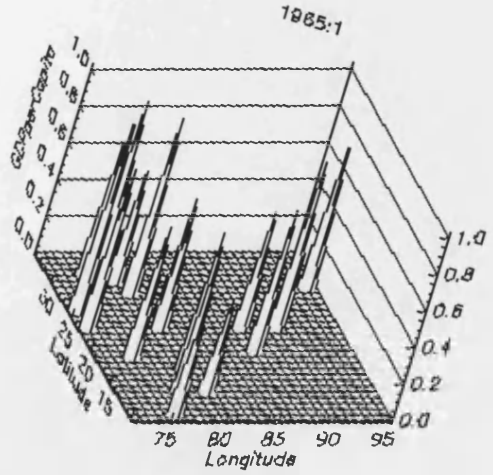
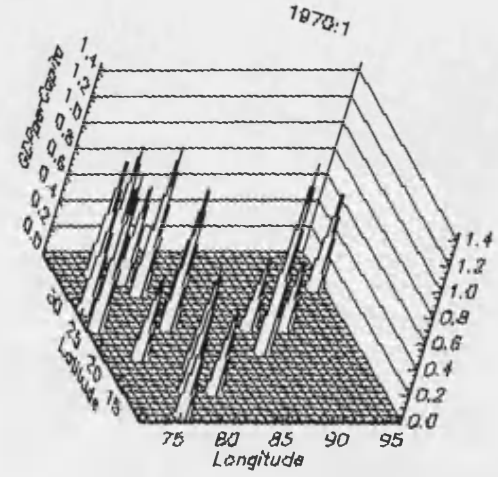
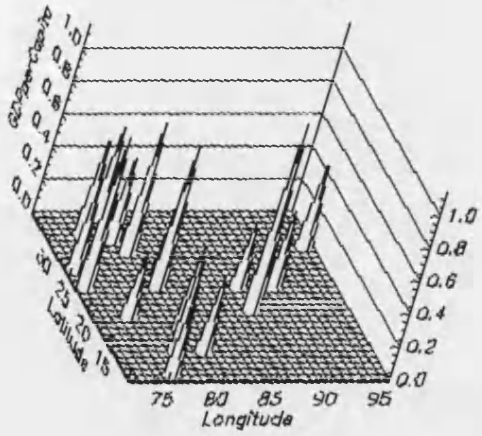


Fig.2 Indian inter-state spatial dynamics of GDP per capita 1965, 1970, 1977,1988







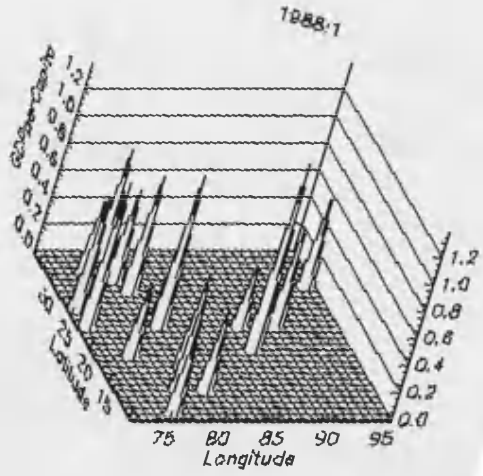
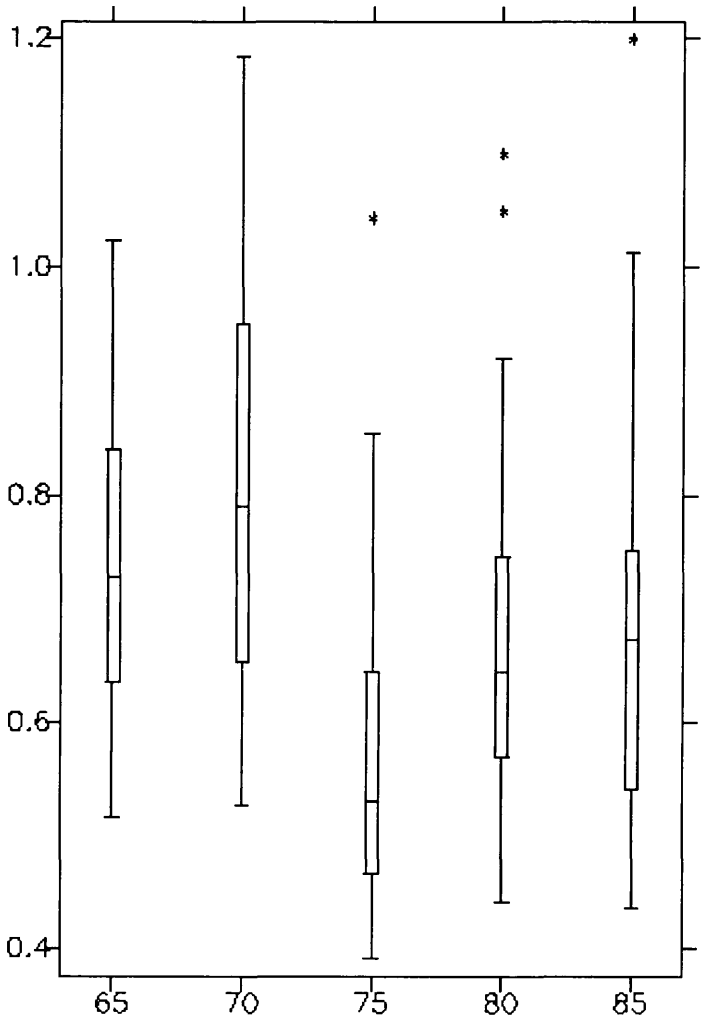


Fig.3a: Tukey Boxplots, relative per capita incomes across Indian states



1965, 1970, 1975, 1980, 1985

Fig.3b: Tukey Boxplots, relative per capita incomes across Indian states

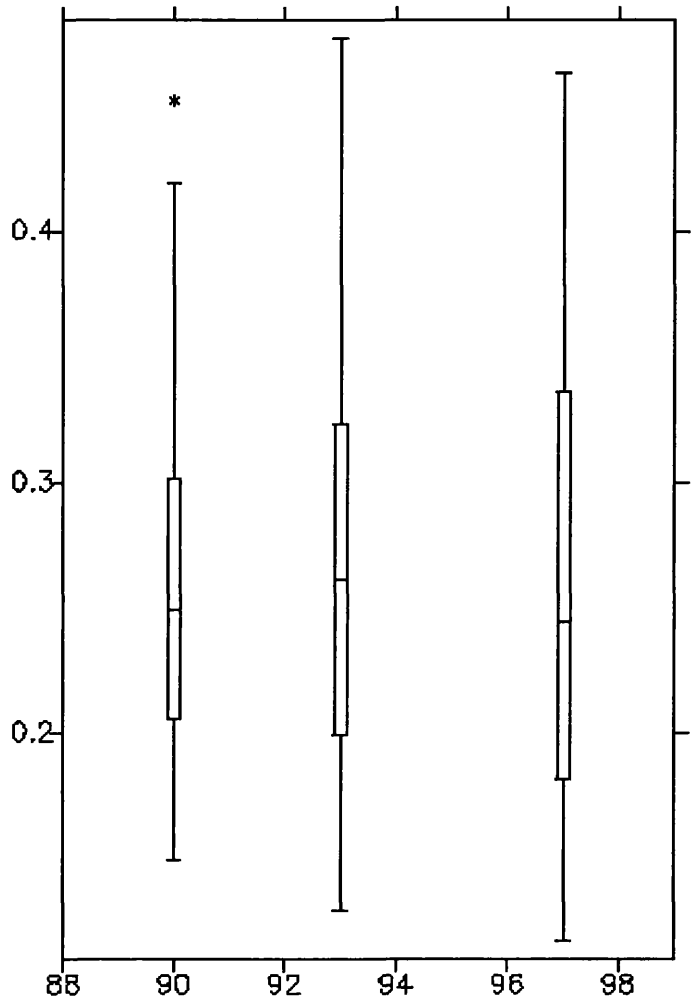
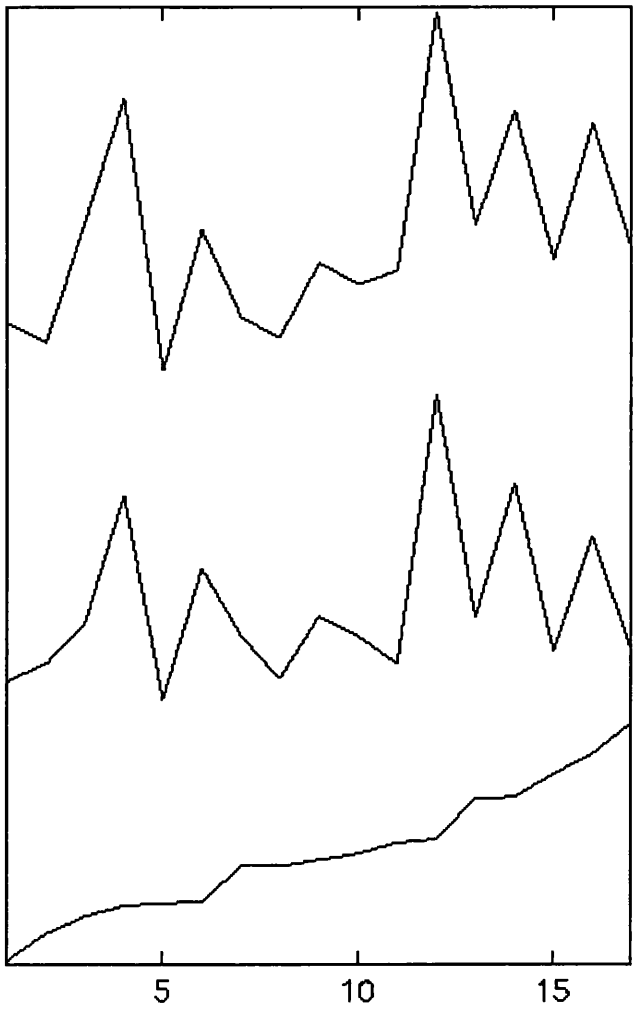
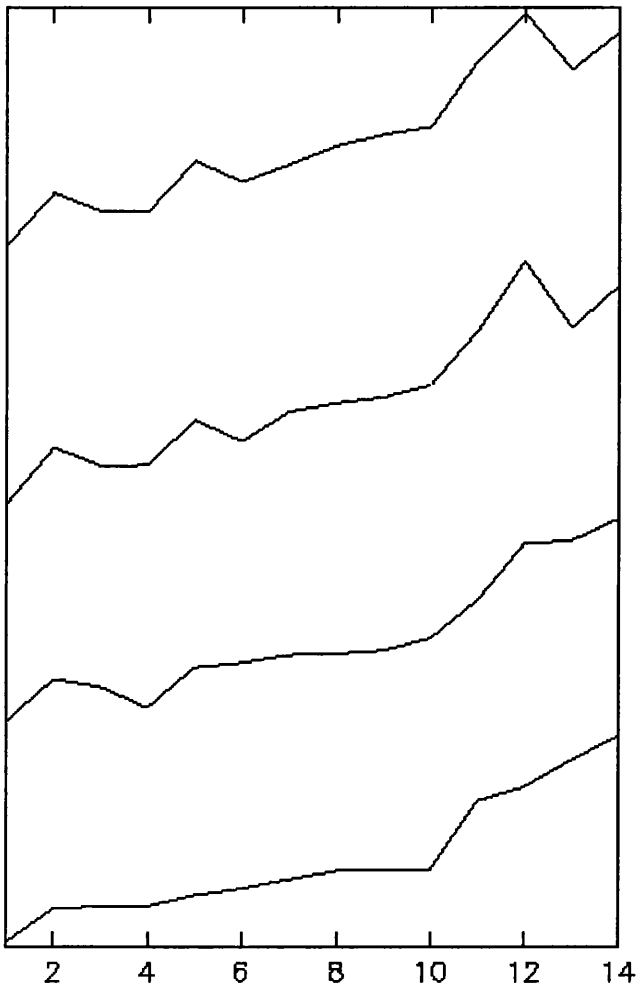


Fig.4a: Cross profile dynamics across Indian States



Moving upwards: 1965, 1975, 1985

Fig.4b: Cross profile dynamics across Indian States



Moving upwards: 1988, 1990, 1995, 1997

Fig.5a.i: Relative Income Dynamics across Indian States, 1 year horizon, 1965-87

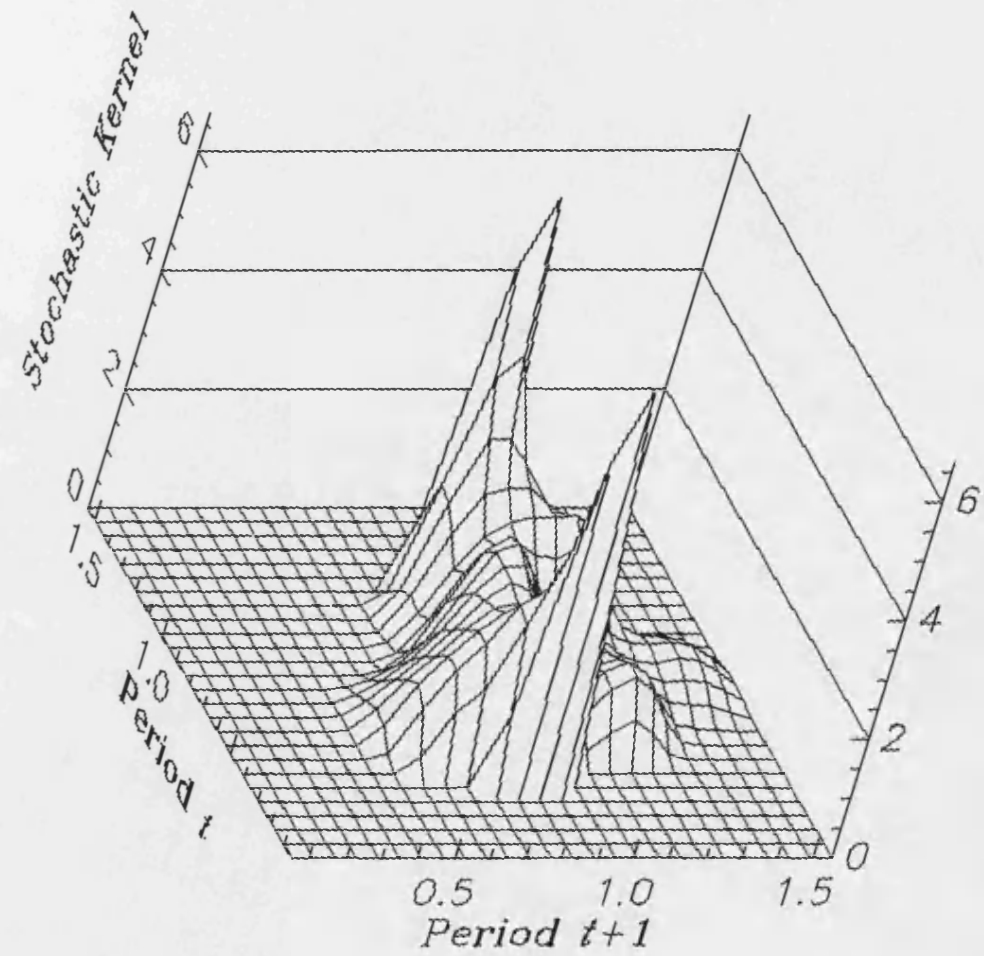


Fig 5a.ii: Relative Income Dynamics Across Indian States, 1 year horizon Contour Plot

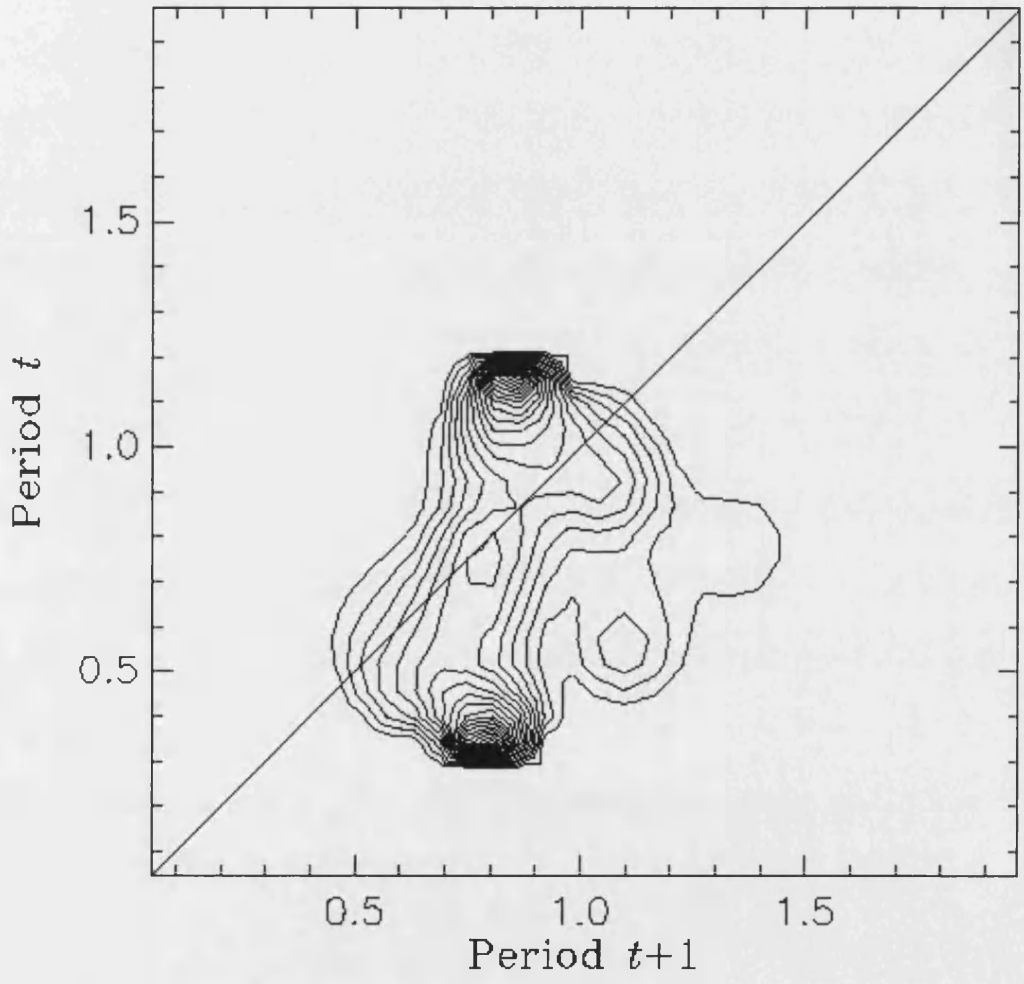


Fig. 5b.i: Relative Income Dynamics across Indian States, 5 year horizon, 1965-84

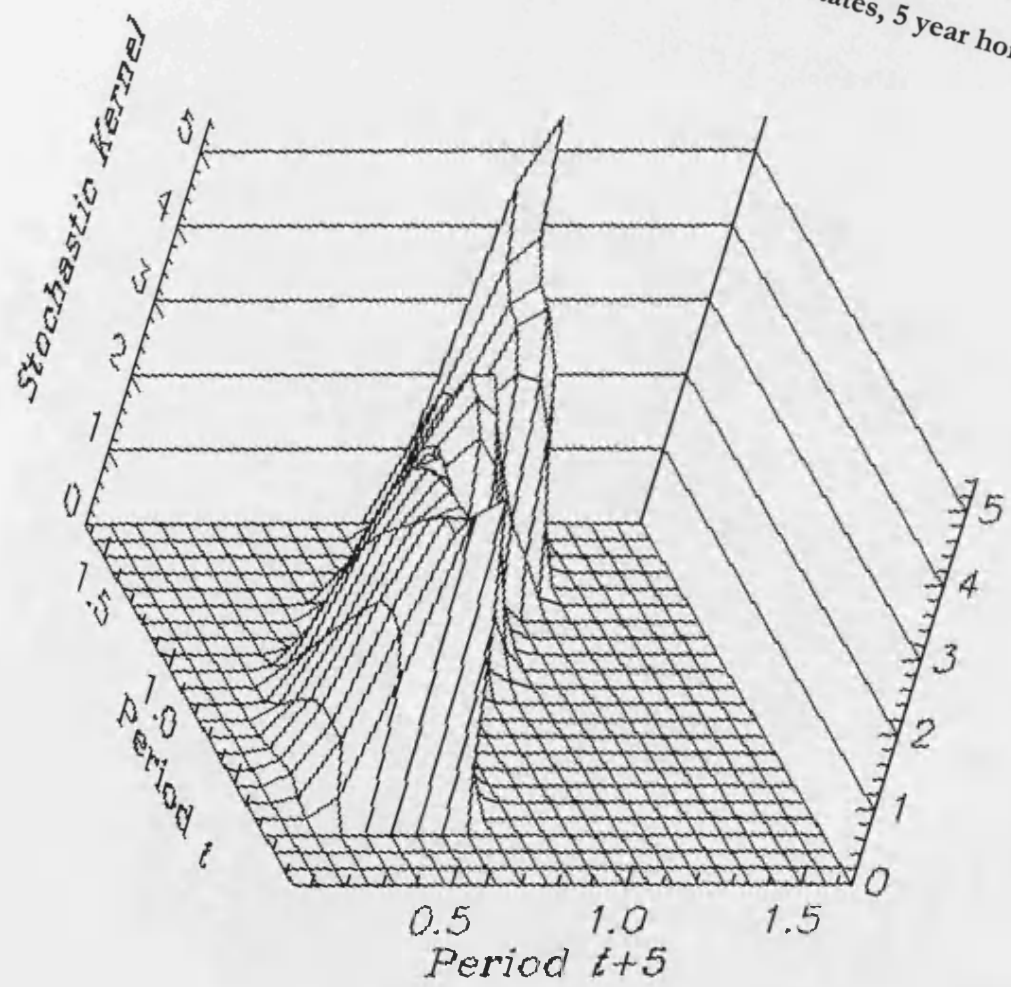


Fig 5b.ii: Relative Income Dynamics across Indian States, 5 year horizon
Contour Plot

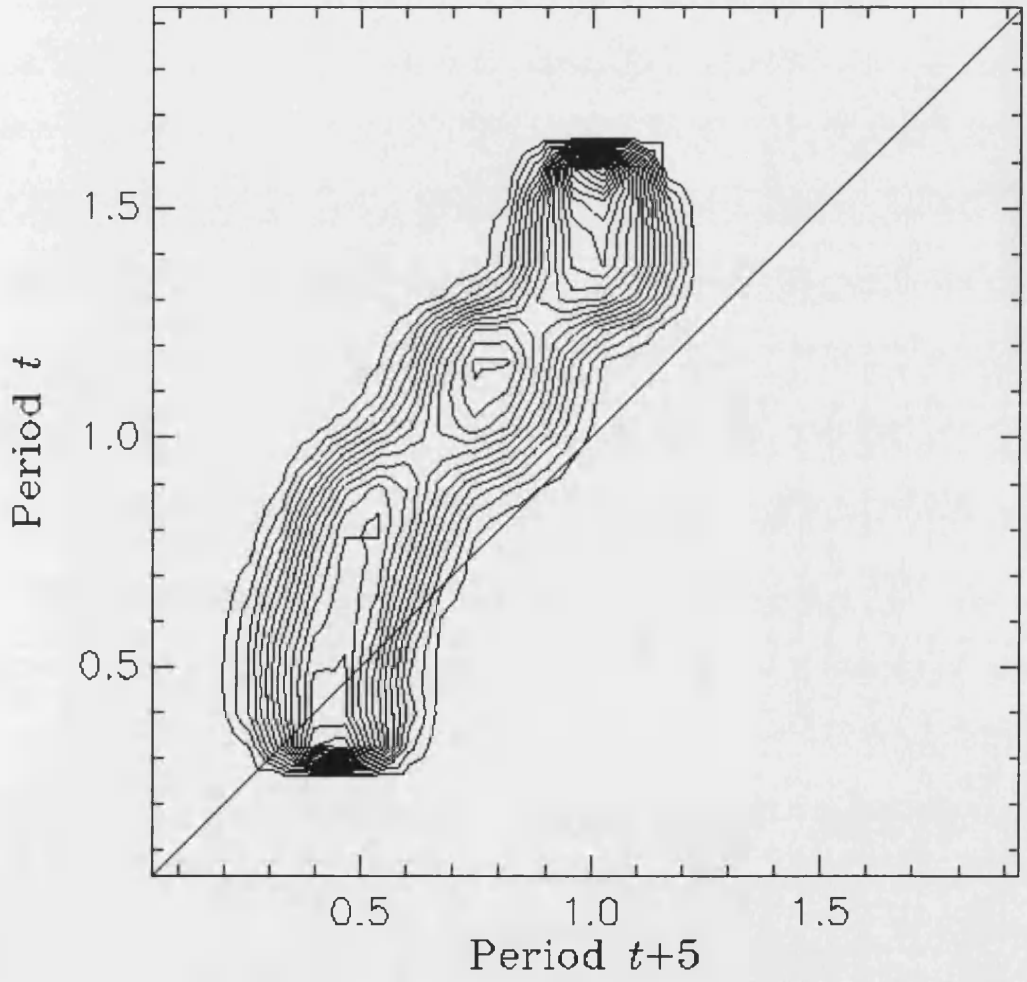


Fig5c.i: Relative Income Dynamics across Indian States, 1 year horizon 1965-70

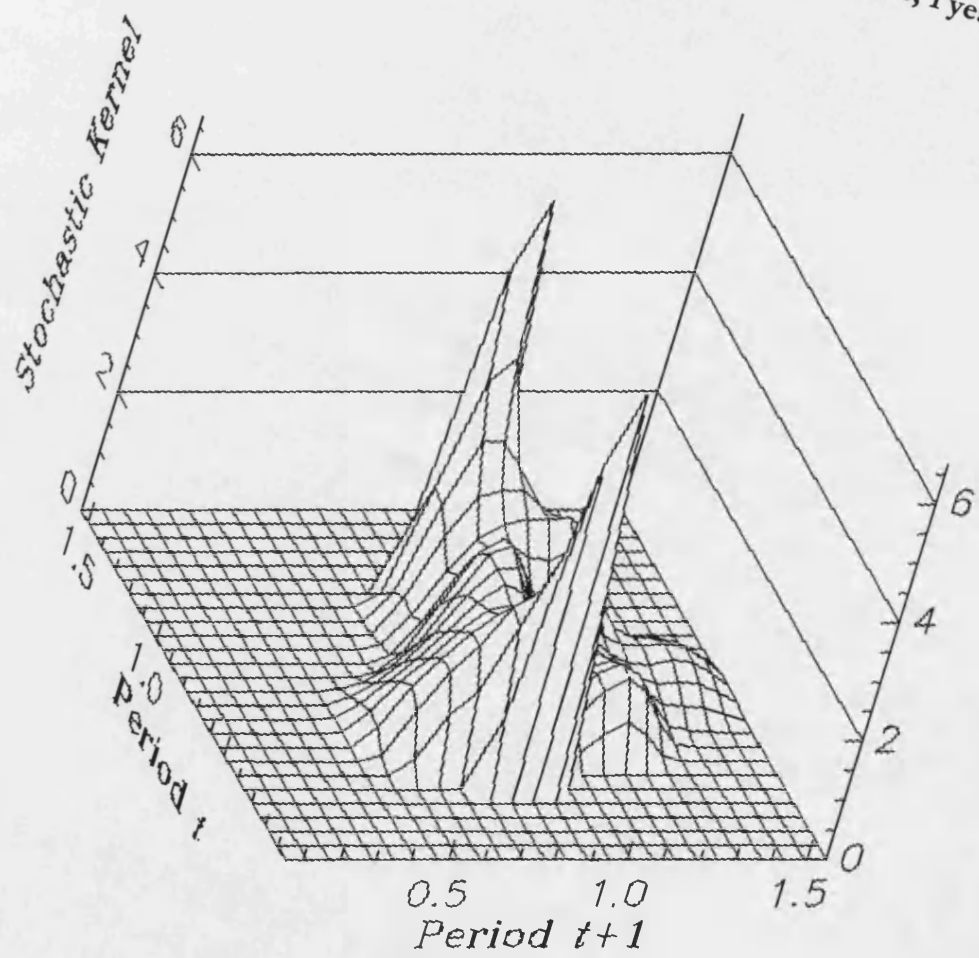


Fig5c.ii: Relative Income Dynamics across Indian States, 1 year horizon 1965-70, Contour Plot

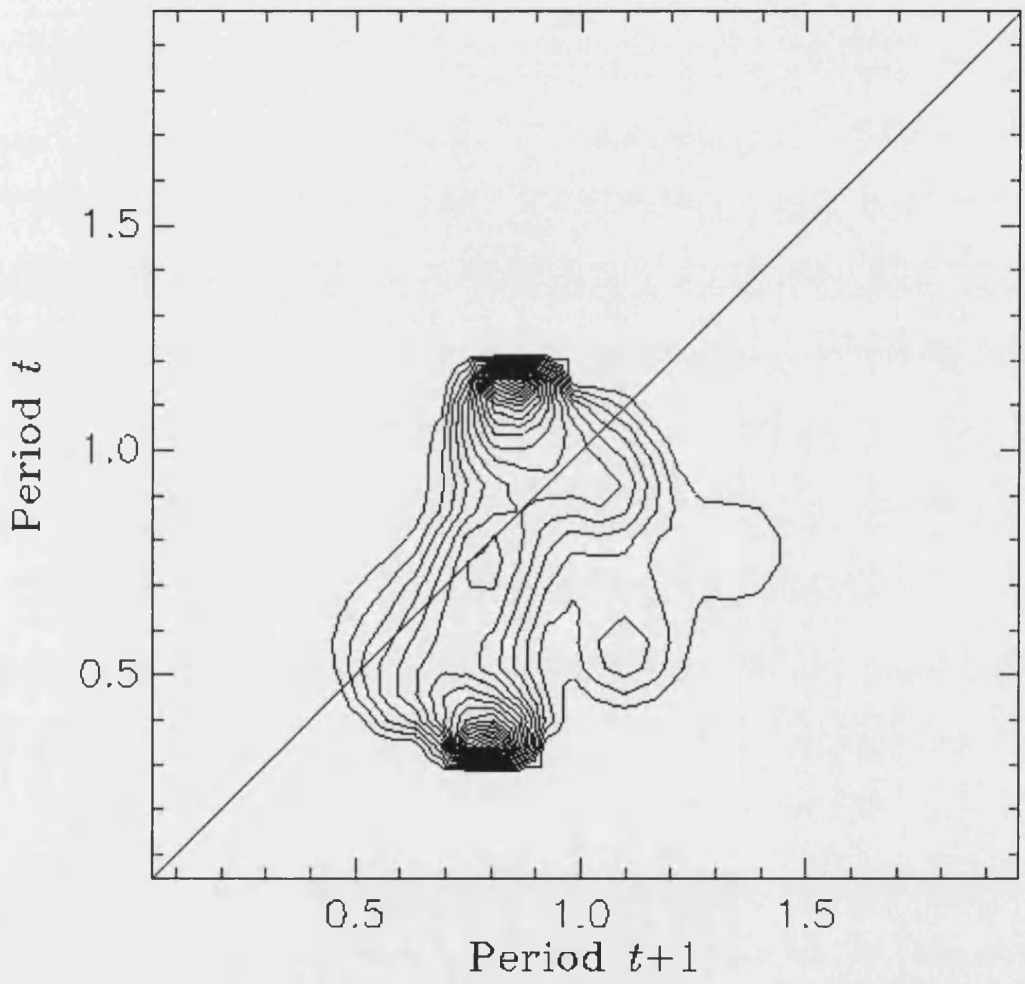


Fig. 5d.i: Relative Income Dynamics across Indian States, 1year horizon 1971-80

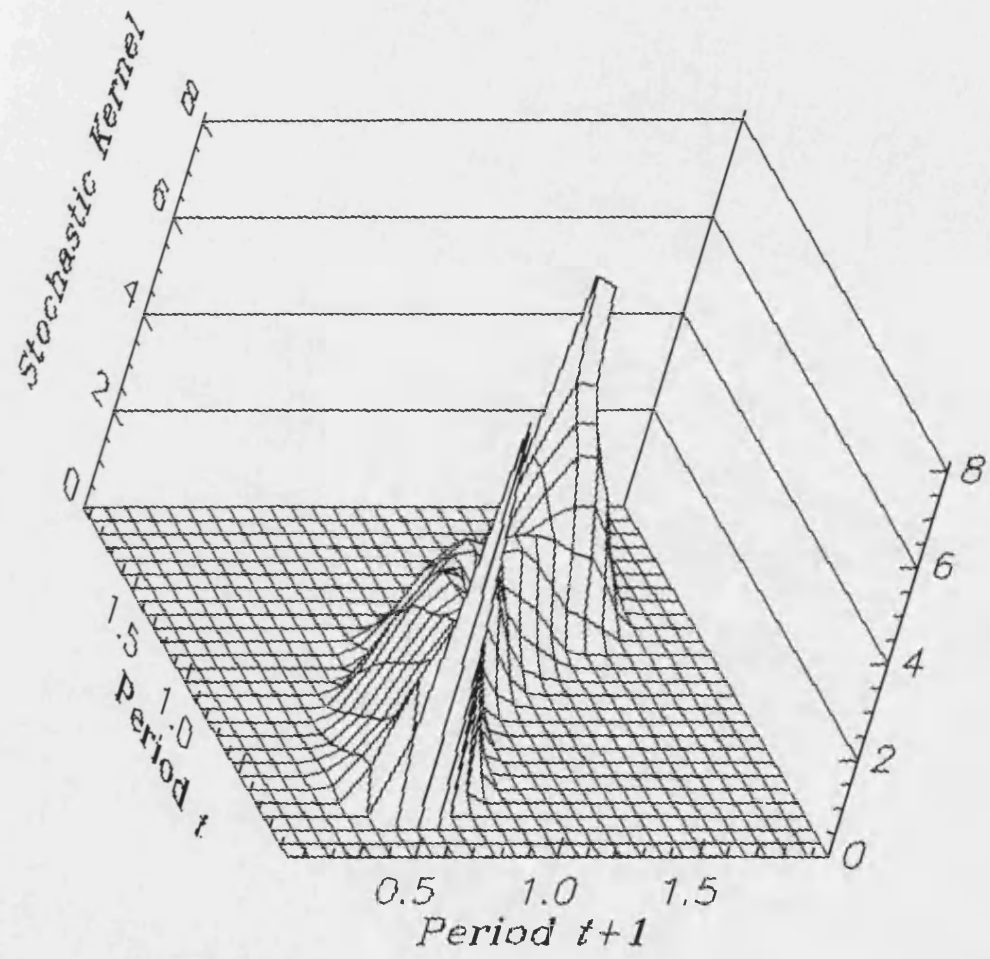


Fig. 5d.ii: Relative Income Dynamics across Indian States, 1 year horizon 1971-80, Contour Plot

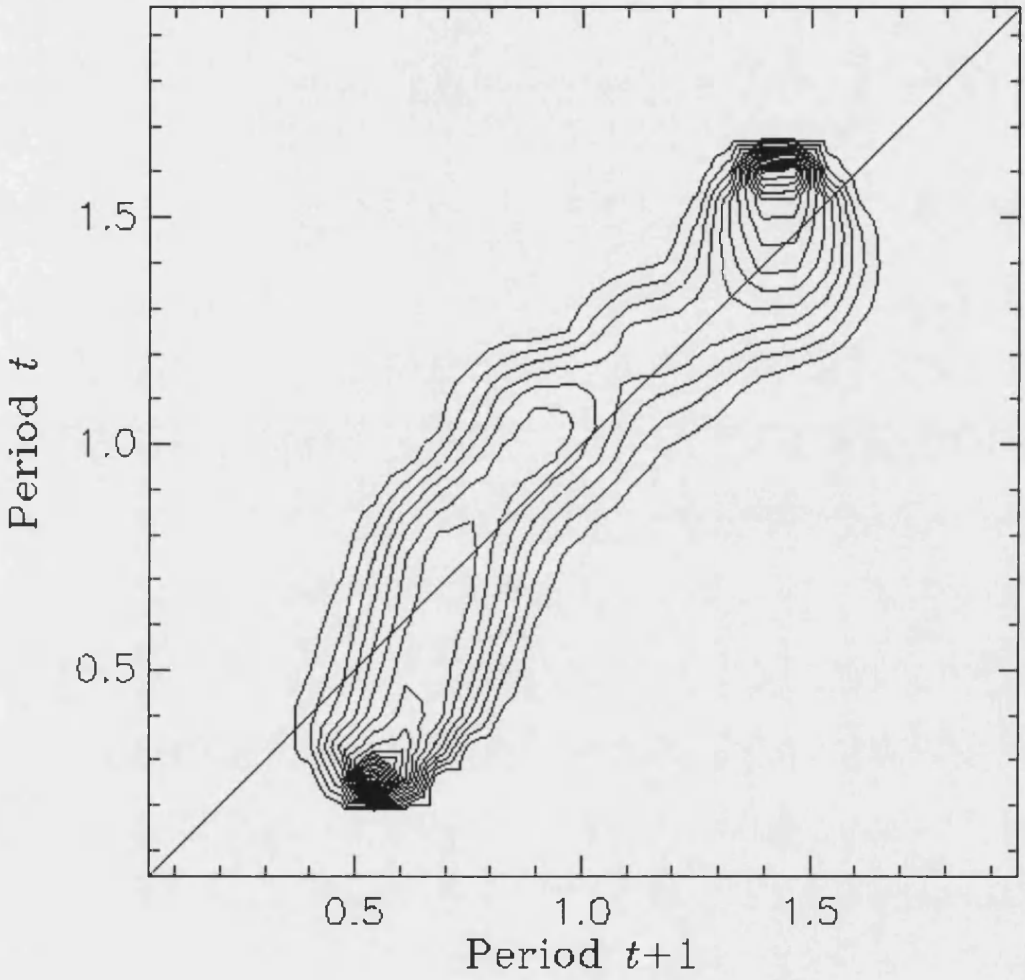


Fig. 5e.i: Relative Income Dynamics across Indian States, 1 year horizon 1981-87

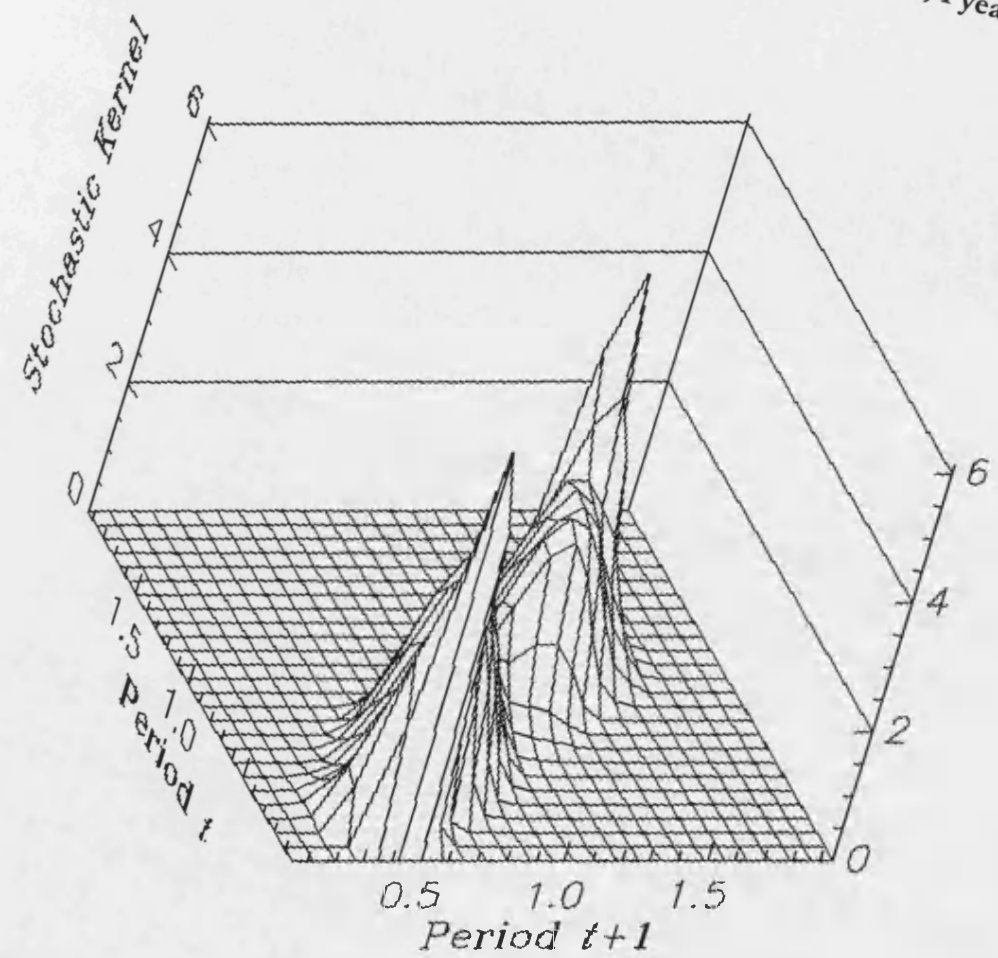


Fig. 5e.ii: Relative Income Dynamics across Indian States, 1 year horizon 1981-87

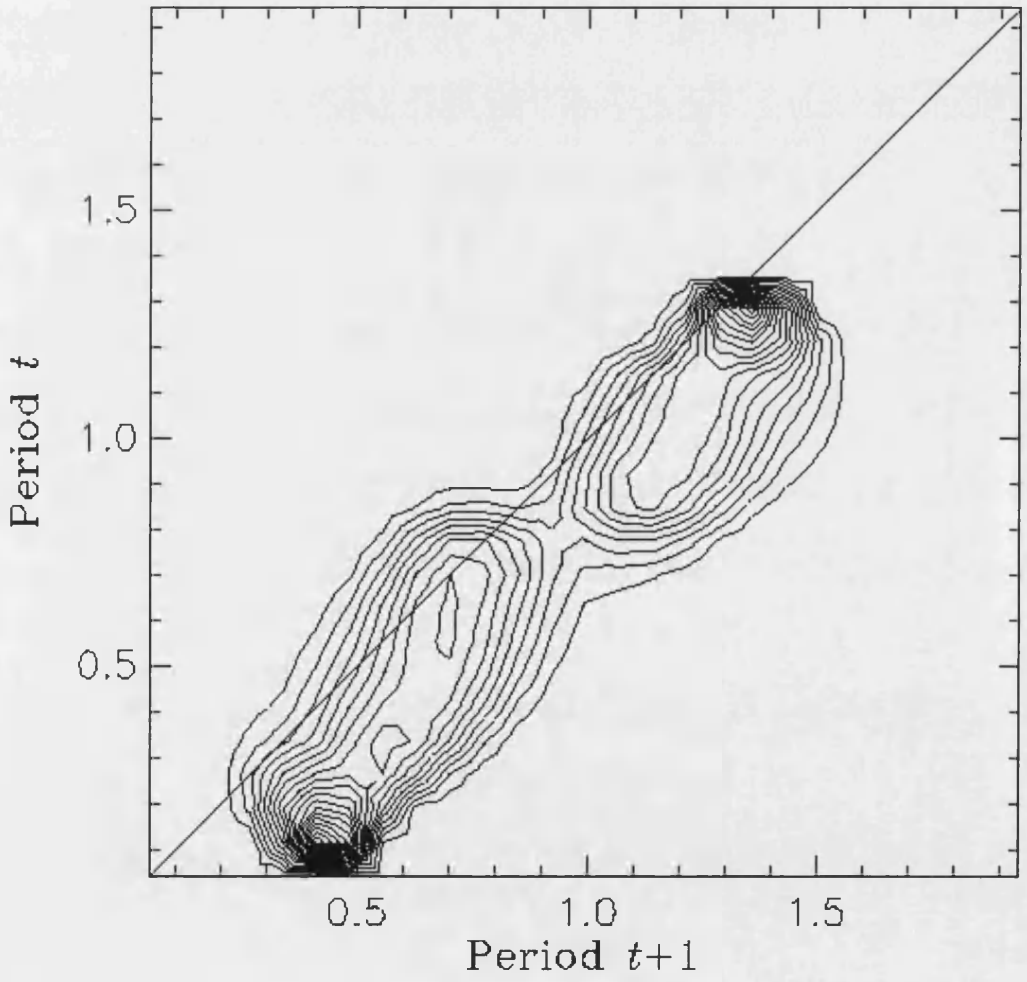


Fig. 5f.i: Relative Income Dynamics across Indian States, 1 year horizon 1988-97

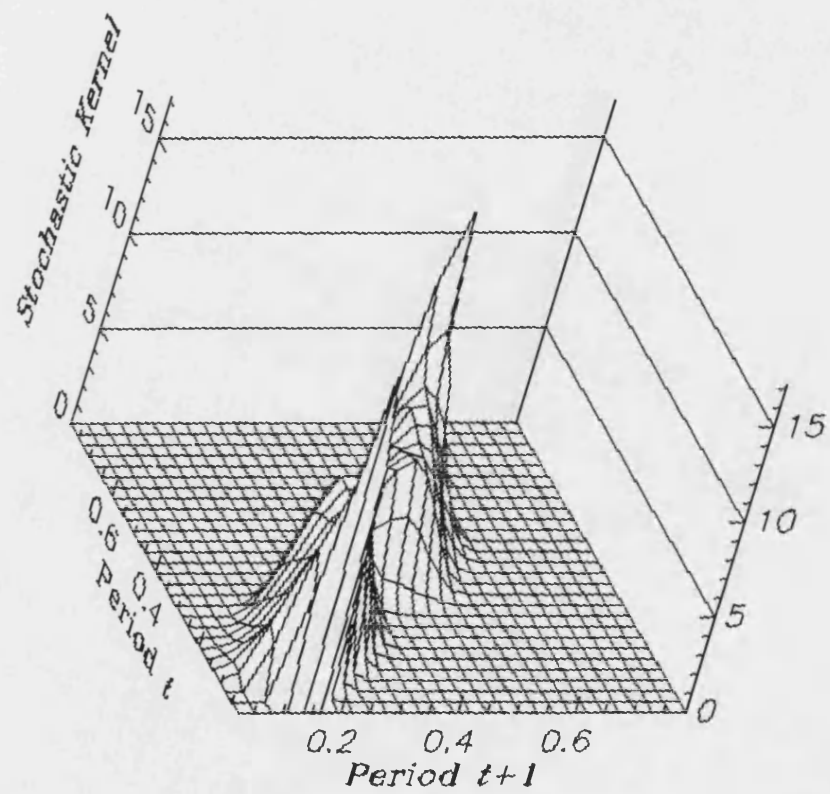


Fig. 5f.ii: Relative Income Dynamics across Indian States, 1 year horizon 1988-97, contour

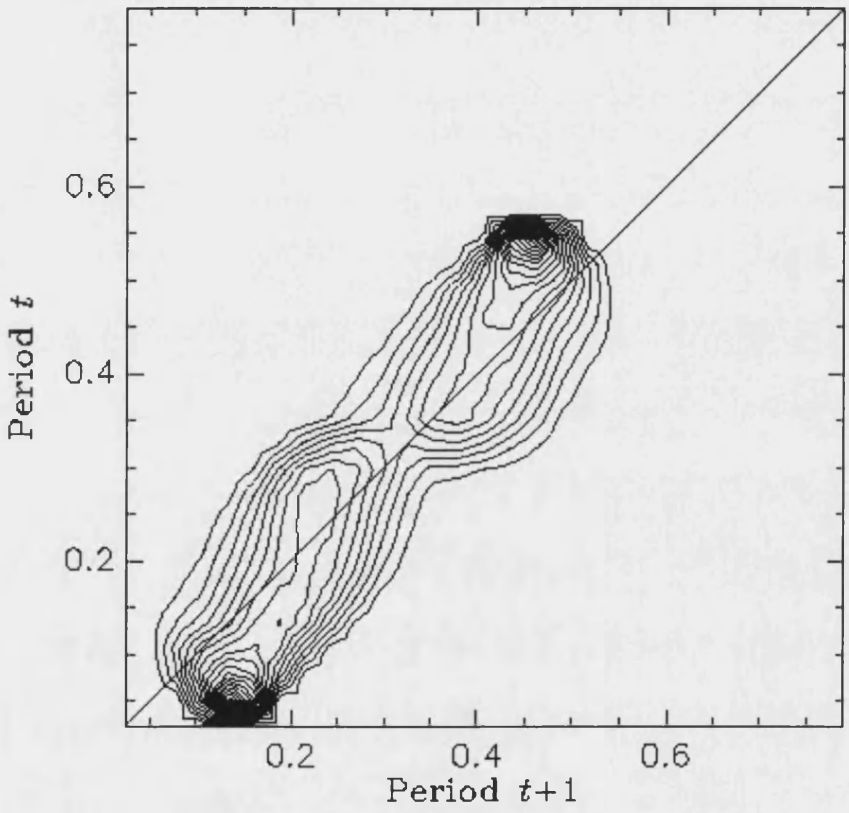


Fig. 5g.i: Relative Income Dynamics across Indian States, 5 year horizon, 1965-70

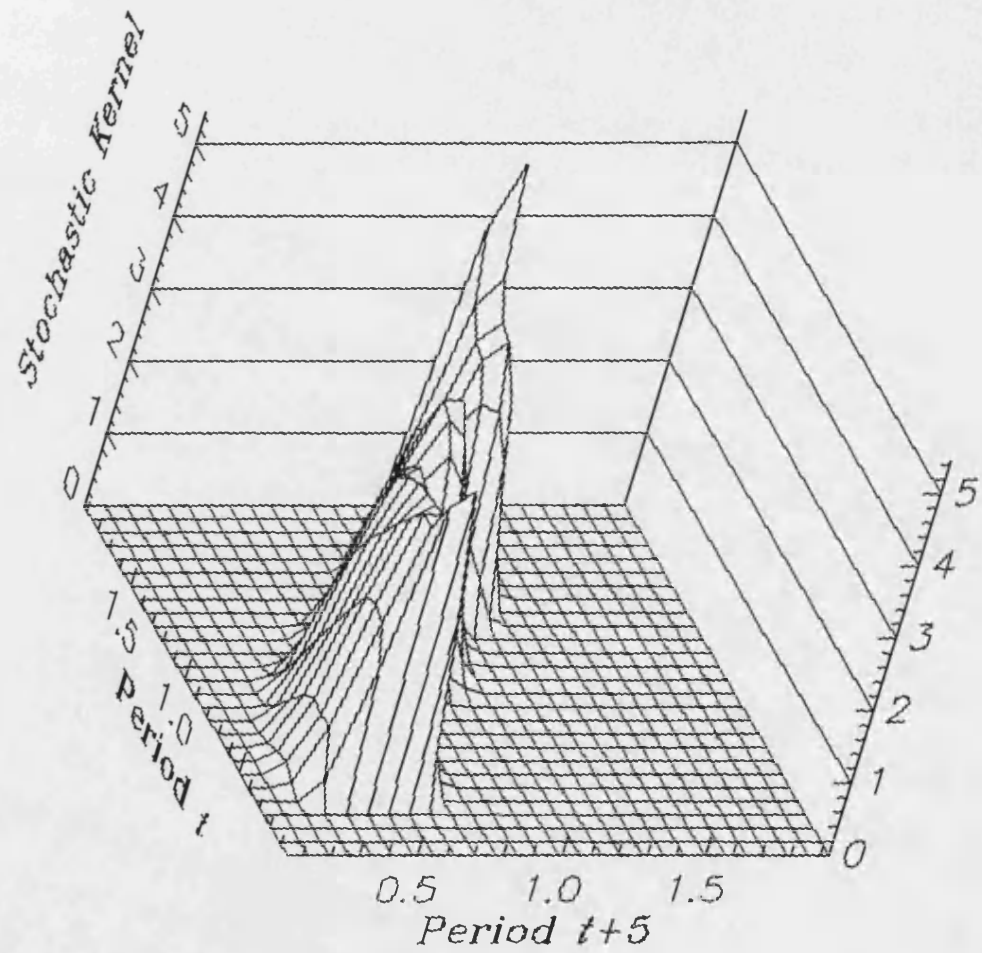


Fig. 5g.ii: Relative Income Dynamics across Indian States, 5 year horizon 1965-1970, Contour Plot

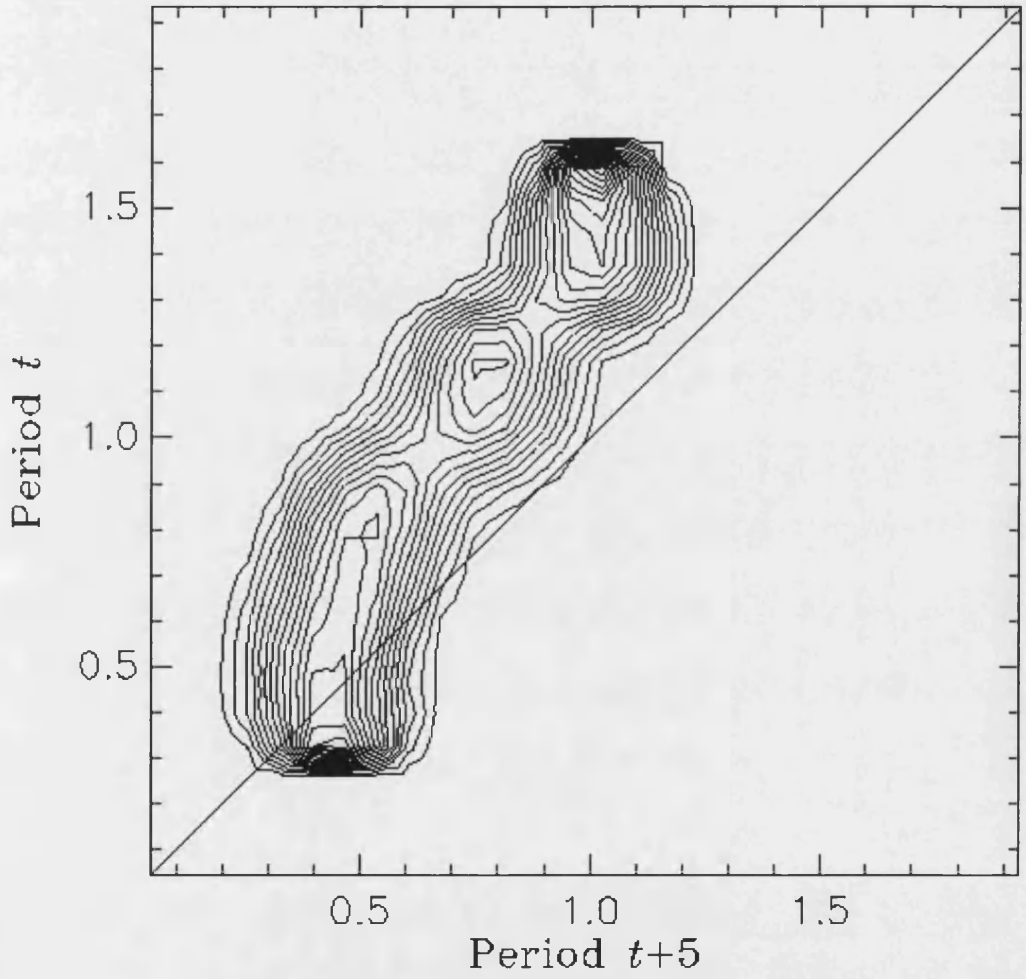


Fig. 5h.i: Relative Income Dynamics across Indian States, 5 year horizon 1970-75

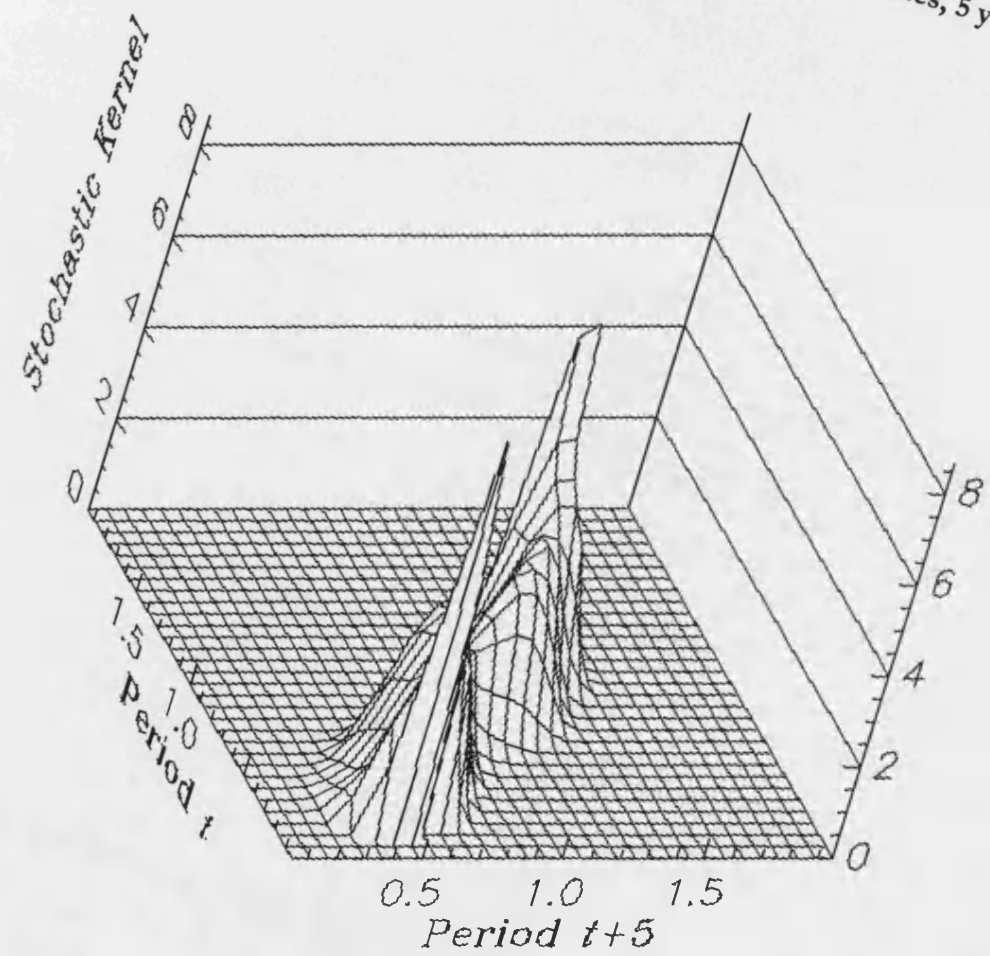


Fig. 5h.ii: Relative Income Dynamics across Indian States, 5 year horizon 1970-75, Contour Plot

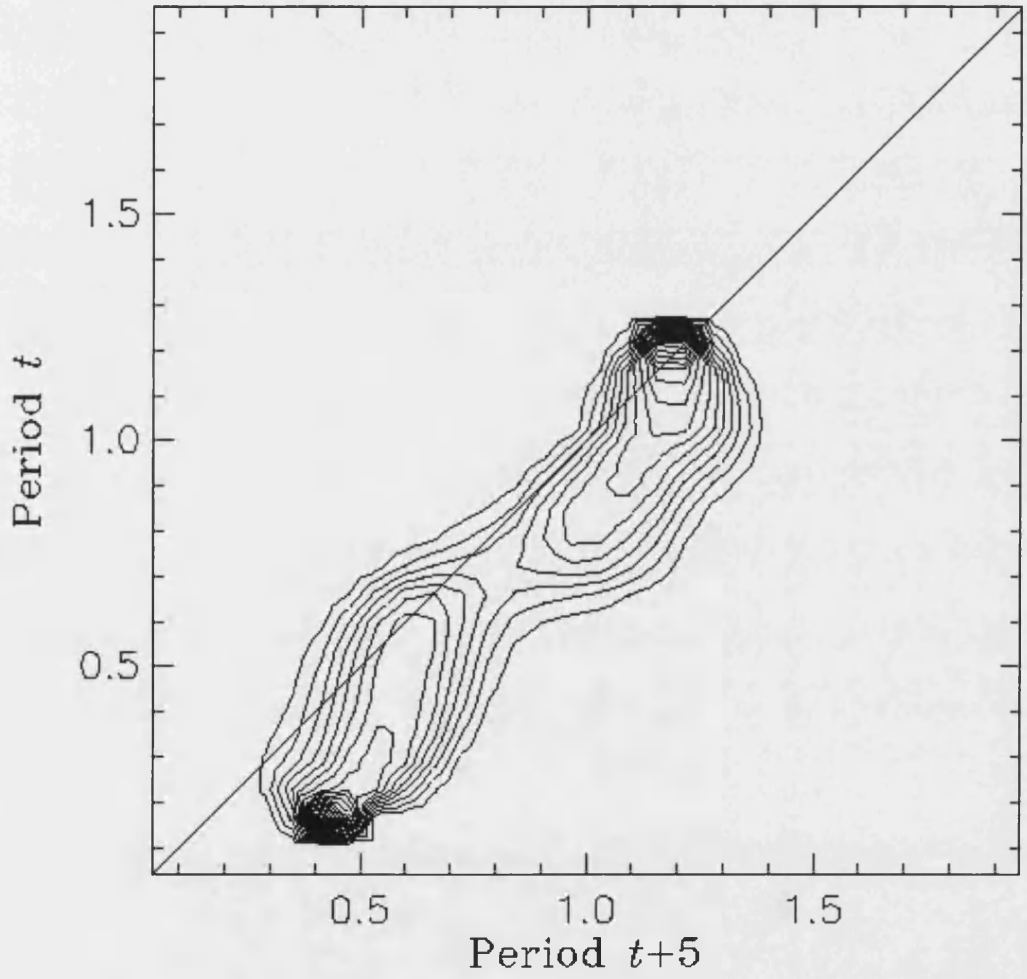


Fig. 5j.i: Relative Income Dynamics across Indian States, 5 year horizon 1978-83

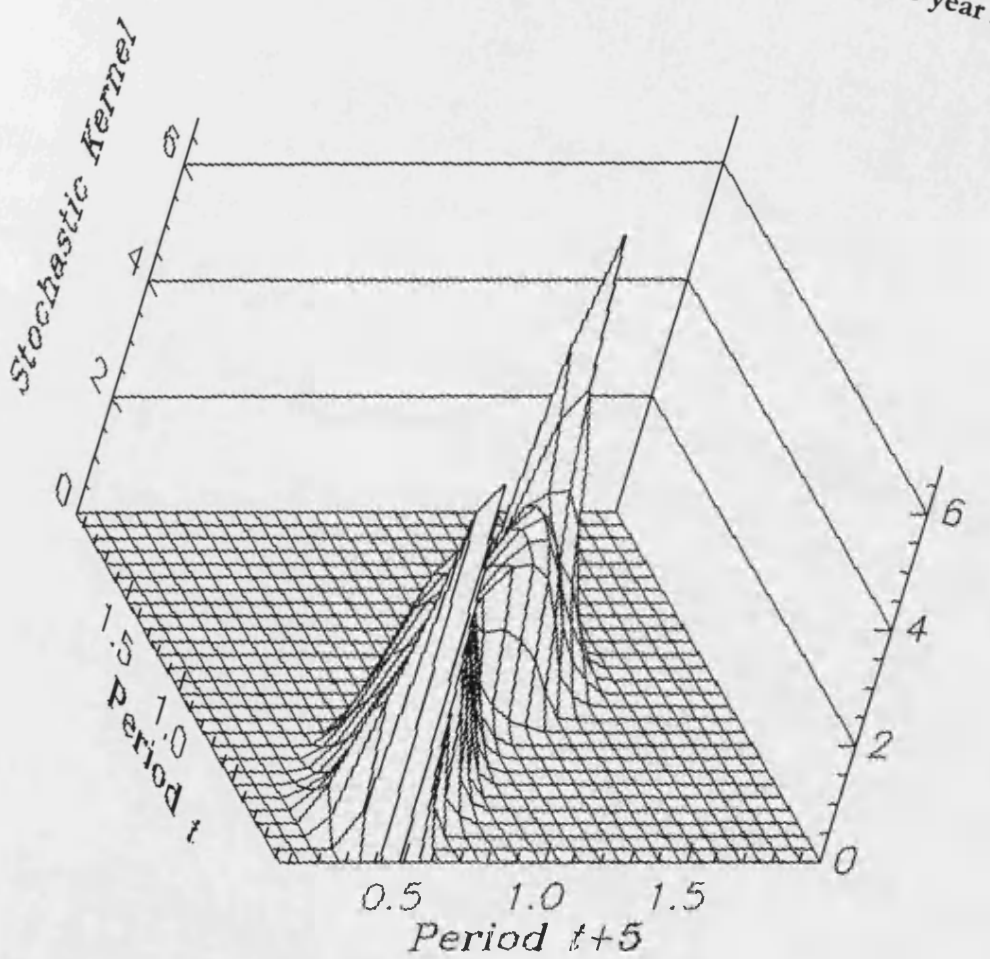


Fig. 5j.ii: Relative Income Dynamics across Indian States, 5 year horizon 1978-83, Contour Plot

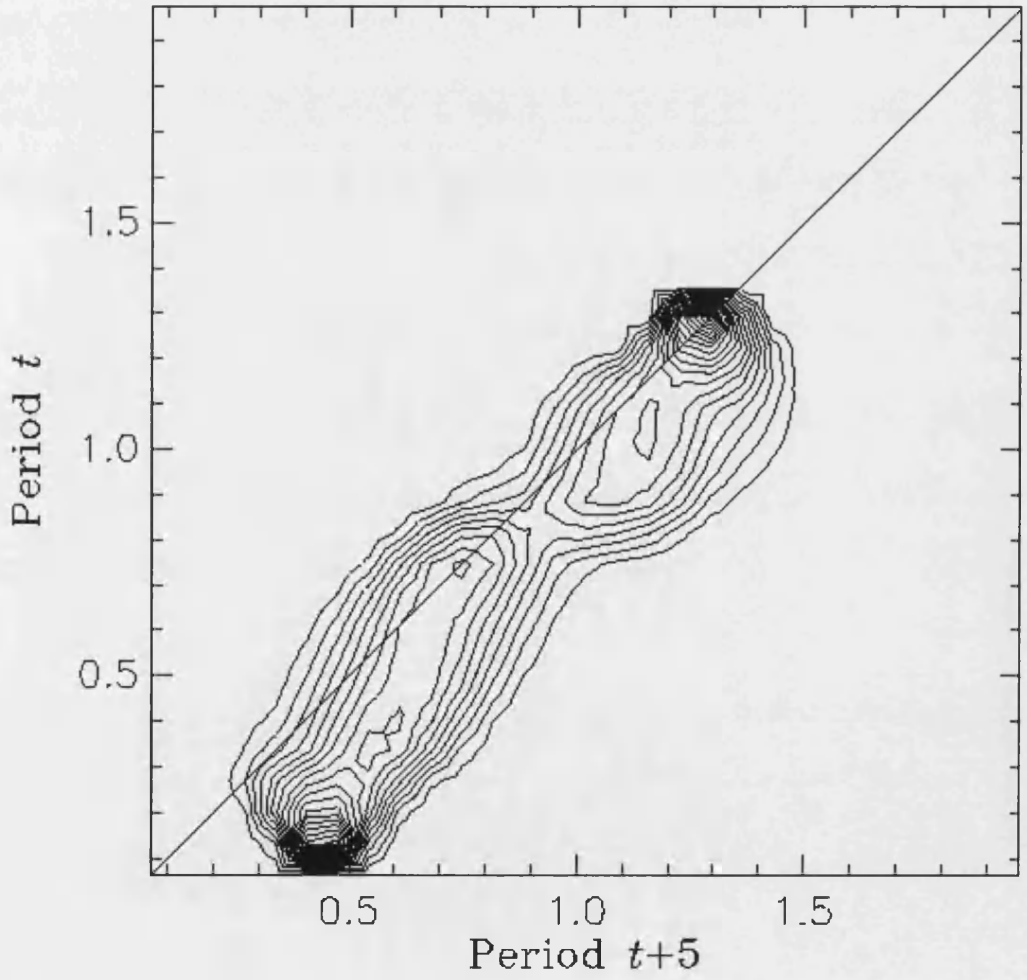


Fig. 5k.ii: Relative Income Dynamics across Indian States, 5 year horizon 1988-92

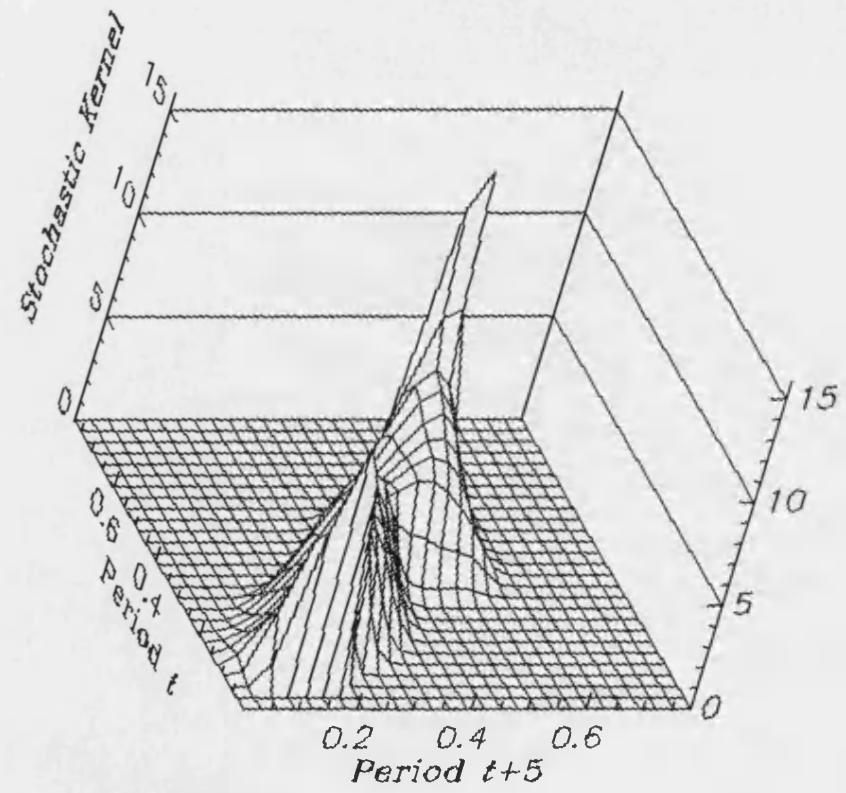
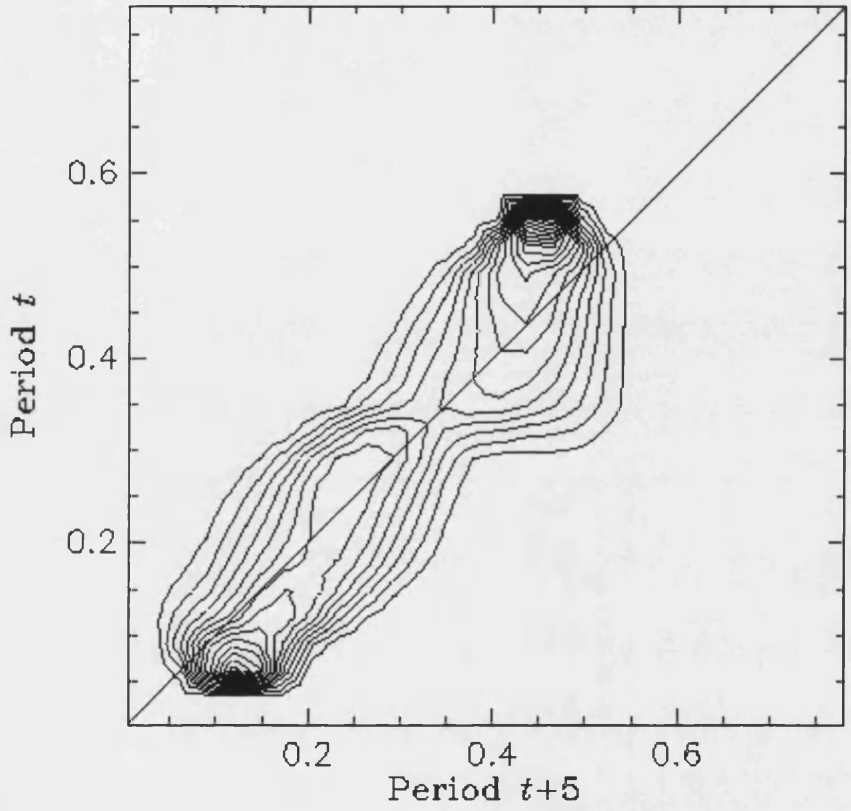


Fig. 5k.ii: Relative Income Dynamics across Indian States, 5 year horizon 1988-92, contour



Chapter 3

Regional Distribution Dynamics of GDPs across Indian States, 1977-93: Role of infrastructure

3.1 Introduction

Indian states have experienced a polarisation of income per capita over the period 1965 to 1997. The previous chapter documents the following stylised facts summarised in Figures 1a to 1d:

(i) Over the period 1965-70, there were signs of equalisation which, however, disappear in the following decades, i.e. 70s, 80s and 90s, exhibit further divergence.

(ii) There is evidence of the formation of two income convergence clubs - one at 50 per cent of the national average, and another high income group at 125 per cent of the national average. Alongside such polarity we find that states with intermediate initial incomes experienced mixed fortunes. Some had a marked improvement in their incomes, while some fell drastically, while still others saw it unchanged.

(iii) The long term view on the basis of the above stylised facts suggest a gradual weakening of the forces of polarisation with the lower income group vanishing.

In this paper, we question: what drives this polarisation? Experience suggests that the development process does tend to set up inter-regional tensions. One could consider such polarising tendencies to elicit evidence of such a process. Yet, increasing disparities in welfare and incomes are a threat to social and political stability and hence it is important

that policies for containing regional disparities are implemented early in the rapid phase of development. In this paper we evaluate a number of alternative explanations for the stated stylised facts. In particular, we focus on the levels of infrastructure provision - both economic and social - and levels of state development expenditure in the different states. Indeed, the poorer states are evidently with the weakest physical infrastructure. They are not only disadvantaged in terms of physical infrastructure, but also have dismal levels of human development. The six poorest states constitute more than half the Indian population and contribute less than 35% of the Indian GDP.

We use the distribution dynamics approach to find a number of explanations of the polarising income distribution and complement our non-parametric results with standard parametric regressions as well. Adopting the distribution dynamics approach lends us a number of interesting insights not obtainable using standard parametric approaches. It enables the researcher to move away from a representative economy approach to that of explaining the evolution of the entire distribution, thus allowing us to observe what is happening at different parts of the distribution. The approach also derives its intuition from a number of new theoretical developments which characterise different distributional patterns other than that of convergence, such as polarisation and stratification.

The findings in this paper document that physical and social infrastructure matter most to the lowest income group (those with income levels at 50 per cent of the national average) - that levels of infrastructure provision, both physical and social, serve to explain formation of the lower income convergence club. The state-wise structure of production and the levels of state development expenditure also partially explain the observed polarisation.

The parametric results obtained reinforce our non-parametric results. Of the infrastructure indicators we find the extent of irrigation, roads, power consumption in industrial sectors, education and bank deposits to be infrastructure which significantly explains inter-state variation in growth. Conditional convergence is occasionally observed but is not robust to specifications. Given that the distribution dynamics suggest that economic and social infrastructure explain the formation of the lower income club, the parametric results highlight the individual elements of infrastructure which explain the cohesive forces at the lower income convergence club.

In the following section, we outline the (non-parametric) distribution dynamics methodology for conditioning and present our results. Section 3 presents standard parametric results. Section 4 discusses policy implications for public investment in infrastructure. Section 5 concludes.

3.2 Conditioning: Non parametric results

How does one go about explaining the observed polarisation? In this section we will undertake distribution dynamics methodology to identify some explanatory factors. In the following section we will complement these results using some standard parametric methods.

The non-parametric tools which we will be using are those proposed by Quah (1995, 1997b). Using this approach is noteworthy in two important aspects - first, it differs from the conventional models of growth and accumulation in the direction of theorising in terms

of the entire cross section distribution, and second, it departs from standard techniques of testing for convergence (or conditional convergence).

Quah (1995, 1997b) proposes a simple conditioning methodology where explaining distribution dynamics is conceptually the same as analysing the effects of conditioning under standard techniques. Conventional methods of regression analysis, in asking if a factor X explains variable Y entails examining whether E(Y) and E (Y|X) are different. Quah(1995) opines that our interest lies far beyond that of comparing their respective expectations - our line of inquiry should be to see whether their respective distributions, Y and Y|X are the same, and more importantly, how Y has been transformed into Y|X.

The intuition underlying this approach follows from theoretical developments in new growth theory permitting explicit patterns of cross section interaction - for instance, regions clustering together into distinct groups to endogenously emerge (Baumol 1986, De Long 1994, Quah 1997a,b to name a few), resulting in polarisation, or stratification, also commonly termed "club convergence". Given these possibilities, the extant tools of analysis, such as standard regression analysis[22], are rendered defunct as it can only inform the researcher about the representative economy and not about the evolution of the entire income distribution.

In the distribution dynamics approach, the objective is to observe the evolution of each state's income in relation to a group of other states' incomes, where all these states share similar characteristics. Each group consists of states with similar characteristics - for

[22] The conventional approach to detect underlying factors determining growth is to study the growth and convergence models of representative economies, and then analyse such models using panel-data econometric methods that absorb heterogeneity into what are called "individual effects". However, such

example, states with similar levels of development, physical neighbours, trade partners, similar sectoral composition of GDP, similar levels of human capital etc. If each state (or some states) does follow it's groups behaviour, i.e. of a similar characteristic, like that of its neighbours, or its trade partners, then one can say that the grouping criteria involved explains the observed income dynamics. For our neighbours example, if each state does follow it's neighbour's outcome, i.e. has similar incomes to it's neighbours, then one can say that there is some kind of a spillover effect from neighbouring regions which are responsible for the observed income dynamics.

First, thus, one needs to derive the conditioned distribution on the basis of a conditioning scheme or what can also be called a grouping criteria. For example, for a conditioning on neighbouring states, we will derive a conditioned distribution where each income unit in the conditioned distribution is the state income relative to its neighbours' average income. For the state of Punjab, for instance, the income unit in the conditioned distribution will be its own GDP relative to the average income of its neighbours: Haryana, Uttar Pradesh, Gujarat, Rajasthan. The relevant income unit for Haryana will be its own GDP, relative to the average of Punjab, Uttar Pradesh, Gujarat and Rajasthan. We thus derive the relevant (i.e. conditioned) income figure for all the states to give us the conditioned distribution. Similar conditioning schemes, for instance, those with similar levels of education, can also be derived in a similar manner. We divide the states into different groups according to different levels of education (in our case, levels of literacy per 1000 population). For example, in our exercise of education conditioning, later to be detailed, states of Bihar, Rajasthan, Orissa and UP belong to the group with lowest rates of literacy. The

methods are not considered appropriate in investigating for convergence, even though these techniques deal with data with rich cross section and time series variation. See Chamberlain (1984).

conditioned distribution will then consist of each states' income relative to its group's average income.

Observing for conditional convergence will thus entail obtaining a mapping from a distribution of each of the states' GDPs (relative to national average), i.e. the original distribution, to the conditioned distribution and follow how closely it has followed the group behaviour. Quah (1996) uses the stochastic kernel (and the transition probability matrices) to model evolving distributions, and also the effects of conditioning - thus not just across time, but also more generally to explain the evolution of a distribution. If the states have followed group behaviour/characteristic, then we will observe conditional convergence – which will reveal itself in stochastic kernels (and the probability matrices) in a way identical to the earlier tests for convergence. We will detail this shortly.

For this non-parametric exercise, we will undertake conditioning with the following factors - physical neighbours, sectoral composition of state domestic product, states with similar levels of infrastructure, regions with similar levels of education (using levels of literacy) and state development expenditure. We will be using the stochastic kernels and transition probability matrices as models which account for the conditioning distribution dynamics, which we will now discuss.

3.2.1 What to look for in the stochastic kernels?

How will all this be revealed in the stochastic kernels? These mappings are extensions of the mappings obtained earlier characterising transitions over time – Figures 1a – 1d reveal transitions over different periods of time. It can further be shown (see Quah 1996) 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. Thus, our task is to obtain a mapping between the unconditional and a conditioned distribution, where our conditioned distribution has been obtained as described earlier. To understand if a hypothesised set of factors explains a given distribution we can simply ask if the stochastic kernel transforming the unconditional one to the conditional one removes those same features.

One extreme situation, Fig 2a, would be where we find that the mapping from the unconditional to the conditional distribution would have the probability mass running parallel to the original axis at one. This would mean that all states, irrespective of its own income (relative to national average), would have its income relative to its group average close to one. In other words, each state has been following its groups' outcome. Such a result is called "conditional convergence" in the conventional literature and the conditioning factor would be deemed an explanatory factor for the polarisation of incomes.

Another extreme, Fig 2b, would be where the stochastic kernel mapping the unconditional income distribution to that conditioned has its probability mass running along the diagonal. Unlike the previous case, this now implies the opposite possibility – each state, irrespective of its position in the initial distribution, has its income relative to its group average unchanged. This implies that there exists no group effect whatsoever; that there is no "group outcome" to follow. This renders the conditioning factor as one which does not explain the observed polarisation.

We will now group regions according to a number of different criteria to observe if they remove the bi-modal features of the observed income dynamics.

3.2.2 Conditioning on physical neighbours

One straightforward explanation could be that the evolution of the inter-state income disparities can be understood in terms of the evolution of groups with neighbouring regions with similar outcomes. A number of studies bear evidence of disparate cross regional economic performance well explained by spatial spillovers from neighbouring regions; one where a region's economic performance follows its neighbours' outcomes (Overman 1999 Quah, 1997b). To look into this possibility, we estimate a stochastic kernel which maps the state's incomes (unconditional distribution) to a conditioned distribution consisting of each state's income relative to the population-weighted average of incomes of physically contiguous states (not including the state itself). Here again, neighbouring partners may be determined by other criteria, like separation of levels of development, one's trading partners, or even physically well connected partners[23].

Figure 3a[24] tells us what is happening - we do not obtain any evidence of states' outcomes following that of its geographic neighbours. The bulk of the probability mass lies on the diagonal. This is even clearer in the contour plot in Fig 3b. This is indicative of that spatial spillovers have not been the governing factor in resulting in polarisation of incomes.

3.2.3. Conditioning on sectoral composition of State Domestic Product

[23] Other definitions of "neighbouring states" cannot be undertaken in this study due to unavailability of data of the factors mentioned above. It would be an interesting study to observe the case of physically well connected "neighbours", as results derived later in the paper suggest density of road and rail networks to be important factors explaining cross regional economic disparity.

[24] All non-parametric graphs and calculations were done using Quah's econometric shell tSrF.

Much of India's economy remains dominated by agriculture. Over the period 1965 to 1993 the share of agriculture in GDP has only shifted from 45 per cent to little over 35 per cent and industry from 18 per cent to little over 30 per cent and the rest is composed of services in the informal (mainly) and formal sectors. Till today, India's aggregate growth is strongly circumscribed by the fortunes of the agricultural sector. A number of studies on conditional convergence in India have advocated the importance of the differences in production structure across states in inferring conditional convergence (Nagaraj 1998, Cashin and Sahay 1996, Akkina, 1996). Could the continuing differences in production structure across the states be the driving force behind the polarisation?

Fig. 4a suggests, no. This stochastic kernel maps each state's income (relative to the national average) to that relative to the average income of states with the same sectoral composition. The conditioning groups regions by the sector (primary, secondary, or tertiary) in which their share in SDP was highest (relative to the national average). We find that the probability mass lies predominantly on the diagonal, suggesting that states with similar initial sectoral composition have not experienced similar outcomes. However, there is a twist anticlockwise, though weak, at the lower tail. The contour plot, Fig.4b, reveals this more clearly. This implies that poor states (states with 50% of national average income and below) have (mildly) experienced similar outcomes. States with GDP below 50 per cent of the national average, for example Rajasthan, Bihar and Orissa, Uttar Pradesh and Madhya Pradesh, constitute a group who are based on subsistence agriculture (except for Uttar Pradesh which has a developed agricultural sector), and those who contribute to less than 35 per cent (in aggregate) of India's GDP. The result obtained thus implies that, though we do not observe any conditional convergence, the structure of production does, to a certain extent, explain the formation of the lower income convergence club.

3.2.4 Conditioning on infrastructure

The precise linkages between infrastructure and economic growth and development are still open to debate. But it is widely agreed that the adequacies of infrastructure helps determine one country's success and another's failure - in diversifying production, expanding trade, coping with population growth, reducing poverty, or improving environmental conditions. Good infrastructure raises productivity, lowers costs, but it has to expand fast enough to accommodate growth[25], it must adapt to support the changing patterns of demand. How far does the distribution of infrastructure explain disparate economic growth performance in the Indian case? In this section we will show that the changing pattern of the distribution of infrastructure serves to explain much of the evolution of disparities in economic performance across Indian states.

Construction of an index of general infrastructure

The infrastructure indicators[26] (panel data) which we use for the analysis are the following. The states covered for the analysis are stated in the Appendix, and the period of study is 1977-1993. There are no missing observations.

Per capita electrical consumption (in kilowatt hours)

Per capita industrial consumption of electricity (in kilowatt hours)

---

[25]Infrastructure capacity grows step for step with economic output - a 1 per cent increase in the stock of infrastructure is associated with a 1 per cent increase in GDP across all countries in the world (World Development Report, 1994)

[26] The infrastructure indicators' data set has been provided by the India team, Development Centre, OECD, Paris. The author gratefully acknowledges thanks to Dr. A. Varoudakis and Dr. M.Veganzones for kindly providing the data set.

Percentage of villages electrified.

Percentage of gross cropped area irrigated

Road length (in kms per 1,000 square kms)

Number of motor vehicles per 1,000 population.

Rail track length (in kms per 1,000 sq.kms)

Literacy rates (in percentage of the age group)

Primary school enrolment (age 6-11, in percentage of the age group)

Secondary school enrolment (age 11-17, in percentage of the age-group)

Infant mortality in percentage)

Number of bank offices per 1,000 population

Bank deposits as a percentage of the SDP

Bank credit as a percentage of the SDP

To obtain a general idea on the overall provision of infrastructure across the states, and to observe the role of economic and social infrastructure as a whole in explaining the evolution of the income distribution, we construct a single index accounting for the each of the state's infrastructural base. One is also faced with the problem of multicollinearity because of a large number of infrastructural variables, which may result in inconsistent estimates. We use factor analysis to obtain the general index of infrastructure. This technique is a method of data reduction and attempts to describe the indicators as linear combinations of a small number of latent variables[27].

[27] This method was first used in development economics by Adelman and Morriss (1967) in an ambitious project to study the interaction of economic and non-economic forces in the course of development, with data on 41 social, economic and political indicators for 74 countries. For further discussion, see Adelman and Morriss (1968), and for more on factor analysis, see Harman (1976), or Everitt (1984)

The results of the factor analysis are tabulated in Table 1. We accept the first factor (f1, which we will call INFRA) to be the general index of infrastructure, which takes an eigenvalue of over 12. This means that this factor accounts for 12 (out of 17) variables of infrastructure. Our results suggest that the indicator INFRA accounts for over 87 per cent of the variation in the 17 infrastructure variables. We will be using this indicator for both non-parametric and parametric analyses.

The distribution dynamics of the index INFRA in Figure 5 sheds some interesting light on the change in its distribution. Though the bulk of the upper half of the probability mass lies on the diagonal, the bottom half twists sharply anticlockwise and runs parallel to the vertical line passing through 1. This implies that lower income group states have seen a convergence in their levels of infrastructure.

Conditioning on infrastructure.

Does the inter-state distribution of infrastructure have a role to play in explaining the polarisation of income across the states? Our results suggest, yes. Fig. 6a plots the stochastic kernel mapping each state's income (relative to the national average) to that relative to the average income of states with the same level of infrastructure[28]. The stochastic kernel is constructed using 6 groups of states which have the same level of infrastructure, based on the general index of infrastructure constructed earlier. The mapping obtained is encouraging, particularly so for the higher income and lower income group states. For the middle income states, however, one finds that the mass lies close to the diagonal, implying that one does not observe a "group effect". Level of infrastructure,

[28]Calculating *same level of infrastructure relative income* entailed calculating each state's income relative to the group average income to which they belong for each year.

hence, does not appear to be a factor which explains cross section disparity in middle income group states.

The range above 1.2 times the national average, and those below the national average stands out from the rest. This is clearly revealed in Figure 6b - here we observe a vertical spread of the probability mass centred around one. This suggests that these states have seen similar outcomes. The spike at around 0.5 of the national average in this range corresponds to the states of Bihar, Orissa, Rajasthan and Uttar Pradesh, Madhya Pradesh and Rajasthan, while the spike at around 1.2 of the national average corresponds to higher income states of Punjab, Haryana, Gujarat and Maharashtra. In Section 4, we will be using individual infrastructure indicators to observe their role in explaining the polarising feature of the income distribution.

3.2.5 Conditioning on State Development Expenditure

It has been argued by many that increased public spending in development is an important prerequisite for promoting sustained economic growth. (Sen and Ghosh 1993, Ravallion and Dutt 1998). Under India's constitution, the states are responsible for the bulk of the public services which are likely to matter most for the development of physical and human capital - such as agriculture, rural development, basic health and education spending. Development expenditure constitutes of expenditure on both economic and social services. The economic services include agriculture and allied activities, rural development, special area programmes, irrigation and flood control, energy, industry and minerals, transport and communications, science technology and environment; the social services include education, medical and public health, family welfare, water supply and sanitation, housing,

urban development, labour and labour welfare, social security and welfare, nutrition, and relief on account of natural calamities. In any case, these have a direct effect by increasing the productivity in investment, and also some indirect effects on aggregate demand in both rural and urban economies.

Could differing levels of state development expenditure be responsible for differential development across the states? Here, we do not assume state development expenditure to be exogenous – state development expenditure may feed into increasing domestic product, which again feeds into increased levels of development expenditure. The conditional distribution now is estimated in a different manner. Earlier we had grouped "similar" states and obtained the conditional distribution constituted of each units' individual income relative to its own group average. Conditional convergence would thus imply following group behaviour. But here, testing for conditional convergence will entail an approach almost similar to that undertaken under standard panel regression techniques. Here we will map the original distribution onto the conditioned distribution, where the conditioned distribution has been obtained by taking into account the endogenous nature of the conditioning factor with economic growth. We compute the conditional distribution by regressing state growth rates on a two sided distributed lag on log state development expenditure – current, lagged, and future, and some control variables (which are also used later in Section 4) and extract the fitted residuals for our analysis. This procedure, in large samples, is to result in an appropriate conditional distribution irrespective of the exogeneity of the explanatory variables. Such two sided distributed regressions are common in Granger causality analysis, and have been used earlier in Quah (1995, 1997b), Sims (1972). The method derives from that suggested by Sims (1972), and is adopted by 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 coefficients. If they are zero, i.e. future values of exogenous variables do not determine the present value of the LHS variable, then one can say that there exists no "feedback", or bi-directional causality. Needless to say, the residuals resulting from such an exercise would constitute the variation of the dependent variable unexplained by the set of exogenous variables, irrespective of endogeneity. The main novelty of using this time series methodology is that it uses a direct test for the existence of uni-directional causality.

Table 2 presents the results. In this regression we do not allow for individual effects, as permitting them is in effect leaving permanent differences in growth rates unexplained – which is exactly what we have set out to find. Coefficients of control variables are not stated in results. In all of the regressions we observe that the state development expenditure at lead 1 to lag 2 are significant in effecting growth – the rest are not so. For the estimation of the stochastic kernel, which follows, we use residuals from the second regression.

Figure 7a presents the stochastic kernel for the state development expenditure conditioning – the dominant features that characterise the kernel is that of the probability mass running mainly along the diagonal, indicating persistence and immobility for the most of the income distribution. A closer look, (the contour plot of Figure 7b) however, reveals that at higher income levels (those above the national average) and below 50% of the national average, the kernel twists anticlockwise. This implies that state domestic expenditure does affect the dynamics of the distribution at the higher and lower ends. As we will find in section 4, with or without accounting for the possible endogeneity, standard regression analyses obscure the distributional behaviour which is revealed using the distribution dynamics approach.

3.2.6 Conditioning on Education

It has been argued by many that the prospects for economic growth and properity are severely constrained by (inter alia) inequalities in basic health and education (Barro and Lee 1994, Dreze and Sen 1995). The distribution of education, in terms of the percentage of population literate, and with primary or secondary education across Indian states is indeed disparate - with the exception of Kerala, Tamil Nadu and West Bengal, which have neared total literacy, levels of literacy are as low 30 per cent as in the northern Indian states of Uttar Pradesh and Bihar. In this light we are interested in investigating whether the polarisation of the income distribution reflects the disparate dissemination of education across the states. Fig. 8a presents the stochastic kernel mapping each state's income (relative to the national average) to that relative to the average income of states with the same level of education. We construct the stochastic kernel using 6 groups of states which have the same level of education, based on a general index of education, constructed by factor analysis[29]. We use three indicators of educational attainment to construct this index – percentage of the population literate, primary school enrolment rates, secondary school enrolment rates. Here again, the map obtained is encouraging – though the results are not as strong as for the infrastructure conditioning. We find that for the lower income states the kernel twists anticlockwise, running fairly parallel to the "original" axis. Most of the upper half of the kernel runs along the diagonal.

Thus for the higher income states, a state's level of education tells us little about the evolution of its SDP. However, for the lower income states with 0.5 of the national average, and at the end of upper tail, the kernel twists anticlockwise, running fairly parallel to the

[29] The results of the factor analysis are not presented in the paper – the factor (f1) used for the analysis had an eigenvalue of over 2 (out of three variables) and accounts for 93 per cent of the variation of the 3 indicators. The stochastic kernel obtained by conditioning with only literacy or percentage with primary education yields almost identical mappings.

"original" axis. This implies that for lower income groups, and at the very upper end of the income distribution, education does explain the evolution of a state's SDP to a certain degree. The results only reinforce the argument that education is an essential pre-requisite to ensure success for any growth and development programme, particularly for the low income states.

3.2.7 Discrete version of the stochastic kernels: Using transition probability matrices

We now complement our stochastic kernel estimates with the discrete version of the stochastic kernels – the transition probability matrices. Here we divide the space of possible income values into r income states. An income state (0.2, 0.5) is one which comprises of regions with an income lying between 0.2 to 0.5 times the average income of the country. The probabilities obtained, give us the percentage of regions (in our case Indian states) which, given a starting income, have moved on to a different one. So, our row probabilities add up to one. The diagonal, in particular, provides interesting information. A diagonal with high values, indicates higher probabilities of persistence – the likelihood of remaining in a particular state when one starts there. Thus the smaller the diagonal, the greater intra-distributional mobility there exists. Like the stochastic kernel, conditional convergence would be indicated by the bulk of the probabilities concentrated at the income state around 1.

Tables 3a to 3e present the conditioning transition matrices for conditioning schemes which we have used earlier. The results confirm those of our continuous model. Once again, we find a heavy diagonal for the neighbours' transition matrix, indicating persistence, while the diagonal elements for the composition of SDP transition matrix are small. For the latter, we find that the probabilities for shifting to the higher income states are encouraging. Results

for the infrastructure transition matrix also reveal that economies in the second and third state have high probabilities of moving to higher states (2nd and 3rd, and 3rd and 4th respectively). The development expenditure matrix is also suggestive of mobility, particularly at the lower and higher states. Finally, the education transition matrix confirms our earlier findings – indicating mobility at the lower and very high income states.

3.3 Conditioning with parametric specifications

We now complement the earlier results with those derived from some standard parametric specifications to confirm the robustness of our results. Focusing on the evolution of the distribution as a whole allowed us to observe different interactions at different levels of the distribution. In most of our conditioning schemes we have found that different conditioning criteria have mattered at different parts of the distribution. For example, for conditioning schemes with infrastructure and state development expenditure, we found that they mattered most at the two tails of the distribution, with little effect on the middle-income group states. Observing differential behaviour at different levels of the income distribution is particularly important for policy purposes in targeting specific states with particular development strategies.

To complement our non-parametric results, and to confirm the robustness of our results we will now propose some parametric specifications.

For each state, i = 1,...., N over dates 1,....,T we estimate a growth regression given by

$$\ln Y_{it} - \ln Y_{it-1} = \alpha_i + \gamma X_i + \varepsilon_{it} \quad \text{.....(1)}$$

where the dependent variable is the growth rate of per capita income of state i in year t, α_i is a state- specific effect, X_i is a vector of regional characteristics, comprising of initial conditions and trends in exogenous time-dependent explanatory variables. The explanatory variables which are used in the analysis are as follows.

-share of agriculture in state domestic product

-rate of inflation measured as the change per year in the natural log of the (adjusted) CPIAL

-infrastructure (measured as INFRA, calculated earlier, incorporating both physical and social infrastructure. Individual infrastructural indicators as described earlier will also be used in the analysis.

-real state development expenditure per capita[30].

We account for differences in production structure across states by introducing the share of agriculture in SDP as a control variable. We also control for inflation; the adverse and disparate impact of inflation on regional growth has been identified in past research (Saith 1981, Bell and Rich 1994, Ahluwalia 1985)

One can specify the state-specific effects in two ways – as fixed or random. In the fixed effects approach, the regression intercept is assumed to vary across the states. We then estimate the regression using the least squares dummy variable approach (i.e. using a dummy variable for each state), or using a suitable transformation of the model to facilitate computation. On the other hand, when one estimates using the random effects approach, the state specific effect is modelled as an additional, time-invariant error term for each state.

[30] Data on state development expenditure and prices has been obtained from the World Bank dataset on India (Ozler, Ravallion, Dutt, 1998)

The covariance structure of the composite error term $\alpha_i + \varepsilon_{it}$ allows estimation by the generalised least squares method. This is our preferred specification, as allowing for individual effects is in effect leaving permanent differences in growth rates unexplained. The random effects approach also has an advantage in that it reduces the number of degrees of freedom lost due to the number of dummy variables introduced in the fixed effects approach. It also does not preclude the inclusion of time-invariant variables, such as regional dummies. However, the random effects approach assumes that the state specific random error is uncorrelated with the other explanatory variables which may not be the case. Thus to check for the appropriateness of the random effects approach we test for orthogonality of the random effects and the regressors using the Hausman test (1978). We will present results for both fixed and random effects specifications; the results only marginally differ. For all our tests (i.e. tests of significance and the Hausman test), we use the Huber-White estimate of variance which allows for different error variances across states as well as serial correlation for the states. To account for the endogeneity of infrastructure, we use the method of two stage least squares, to be detailed shortly.

Table 4 represents our results. In our first specification (columns 1 and 2) we observe the explanatory power of infrastructure in general, summarised by the indicator INFRA calculated earlier in Section 2, real development expenditure, and the initial level of SDP (in year 1977) with control variables - the share of agriculture in SDP and inflation. Column 1 summarises the fixed effects results, column 2 the random effects. We find that 36 per cent of variation in the growth rates are explained by the first model – this improves marginally for the random effects specification. For both specifications we find the coefficient for infrastructure (the variable used is INFRA, estimated earlier by factor analysis) to be positive and significant. The development expenditure indicator, is not significant in both cases. The coefficient for inflation too is not significantly different from zero in both

specifications. The coefficient of the initial level of income is negative, as would be expected, but is not significantly different from zero.

When the state specific effects are specified as fixed, one finds that the precision of the estimates decline (we find that the standard errors increase by about 40%). This is because a great deal of cross section information is absorbed in the state specific dummies. The large standard errors (not shown in results) suggest that the coefficients do not significantly differ between random and fixed effects estimates. This is confirmed by the Hausman test, where we do not reject the null hypothesis that the state specific effects are orthogonal to the regressors. In other words, we need not reject the random effects model in favour of the fixed effects model.

Columns 3 and 4 present results for a similar specification – only that we replace the general index of infrastructure by some basic infrastructural indicators included individually. The indicators which have a significant influence in explaining inter-state variation in growth rates are the following: percentage of net irrigated area of net cultivated area, per capita industrial power consumption, length of road network per 1000 sq km, infant mortality rate (marginally), primary education, and the ratio of bank deposits to the SDP. The last two indicators can be seen to be proxies for level of education and the depth of the financial sector, respectively. Replacing the variable INFRA by the individual infrastructural indicators increases the explanatory power of the model to almost 40 per cent. All of the indicators are observed to be significant. Our two control variables, the structure of production represented by the share of agriculture, and inflation, do not appear to significantly explain inter-state growth performances. The coefficient for development expenditure, too, is not significantly different from zero.

Irrigation, measured as percentage of gross cropped area irrigated, appears to be a significant explanatory variable in all specifications (including the 2SLS specifications following in columns 5 to 10). The states of Punjab and Haryana are exemplary of the radical benefits from the Green Revolution implemented in the mid sixties, which involved creating extensive irrigation facilities, alongside radical land reforms and provision of credit institutions. Per capita consumption of industrial power also appears to be consistently significant across all specifications. Other indicators of power consumption, i.e. that of percentage of villages with electricity, and per capita total consumption do not consistently appear as significant explanatory indicators.

The density of the road network, accounting for the effect of transport and communication, shows a positive and significant effect in all specifications. Other physical infrastructure variables, for example, number of vehicles per 1000 inhabitants, length of rail network, do not show up as significant variables explaining cross section growth variation. The importance of road networks over that of railroad connections and that of motor vehicles can be accounted for by the different forms of informal road transport[31] characteristic of poor economies connecting the villages, small townships, semi-urban areas, to the urban townships and cities. Despite developed rail connections within and between states, roads still remain the main means of communication between villages and the nearest townships.

Of the three education variables, primary education appears to have played a significant role in explaining differential growth performances across Indian states. In later specifications, (column 7-10) we find that literacy also explains a significant amount of variation. This too can be explained by the nature of economic development in rural and semi-urban areas and

townships, where employment is most in the tertiary sector, and is largely informal, requiring no more than a primary education. Also, rural India, which constitute over 75% of the Indian population[32], if at all provided with an educational institution, are most likely to have a government sponsored primary school - hence the significant impact of literacy and primary education in the results.

Finally bank offices per 1000 inhabitants, bank deposits and bank credit as a share of GDP, tested as proxies of financial development, result in a significant role of bank deposits in explaining inter-state growth performances.

3.3.1 Accounting for potential endogeneity bias

Infrastructure

Much of the insignificance, or very easily the significance, of many of the explanatory variables in our estimations so far may be attributed to endogenous nature of infrastructure. Reverse causality between infrastructure and economic growth (especially GDP per capita levels) may arise due to a number of reasons. Most infrastructural projects involve a substantial fixed cost which cannot be undertaken unless income is higher than a given threshold. Also, economies with a larger level of income can undertake bigger infrastructure programmes. It is also likely that new infrastructure is systematically located in areas where firms have more chances of being successful for reasons other than

[31]Apart from buses and different forms of motor vehicles, the main means of inter-village, and particularly village to town and town -town transport for transporting goods are hand-pulled carts, bullock-carts, and cycle rickshaws.

[32] Dreze and Sen (1995)

infrastructure availability. Proximity to markets, coastal areas, primary resources and labour can be factors that can attract productive investment.

To avoid biased estimates because of potential endogeneity we run two-stage least squares regressions. This involves running regressions of the individual infrastructure indicators and using their predicted values thus generated to estimate the growth regressions. The infrastructure equations are presented in Table 5, using random effects specifications. We use the predicted values of variables from these regressions to estimate the growth regressions. The results of the Column 5 and 6 in Table 4 now presents results of the fixed effects and random effects regression with previous specifications. We do not observe a significant increase in explanatory power, neither a major change in the values of the estimates.

The control variables of share of agriculture in SDP, inflation and real development expenditure are dropped in the following specifications, given their insignificance in the previous two specifications. Columns 7 to 10 present the results. In columns 7 and 8 we use the observed values of the variables, for both random and fixed effects - all of the variables used in the previous specification are significant in this specification too. In fact, they reveal a stronger effect. We also use a number of other infrastructural variables in this specification, but are not included in the results as they are insignificant. We also observe that literacy appears to be an important variable in explaining cross section variations in growth. We repeat this test with predicted values of the variables from the infrastructural equations - the main results remain unchanged.

State development expenditure

To rule out the possibility of any endogeneity of state development expenditure, we will run the same structural equations using the relevant residuals obtained earlier for explaining cross section disparities in growth. To obtain these we run two sided lagged distributions by projecting log GDP per capita on log state development expenditure - current, lagged and future. The residuals obtained from the appropriate regression is orthogonal to the regressors, irrespective of its exogeneity. These two sided lag distributions do not have any immediate economic meaning, but generate the appropriate conditional distributions. Table 2 shows the estimated regression coefficients. We re-run the regressions above with the residuals from the development expenditure regression. The results still show that development expenditure does not explain any variation in growth rates across states.

The insignificance of state development spending in our estimates does not necessarily mean that such spending is irrelevant to progress in reducing growth disparities, since other significant variables in the model may themselves be affected strongly by development spending. The impact of roads, education and infant mortality presumably reflects in part the development spending on physical and social infrastructure.

3.4 Implications for Public Investment Policy

Our empirical investigation has revealed quite clearly that measures aiming at the improvement of physical, economic and social infrastructure is imperative for the lower income group states to catch-up with the higher income club. What immediate implications does this have for public policy?

Most infrastructure in India is state-owned, and the responsibility of the public sector till the early nineties has been increasing. The public sector's share of the GDP was 2.5 times

greater in 1994 than in 1960, increasing from 10 to 25 per cent, see Table 6. State enterprises are dominant in the mining and power sectors (100 and 90 per cent respectively), as well as in the banking and insurance system (more than 80 per cent). The public sector accounts for up to 40 per cent of economic activity in transportation and telecommunications, as well as in other services, including health and education. All in all, investment in infrastructure constitutes the largest share of public investment, accounting for 50 to 70 per cent over 1960-94. Also, a substantial part of gross fixed capital formation also consists of infrastructure, between 30 and 40 per cent over 1980-94.[33]

The share of public investment in the various sectors has also been encouraging – public investment in infrastructure was particularly high over 1955-65, roughly covering the first three five year plans, and again from 1975 to the late eighties. Investment in the 1960s was targeted at the agricultural sector, (large irrigation works in particular), electricity and transport (mainly railroads). Higher national growth in the eighties has been attributed to the increase in public investment in infrastructure (Nayyar 1994, Nagaraj 1990). What is discouraging is that public investment has been cut since the liberalising reforms after 1991 (GOI, 1994), detailed in Table 7. This has hit hard on the transport and telecommunications sectors, in particular, and the banking and insurance sector, through public financial adjustment – public investment share in transport has dropped to 18% from 35% in the 1990s, in from 13% to 8% in telecommunications. Also, despite encouragement of private investment in various projects, very little has actually been undertaken[34] (Nagaraj, 1998).

[33] Source: National Accounts Statistics,various issues.

[34] Public investment data cannot be presented due to the difficulty in obtaining data. Public investment data is used in our analysis in the following chapter.

What is worrying is that in spite of the increase in public investment in infrastructure, inter-state incomes have continually polarised in the 1980s – findings of Chapter 1 reveal that income distribution polarised still in the decade of the eighties, through to the nineties. Such continual polarisation despite a step-up in investment in infrastructure suggests both the inadequacy of the amount of investment, and the possibility that existing investments being subject to improper utilisation. The former possibility suggests a further increase in investment required in these areas, while the latter suggests an investigation into the channels of dissemination of such funds into creation of infrastructure. This is beyond the scope of this thesis and remains to be explored in future projects.

3.5 Conclusion

Chapter 1 revealed that the statewise GDPs have undergone polarisation over the period 1965 to 1997. In this chapter, we ask the question – what drives this polarisation? We have attempted to investigate the role of infrastructure, state development expenditure and that of economic spillovers from neighbouring states, over the period 1977 to 1993. Of these, we observe that economic and social infrastructure plays a significant role in driving the process of polarisation, particularly so for the lower income states. State development expenditure and the composition of the state domestic product explains the polarisation to a certain extent too. These results together suggest that higher investment in infrastructure for the lower level states, is essential to counter the forces of polarisation. The role of neighbouring states, in that states follow their physical neighbours' outcomes, is not shown to have a significant role in explaining the observed polarisation.

Of the infrastructure indicators we find the extent of irrigation, roads, power consumption in industrial sectors, education and bank deposits to be infrastructure which significantly explain inter-state variation in growth. Conditional convergence is occasionally observed but is not robust to specifications. Given that the distribution dynamics suggest that economic and social infrastructure explain the formation of the lower income club, the parametric results highlight the individual elements of infrastructure which explain the cohesive forces at the lower income convergence club.

There are directions for future research. The empirical results suggest that the relationship between infrastructure and economic growth is a significant one. This is especially so for the lower income states. What requires to be investigated further is the channels through which these different kinds of infrastructure promote growth. In particular, it would be useful to have a well-defined model defining all the channels through which infrastructure promotes growth, and then use this to separately decompose each effect.

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.

Technical Appendix

(A)Here we will present the formal underlying structure for both models (stochastic kernels and transition matrices) highlighting distribution dynamics. This is detailed in Quah (1997a and b)

Let us first consider the continuous version. The model is one for a stochastic process that takes values which are probability measures associated with the cross section distribution.

Let F_t be the probability measure associated with the cross section distribution. The following probability model holds:

$$F_{t+1} = T^*(F_t, u_t). \qquad (1)$$

Here T* is a mapping operator which maps probability measures in one period (with a disturbance term) to those of another. It encodes information of the intra-distribution dynamics: how income levels grow closer together or further away over successive time periods. Our task is to estimate T* from the observed data set.

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

$$F_{t+s} = T^{*s} \cdot F_t. \qquad (2)$$

As s tends to infinity 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.

Handling equation (11) is difficult; hence, the concept of the stochastic kernel was introduced to estimate the long run behaviour of the cross-section distribution[35].

Let us consider the measurable space (**R**, R). R is the real line where the realisations of the income fall and R is its Borel sigma algebra. B (**R**, R) is the Banach space of finitely additive functions. Let F_{t+1} and F_t be the elements of B that are probability measures in (**R**,R). A stochastic kernel is a mapping M : **R** x R -> [0,1], satisfying the following :

(i) $\forall$ a $\in$ **R**, M (a,.) is a probability measure.

(ii) $\forall$ A in R, M (.,A) is a sigma measurable function.

Then M(a,A) is the probability that the next state period lies in the set A, given that the state now is a.

For any probability measure F on (**R**, R) $\forall$ A in R:

$$F_{t+1} = \int M(x, A)\, dFt(x) \qquad (3)$$

, where M (.,.) is a stochastic kernel, and $F_{t+1}(A) = (T^*F_t)A$. T* is an operator associated with the stochastic kernel that maps the space of probabiities in itself, (adjoin of the Markov operator associated to M). The above equation (12) measures the probability that the next period state lies in the set A, when the current state is drawn according to the probability measure F_t. F_{t+1} i.e. T^*F_t is the probability measure over the next period state, when Ft is the probability measure over this period. Hence we can consider the T* in the previous equations as being generated by the above differential equation. Our empirical estimation will involve in estimating a stochastic kernel as decribed above.

Such stochastic kernels though satisfactory as a complete description of transitions, are however, simply point estimates and we are yet to have a fitted model. It is thus not possible to draw inferences and derive long run estimates. However, it is possible for us to

[35]See Stokey, Lucas and Prescott (1989) and Silverman (1986)

infer whether income levels have been converging and diverging. For these computations, we turn to the discrete formulation of the above.

Transition probability matrices

Now let us consider the discrete version. Given that using the stochastic kernel it is not possible for us to draw any inferences about the long run tendencies of the dsitribution of income, we now turn to a discrete version of the above calculation. Here we calculate T* from the above equation (1.15) and to compute the values using (1.14). T* is calculated assuming a countable state-space for income levels $Yt = \{ y_{1t}, y_{2t}, ..., y_{rt} \}$. Thus T* is a transition probability matrix Q_t , where

$F_t = Q_t (F_{t-1}, u_t)$

Qt encodes information of the short run distribtuion dynamics and the long run information is summarised by the ergodic distribution - it gives the distribution across states that would be acheived in the long run. Here, convergence is takes place when the ergodic distribution degenerates towards a mass point. The transition matrix and the stochastic kernel together expose the deep underlying short run and long run regularities in the data.

(B) Here we shall explain how the stochastic kernel comes useful in explaining distribution dynamics. The idea is that, to understand if a hypothesised set of factors explains a given distribtuion dynamics we will simply be asking whether the stochastic kernel transforming the unconditional distribution to a conditional one removes the same features which characterised income distribtuions as distorted. The following explains the above.

We consider the definition of the stochastic kernel, once again.

Consider the measurable space (R, R). R is the real line where realisations of income fall and R is its Borel sigma algebra. B(R,R) is the Banach space of finitely additive functions. Let ν and μ be elements of B that are probability measures in (R,R). A Stochastic Kernel is a mapping M:RxR -> [0,1], satisfying:

(i) $\forall x \in R$, $M_{(\mu,\nu)}$ (x,.) is a probability measure.

(ii) $\forall$ A$\in$R, $M_{(\mu,\nu)}$ (.,A) is a sigma measurable function.

Then $M_{(\mu,\nu)}$(x,A) is the probability that the next state period lies in set A, given that in this period the state is in x.

For any probability measure μ (A) on (R,R), $\forall$ A in R:

$$\mu(A) = \int M_{(\mu,\nu)}(x,A)\, d\nu(x)$$

or, $(T^* \nu)(A). = \int M(x,A)\, d\nu(x)$ ...(iii)

where, M (.,.) is a stochastic kernel, and $\mu(A) = (T^* \nu)(A)$. T^* is an operator associated with the stochastic kernel that maps the space of probabilities in itself (adjoin of the Markov operator associated to M). Conditions (i) and (ii) simply guarantee that interpretation of (iii) is valid. By (ii), the right hand side of (iii) is a well defined Lebesgue integral. By (i), the right hand side of (iii) is weighted average of probability measures. It however, nowhere requires that ν and its image μ under T^* be sequential in time. Thus the stochastic kernel M representing T^* can be used to relate any two different distributions - sequential in time, or not. In the distribution dynamics case, we specify ν and its image μ to be F_t and F_{t+1}, which are sequential in time. For the conditioning exercise, we use the stochastic kernel M representing T^* (with ν and its image μ under T^*) to relate two different distributions -. distribtuions of which ν and its image μ are two realisations of the random element - the unconditional distribution and the conditional distribution in the income distribution space.

Table 1

Results of Factor Analysis

Components	Eigenvalue	Cumulative R^2
f1	12.41	0.83
f2	1.22	0.91
f3	1.00	0.97

Factor Loadings

	f1	f2	f3
total power consumption	0.97	-0.16	0.10
power consumption in industrial sector	0.95	-0.12	0.04
percentage of villages electrified	0.99	0.04	-0.08
percentage of net area operated with irrigation	0.95	-0.20	0.18
length of road network per 1000 sq kms.	0.97	-0.12	0.10
number of motor vehicles per 1000 inhabitants	0.89	0.07	-0.37
length of rail network per 1000 sq.kms	0.61	-0.47	0.60
literacy rate of adult population	0.98	-0.04	-0.15
primary school enrolment rate	0.97	0.04	-0.08
secondary school enrolment rate	0.98	-0.13	-0.02
infant mortality rate	-0.96	0.05	0.22
bank offices per 1000 people	0.91	0.24	-0.30
bank deposits as a percentage of SDP	0.75	0.57	0.28
bank credit as a percentage of SDP	0.58	0.68	0.40

Table 2. Conditioning regressions (two sided projections) of growth rates on State development expenditure (real)

State development expenditure	Co-efficients in two-sided projections		
Lead 4			-0.00 (0.003)
3		0.010 (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)
4			
Sum of co-efficients	-0.01	-0.04	-0.014
R^2	0. 10	0. 10	0. 11

Note: Numbers in parentheses are OLS standard errors

Table 3a. Inter-state conditioning on neighbours transition matrix

Number	Upper end point				
	0.272	0.623	0.760	0.916	1.22
76	0.35	0.35	0.24	0.05	0.01
76	0.00	0.42	0.33	0.14	0.11
27	0.00	0.25	0.53	0.14	0.08
45	0.03	0.00	0.55	0.32	0.10
41	0.00	0.04	0.00	0.04	0.74
Ergodic	**0.015**	**0.042**	**0.30**	**0.51**	**0.133**

Table 3b. Inter-state conditioning on composition of state domestic product, transition matrix

Number	Upper end point				
	0.288	0.614	0.756	0.925	1.18
71	0.35	0.14	0.35	0.14	0.01
67	0.00	0.25	0.19	0.46	0.09
34	0.00	0.06	0.56	0.26	0.12
38	0.00	0.00	0.13	0.21	0.66
30	0.00	0.00	0.00	0.00	0.00
Ergodic	**1.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 3c. Inter-state conditioning on infrastructure transition matrix

Number	Upper end point				
	0.208	0.626	0.762	0.916	1.1
89	0.10	0.31	0.40	0.17	0.01
62	0.03	0.08	0.29	0.52	0.08
32	0.03	0.19	0.19	0.41	0.19
31	0.03	0.00	0.32	0.10	0.55
41	0.00	0.02	0.00	0.20	0.78
Ergodic	**0.013**	**0.042**	**0.105**	**0.21**	**0.78**

Table 3d. Inter-state conditioning on state development expenditure, transition matrix

Number	Upper end point				
	0.274	0.620	0.760	0.926	1.22
84	0.21	0.26	0.37	0.14	0.01
66	0.00	0.14	0.33	0.42	0.11
36	0.00	0.14	0.25	0.53	0.08
33	0.00	0.00	0.12	0.24	0.64
30	0.00	0.00	0.00	0.06	0.94
Ergodic	**0.000**	**0.002**	**0.013**	**0.077**	**0.907**

Table 3e. Inter-state conditioning on composition on education, transition matrix

Number	Upper end point				
	0.253	0.605	0.763	0.896	1.12
76	0.32	0.18	0.37	0.12	0.01
76	0.03	0.07	0.38	0.39	0.13
27	0.00	0.19	0.37	0.30	0.15
40	0.00	0.05	0.20	0.28	0.47
46	0.00	0.00	0.00	0.11	0.89
Ergodic	**0.001**	**0.02**	**0.06**	**0.15**	**0.89**

Table 4. Panel Regressions

dependent variable $\ln y_t - \ln y_{t-1}$	1 FE	2 RE	3 FE	4 RE	5 FE – IV	6 RE-IV	7 FE	8 RE	9 FE-IV	10 RE-IV
initial income level	-0.015 (.479)	-0.015 (0.388)	-0.013 (0.65)	-0.013 (0.34)	-0.013 (0.72)	-0.013 (0.78)	-0.016 (0.71)	-0.016 (0.88)	-0.017 (0.715)	-0.017 (0.9)
share of agriculture in SDP	-0.17 (0.69)	-0.17 (0.62)	-0.17 (0.75)	-0.17 (0.55)	-0.17 (0.69)	-0.15 (0.72)				
Inflation	-.218 (1.27)	-0.217 (1.25)	-0.2 (0.21)	-0.2 (0.22)	-0.21 (0.14)	-0.20 (0.22)				
Index of infrastructure (f1)	0.001* (4.78)	0.001* (4.74)								
state development expenditure	-.02 (0.172)	-0.02 (0.146)	-0.05 (0.33)	-0.05 (0.26)	-0.05 (1.78)	-0.05 (1.92)				
%net irrigated area of net cultivated			0.169* (5.87)	0.168* (5.99)	0.169* (6.01)	0.169* (6.99)	0.178* (6.39)	0.178* (6.39)	0.178* (6.01)	0.179* (6.39)
per capita industrial power consumption			0.021* (6.99)	0.022* (7.21)	0.02* (5.12)	0.02* (5.6)	0.062* (9.48)	0.063* (9.6)	0.063* (8.29)	0.063* (8.28)
length of road network per 1000			0.033* (4.99)	0.003* (5.59)	0.003* (6.01)	0.003* (7.89)	0.004* (8.19)	0.004* (8.67)	0.004* (6.29)	0.004* (6.99)
Literacy of adult population							0.485* (6.86)	0.487* (6.99)	0.485* (6.28)	0.485* (6.43)
Primary school enrolment rate			0.073* (4.23)	0.072* (5.17)	0.062* (5.01)	0.063* (5.13)	0.086* (10.01)	0.087* (10.12)	0.085* (10.06))	0.084* (10.11)
Infant mortality rate			-0.007** (2.25)	-0.007** (2.02)	-0.006** (2.12)	-0.006** (2.45)				
bank deposits as a % of SDP			0.012* (5.2)	0.012* (4.3)	0.012* (4.4)	0.012* (4.9)	0.106* (4.71)	0.106* (4.89)	0.106* (4.72)	0.106* (4.8)
R^2	0.36	0.36	0.39	0.39	0.39	0.39	0.64	0.64	0.64	0.64
Hausman specification test		8.4 (0.39)		8.2 (0.43)		8.7 (0.31)		9.3 (0.28)		9.2 (0.30)

Notes: 1. Absolute t ratios in parentheses

2. * denotes that coefficient is significantly different from zero at 5% level, ** at 10% level.

3. The Hausman test is a test of random vs fixed effects

Table 5. Infrastructure Equations

	1 power conspn	2 length of roads	3 primary enrolme- nt	4 infant mortality rate	5 bank deposits
Share of agriculture in SDP			-0.55 (0.72)	-0.55 (0.92)	
Share of industry-transport in SDP	0.17 (2.34)	0.58 (4.28)	-1.03 (8.36)		0.388 (3.03)
Percentage of villages electrified	0.09 (5.83)	0.48 (3.26)	0.39 (11.74)	-0.39 (11.6)	0.09 (5.9)
Length of rail network	36.12 (15.65)	6.49 (11.2)		-0.23 (2.84)	3.27 (8.71)
Percentage of population literate	2.12 (8.93)		-0.64 (7.94)	-1.03 (8.94)	0.42 (15.0)
Percentage of population with secondary education	4.85 (17.67)				
No. of banks in area per 1000 inhabitants		0.39 (6.37)	1.56 (7.16)		0.14 (8.99)
R^2 adjusted	0.97	0.97	0.98	0.98	0.96
Number of observations	255	255	255	255	255
Hausman specification test (p values)	9.22 (0.29)	12.7 (0.32)	8.72 (0.40)	6.7 (0.42)	8.9 (0.39)

Notes: 1. Absolute t ratios in parentheses

2. * denotes that co-efficient is significantly different from zero at 5%, ** at 10%

3. Hausman test is a test of random vs. fixed effects

Table 6

Public Sector Share in Real GDP
(totals and by sectors of activity, in percentage)

	Agric	Mining	Manufg	Electricy. Gas & Water	Constrcn	Transport Storage & Communicn	Banking, Insurance	Other Services	Total
1960-70	1	21	18	86	6	56	43	19	11
1970-80	2	69	20	92	10	56	76	30	17
1980-90	2	100	22	93	18	50	85	43	22
1990-94	2	100	24	91	19	42	83	44	25

Source: National Accounts Statistics, various issues, from Nagaraj (1998)

Table 7

Share of Infrastructure in Public Investment (in percentages)

	Agric	Electricity. Gas & Water	Constrcn	Transport	Communicn	Other Services
1960-70	22	33	1	35	7	3
1970-80	24	38	2	19	13	4
1980-90	18	49	2	18	8	5

Source: Joshi and Little (1994)

Fig1a. Relative income dynamics across Indian States, 1 year horizon

1965-70

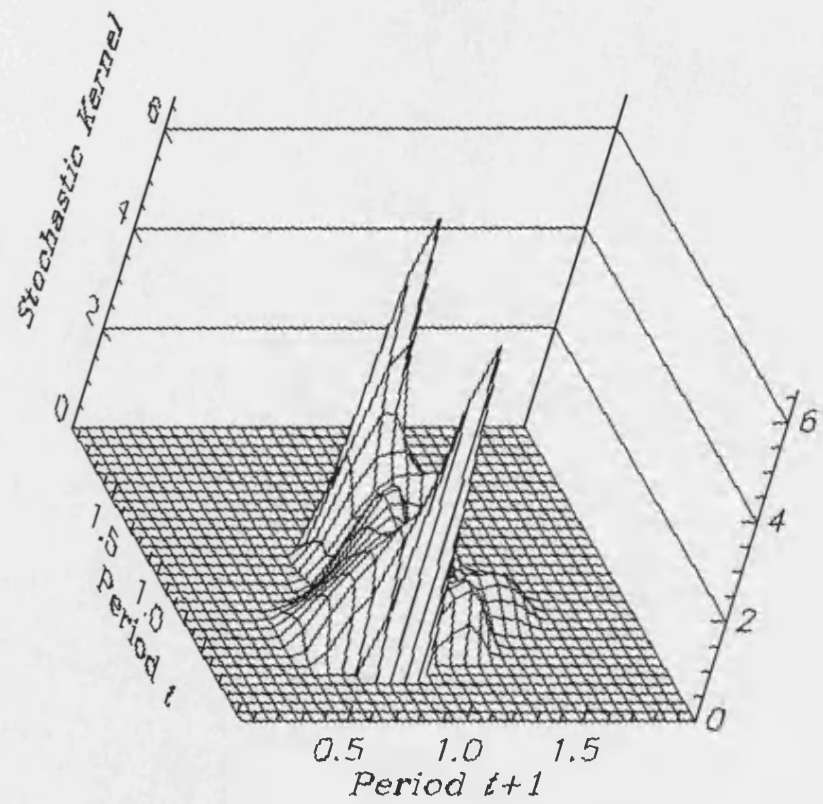


Fig1b. Relative Income Dynamics across Indian states, 1 year horizon 1971-80

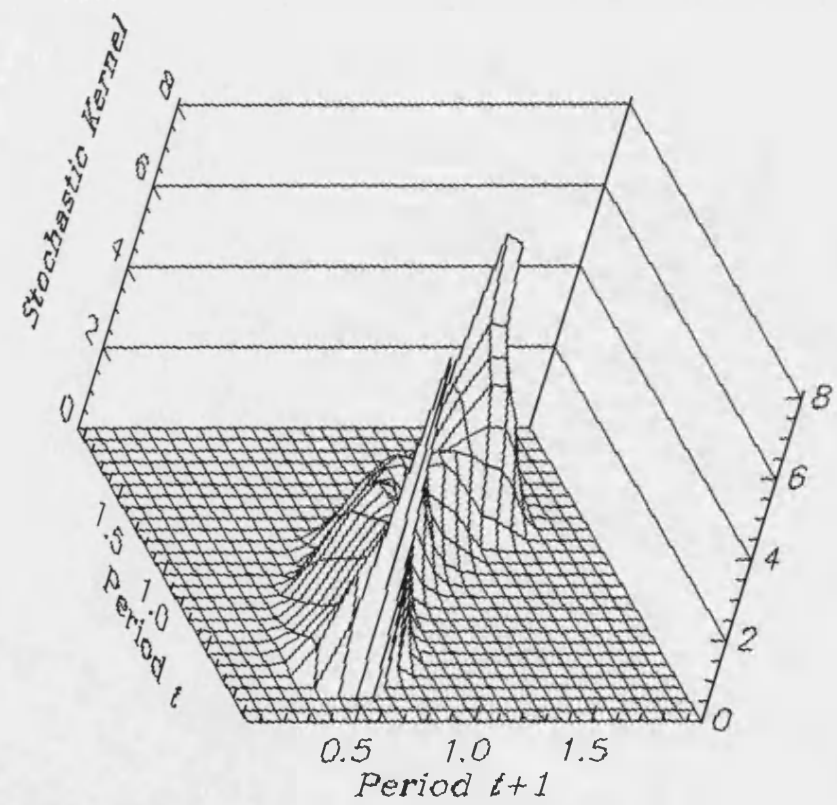


Fig1c. Relative Income Dynamics across Indian states, 1 year horizon 1981-88

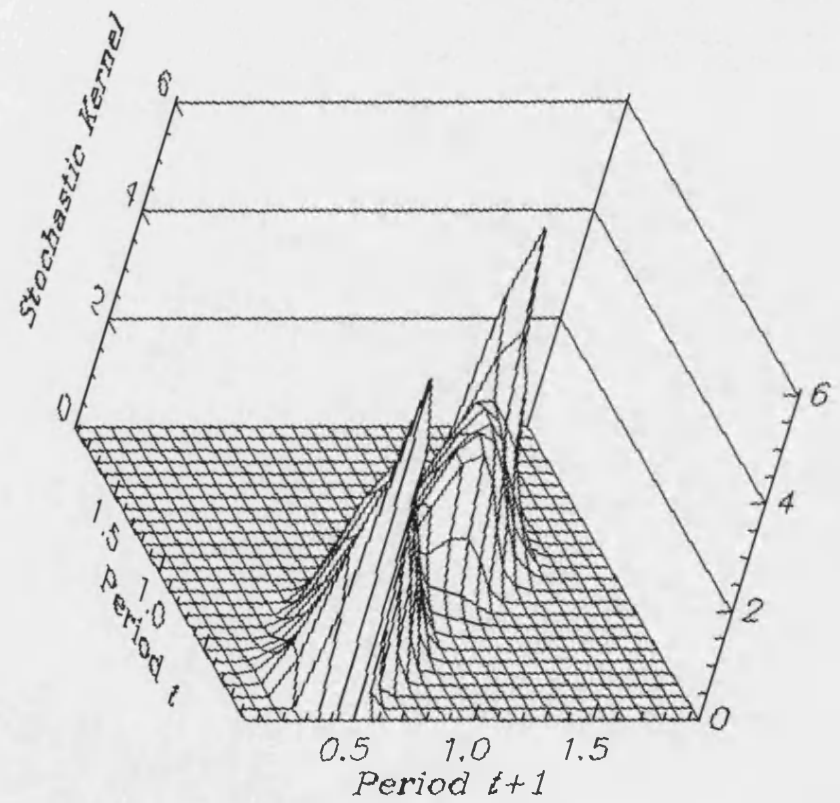


Fig. 1d: Relative Income Dynamics across Indian States, 1 year horizon 1989-96

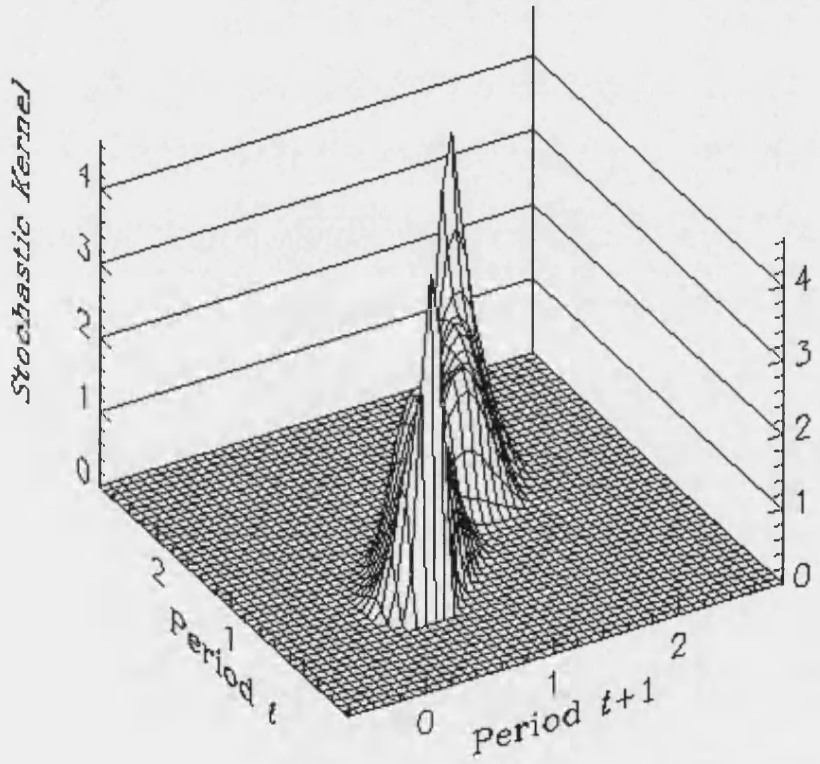
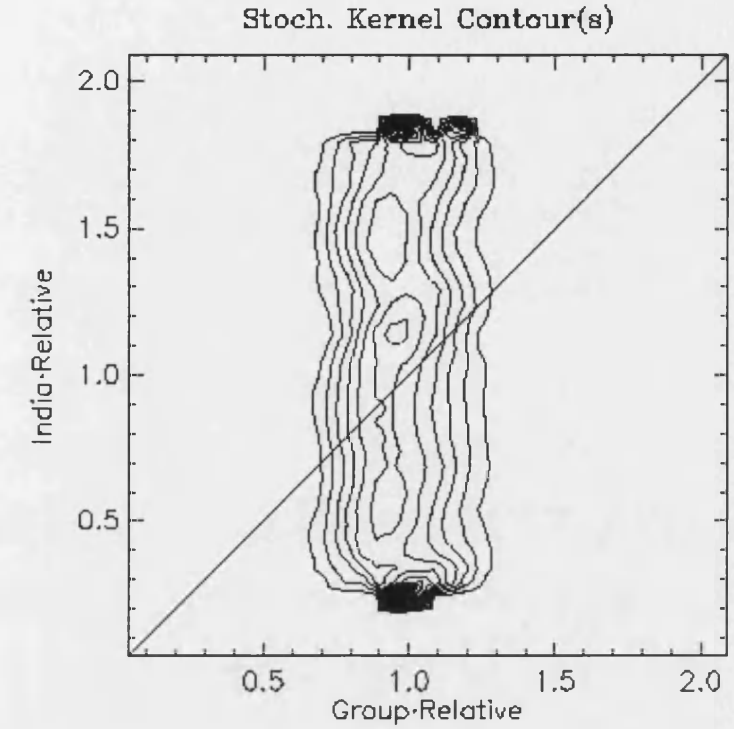


Fig 2a & b. Benchmark Stochastic Kernels



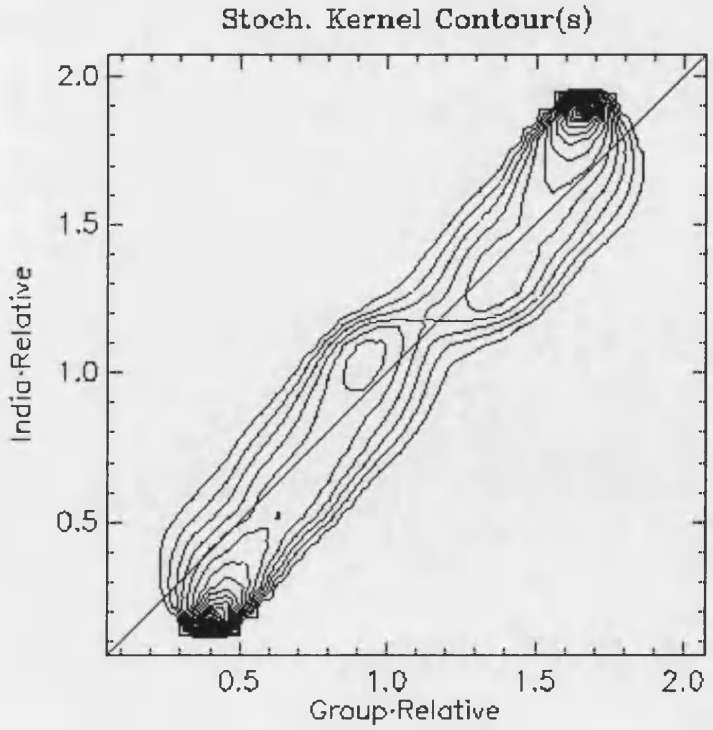


Fig 3a.Relative per capita incomes across Indian states
Neighbours conditioning

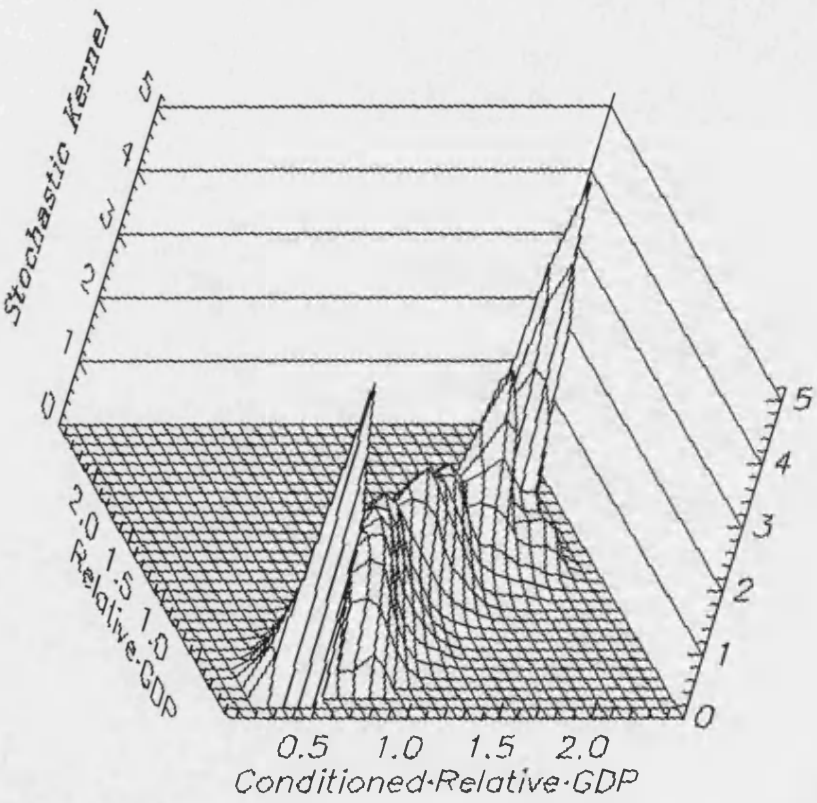


Fig.3b. Relative per capita Incomes across Indian states
Neighbours conditioning, contour

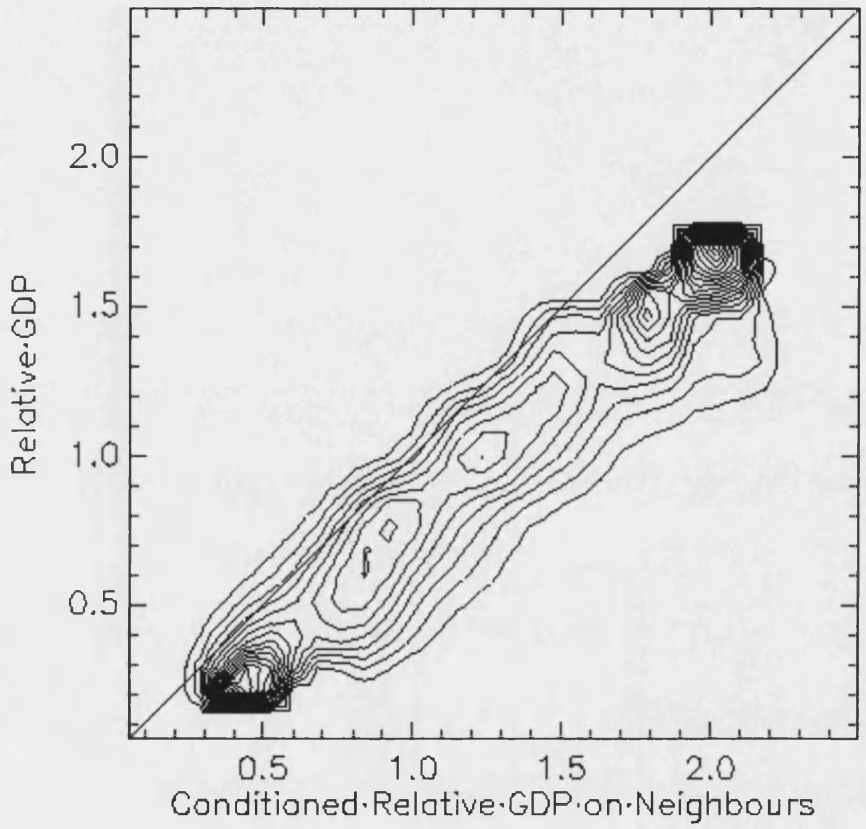


Fig4a. Relative per capita incomes across Indian states
Composition of State Domestic Product conditioning

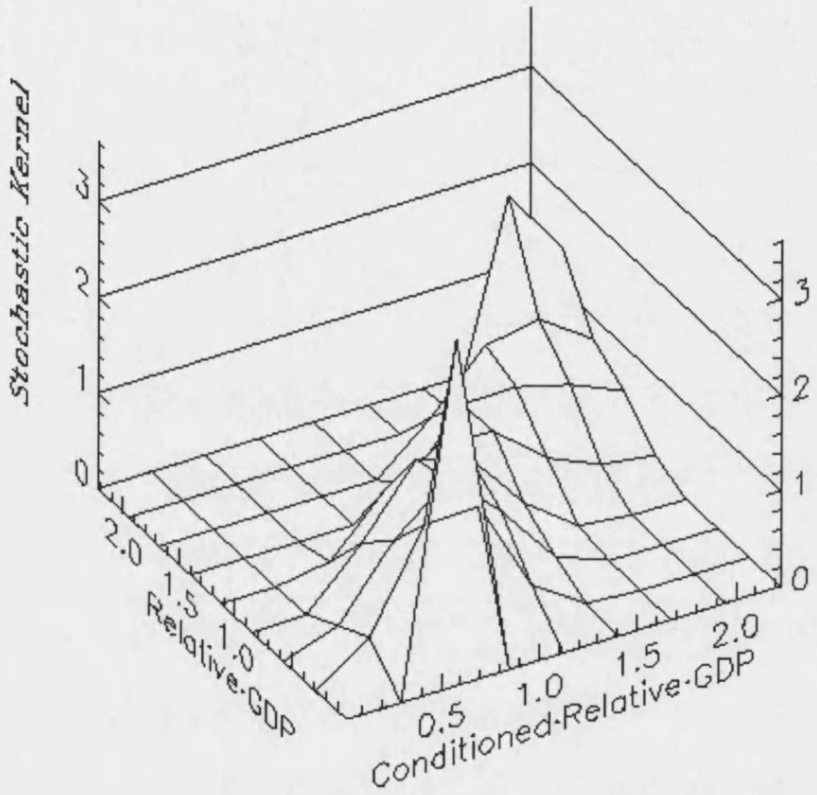


Fig4b. Relative per capita incomes across Indian states
Composition of State Domestic Product conditioning, contour

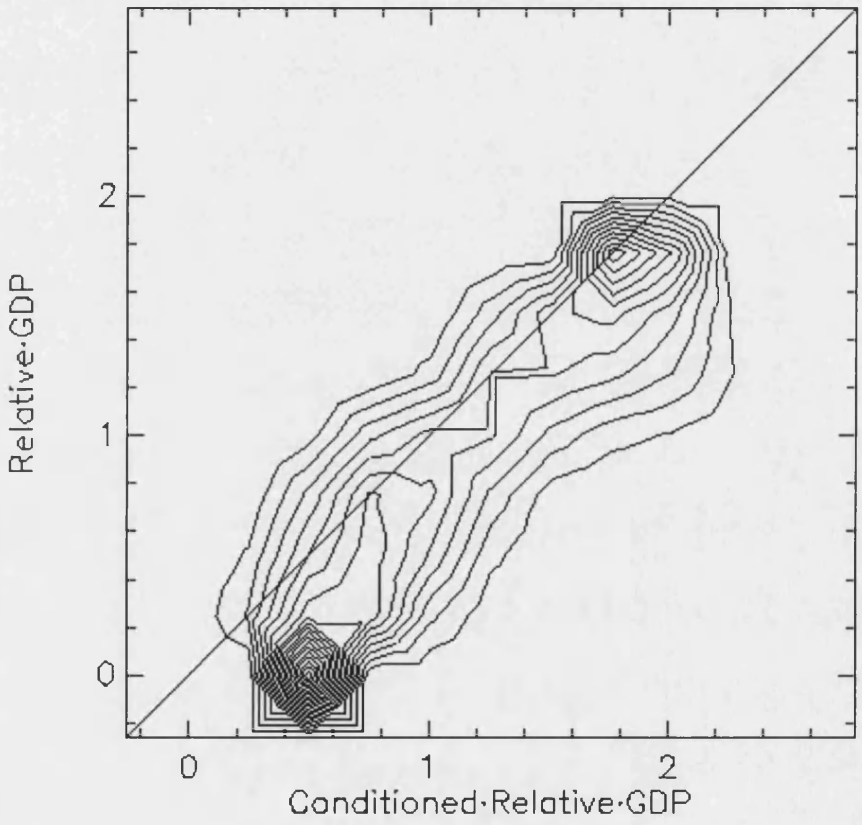


Fig 5. Infrastructure dynamics across Indian states
Contour plot, 1978-1993

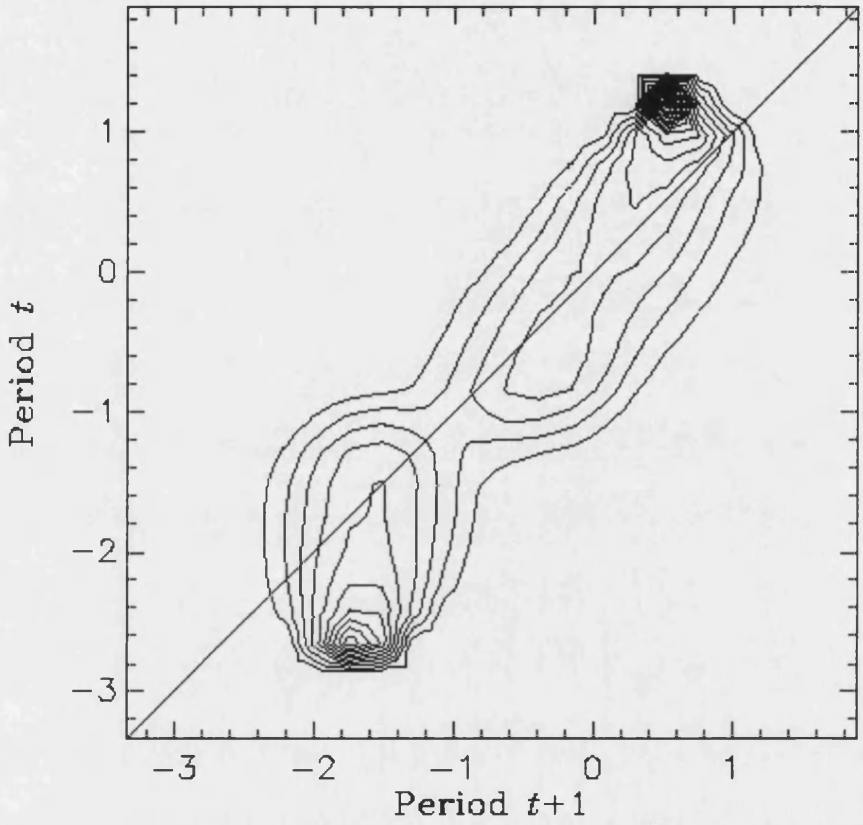


Fig.6a. Relative per capita incomes across Indian states
Infrastructure conditioning

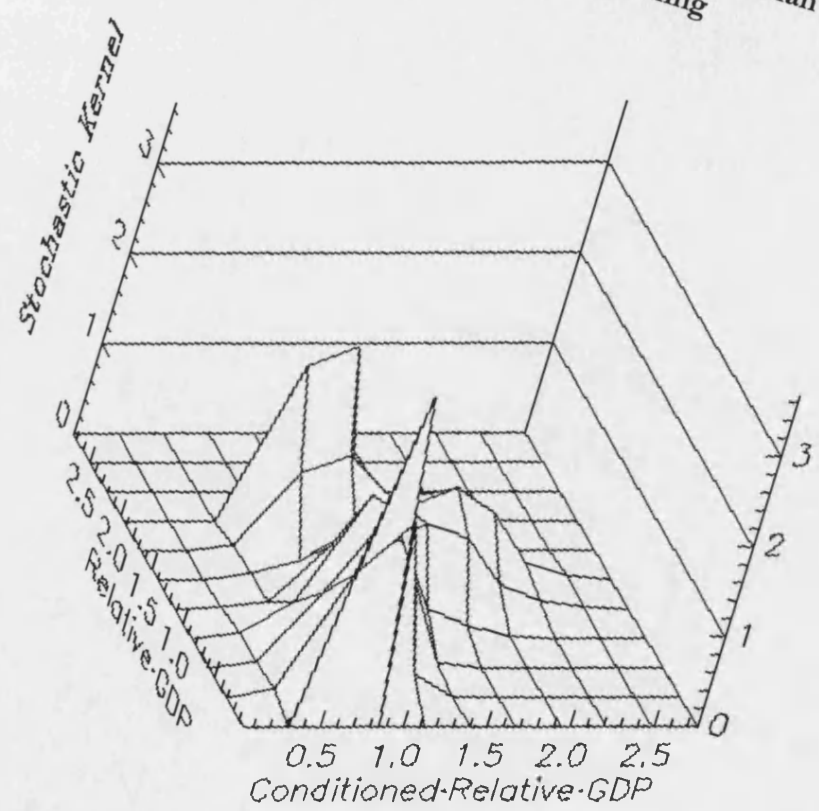


Fig.6b. Relative per capita incomes across Indian states
Infrastructure conditioning, contour

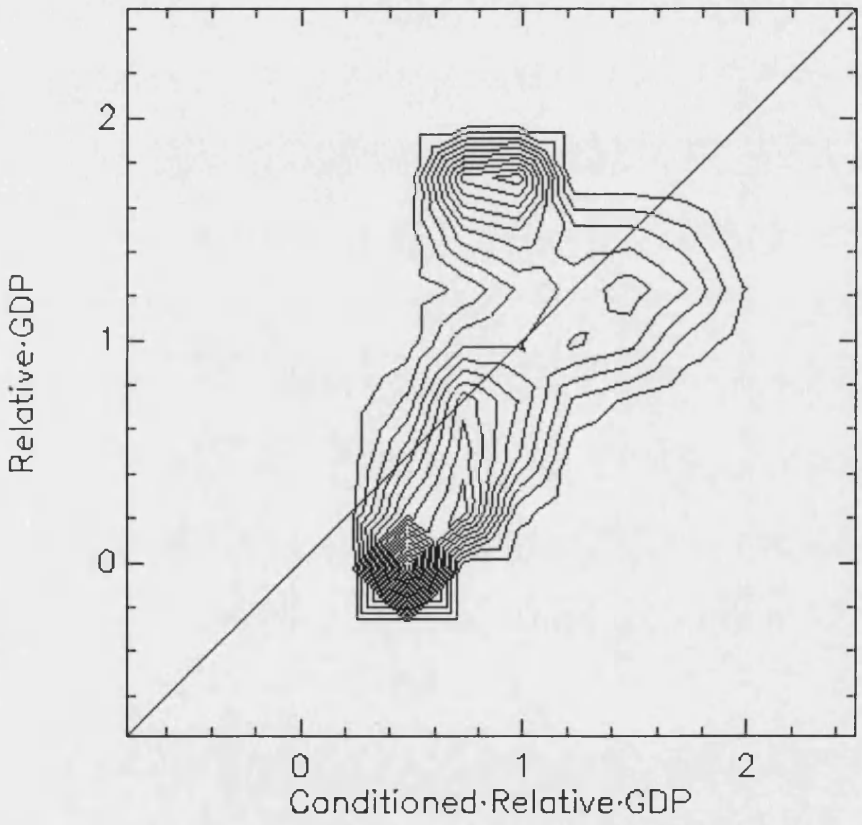


Fig.7a. Relative per capita incomes across Indian states
State development expenditure conditioning

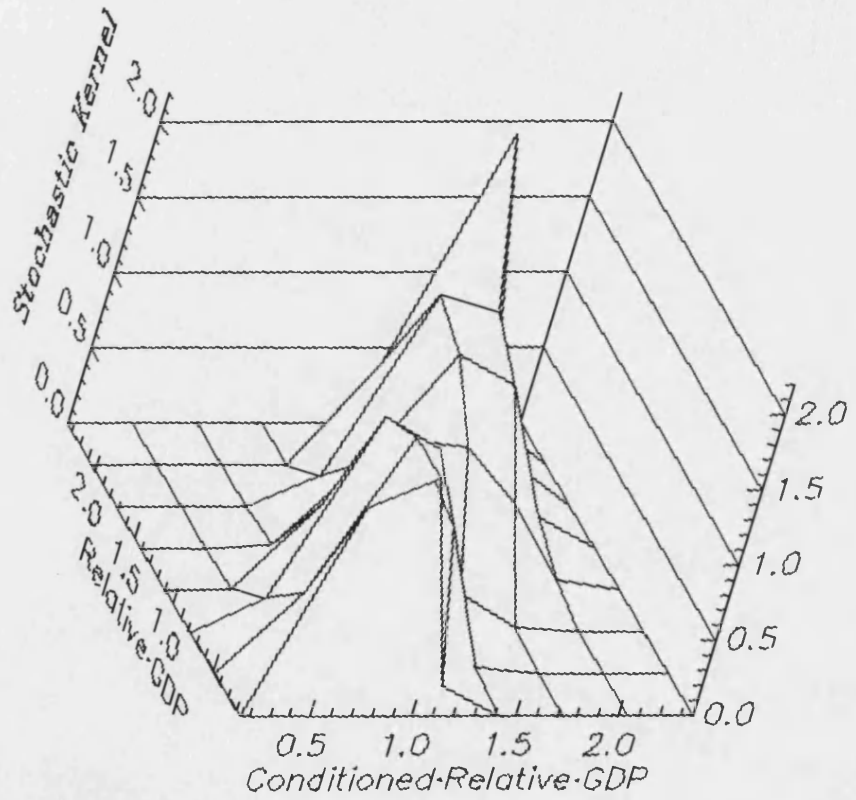


Fig7b. Relative per capita incomes across Indian states
State development expenditure conditioning, contour

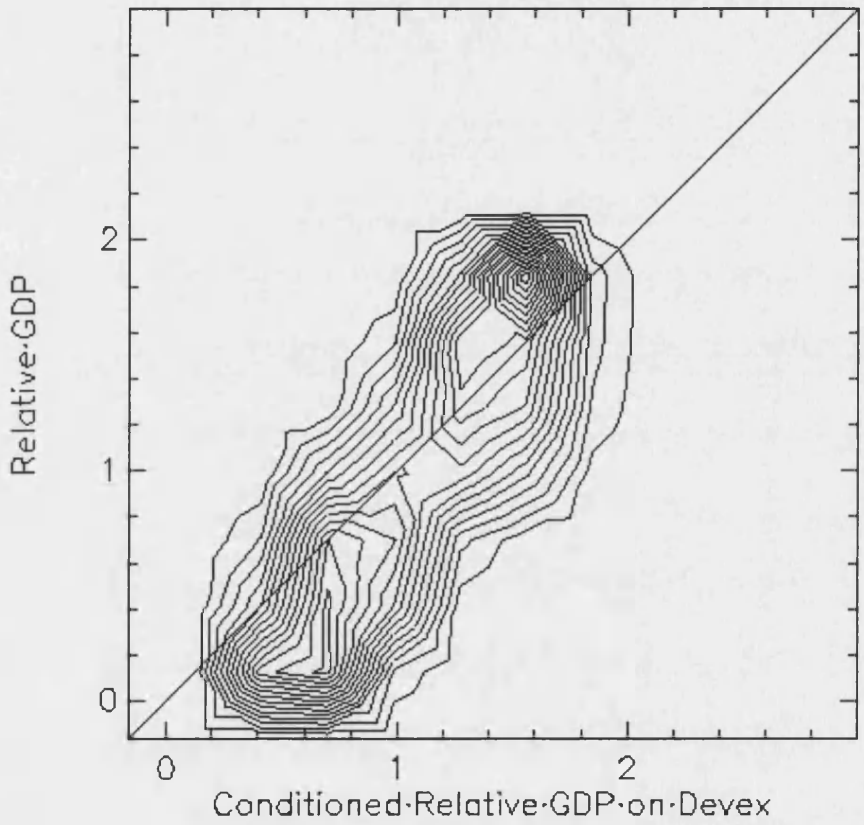


Fig8a. Relative per capita incomes across Indian states
Education conditioning

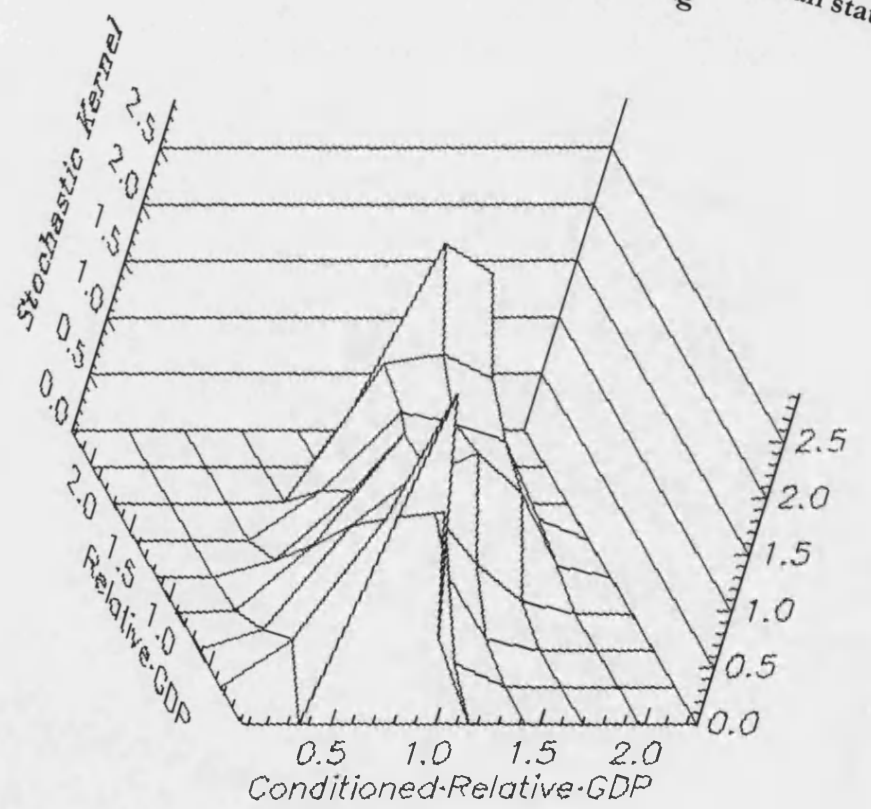
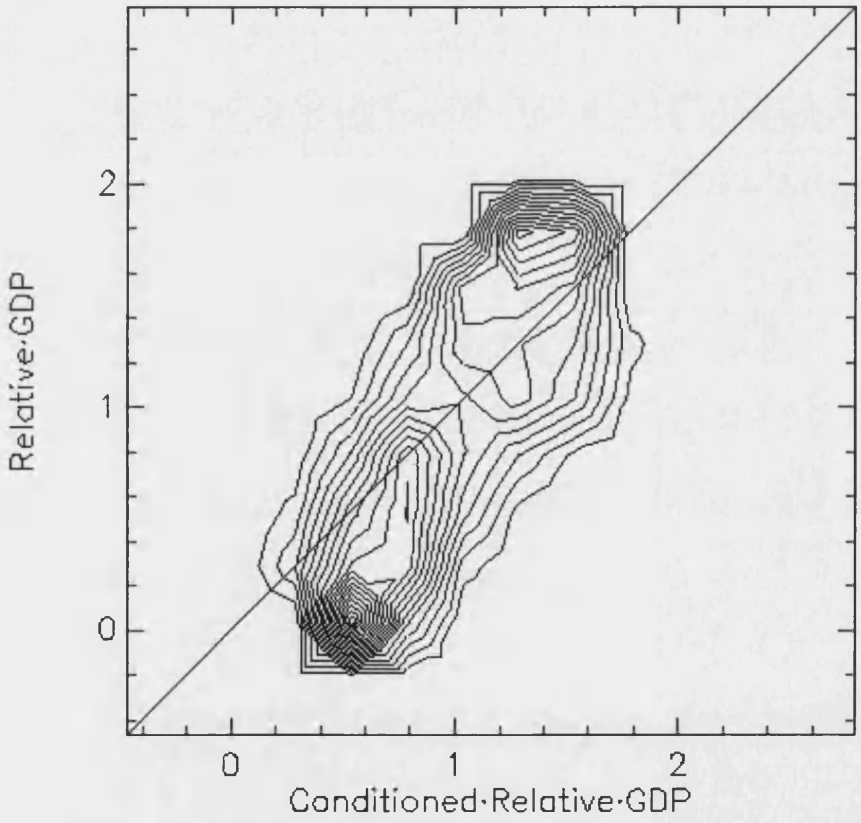


Fig8b. Relative per capita incomes across Indian states
Education conditioning, contour



Chapter 4

Regional Distribution Dynamics of GDPs across Indian states: Role of Macroeconomic Stability and Political Governance

4.1 Introduction

Chapter 1 revealed that the income distribution across the Indian states, over 1965 to 1997 had polarised into two income convergence clubs – one at 50 per cent of the national average, another at 125 per cent of the national average. Further analysis reveals that while there were some cohesive tendencies observed in the late sixties, these were only to dissipate in the later decades of the seventies, eighties and the nineties. Findings in Chapter 2 reveal that infrastructure, both economic and social, explain a lot of the lack of convergence of incomes across the states, over the period 1977-93. What is also of interest is that infrastructure explains the formation of the lower income club, in particular. In this chapter we will look at another set of factors considered to be of significant importance in understanding cross-country or cross-regional growth – the role of macroeconomic stability and political governance.

This is of particular interest given the recent fiscal crisis facing the Indian states – the fiscal deficit to GDP ratio of all states hit an all time high in Indian fiscal history in 1999[36]. Though aggregate growth was at a unprecedented 6% consistently over the period 1987-97, India had one of the largest fiscal deficits in the world, at over 6.2 per cent of the GDP, surpassed only by Brazil, Pakistan and Nigeria. Unsustainable deficits deeply concern

policymakers and there exists no single consensus on the composition of fiscal consolidation. India's trade balance was relatively in control, after the initial balance of payments crisis in the early 1990s, and inflation has mostly been in single digit or low double-digit figures. The fiscal crisis has also been accompanied by a definite change in the political atmosphere since the early 1990s. With more than four changes in the Indian government in the last four years, poverty reduction programmes' budgets and development spending have been slashed, and the states' debt bill has mounted too. The fiscal crisis has been accompanied by political turmoil too. Many of the poorer north Indian state governments, have been afflicted by endemic corruption, unstable governments and weak law enforcement.

That a stable macroeconomic environment[37] is a necessary, though not sufficient, for sustained economic growth is well established. In Latin America, the recovery of economic growth was preceded by the restoration of budget discipline and the reduction of inflation. The fast growing East Asian nations have generally maintained single or low-double digit inflation, have for the most part avoided balance of payment crises, and when faced with it - for example Korea, in mid 1980s – moved swiftly to deal with them. Again, that macroeconomic stability is not sufficient for growth is supported by evidence from Africa, where most of the countries in the franc zone have grown slowly, despite low inflation. There is also a considerable amount of empirical literature which support the view that macroeconomic stability is an essential requisite, though not sufficient, for sustained economic growth (Barro 1997, Fisher 1993, 1991, Easterly and Rebelo 1993, Levine and Zervous 1992).

---

[36] World Bank, 1999

[37] A stable macroeconomic environment is one which is conducive to economic growth; when inflation is low and predictable, real interest rates are appropriate, fiscal policy is stable and sustainable, the real exchange rate is competitive and predictable, and the balance of payments is perceived as stable (Fischer 1993).

Recent literature has also increasingly devoted itself to the study of political and social factors which appear to weaken the macroeconomic environment vital for steady economic growth. Internal political turmoil, external aggression, lack of law and order, and various aspects of rent seeking activities in the presence of corruption in less developed economies are increasingly being recognised and incorporated in the empirical and theoretical literature as potential barriers to economic growth[38].

In this paper we question the extent to which the observed polarisation in economic growth across Indian states has been effected by the above-mentioned factors. We document non-parametric and parametric evidence of the role of macroeconomic stability and political governance in explaining regional distribution dynamics across Indian states over 1965 to 1998. The distribution dynamics approach (studied over 1989-1997) reveals that fiscal deficits partially explain the observed income dynamics of polarisation. We also present standard panel regressions as well as cross section averaged regressions over the period 1981 to 1997, where short run results show that fiscal deficits are negatively associated with growth, while the long run results over 1965 -1998 reveal the negative impact of inflation on growth. Political instability is also observed to be negatively correlated with growth in both short and long run horizons. Expenditure on education, particularly over the 1990s is positively correlated with growth, a result in confirmation with that obtained in the cross-country growth literature.

The chapter is structured as follows. Section 2 briefly discusses the recent macroeconomic crisis in India and reviews the recent evidence of divergent growth across the Indian states. Section 3 reviews the recent cross-country evidence on the link between macroeconomic

policies, good governance and growth. Section 4 discusses the data and presents the empirical results. Section 5 concludes.

4.2 The Macroeconomic Crisis in India in the Nineties

Recent years has 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 in conditions of below the poverty line (Datt 1997). Further, this growth trajectory is accounted for by agriculture growing at an average rate of 7%, while growth in all other major sectors declined[39].

One of the biggest problems facing policy makers has been the unsustainable fiscal deficits generated at both the centre and at the state level. Gross fiscal deficit to GDP ratio of all state governments touched a high of 4.2 per cent in 1998-99[40] – 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

[38] See Alesina and Perotti 1996, Tanzi, and Davoodi (1997), Rodrik (1999), Mauro (1995, 1998), North (1991)
[39] Government of India, 1999

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% (World Bank 1999)[41]. 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 per cent 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 (World Bank 1999).

Such high deficits, thus, have a telling effect on macroeconomic 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

[40] World Bank (1999)
[41] World Bank 1999.

liberalisation, the interest costs of central and state governments have risen by over 1 per cent of GDP since 1990-1[42]. 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[43].

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 center (World Bank 1999). Unstable coalition governments at the centre resulting from the elections between 1996 to 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. 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[44].

---

[42] World Bank, 1999. Prior to the financial reforms that began in the early 1990s, financial repression limited the interest cost of public debt by directing credit into the public sector at low costs, crowing out credit to the private sector and taxing financial intermediation.

[43] For example, India's rating was lowered by Moody's from Baa (investment grade) to Ba2 (speculative) in 1998, after imposition of sanctions on multilateral lending after India and Pakistan's nuclear explosions and following the Budget announcement. Standard and Poor's rating dropped from BB+ (speculative) to BB in October 1999 (GOI 1999, p90)

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 this chapter, we do not investigate a causal link between the role of political governance, and that of macroeconomic instability in effecting disparate economic growth across Indian states. Once again, we will attempt to establish correlates between different indicators of macroeconomic stability and economic growth and also that of political instability and growth. Let us now have a look at the existing literature on the role of macroeconomic stability and political governance in explaining cross-country economic growth.

4.3 Cross country empirical literature on growth and convergence and the role of macroeconomic stability and political governance.

4.3.1 The Role of Macroeconomic Stability

What does the recent empirical literature say about the role of macroeconomic factors on growth? It is widely accepted that a stable macroeconomic environment is required, though not sufficient, for sustainable economic growth. That taxation, public investment, inflation

---

[44] Mauro (1999), Dollar (2001)

and other aspects of fiscal policy can determine an economy's growth trajectory is well documented in the growth literature. Growth models, old and new, feature simple channels that link certain taxes, for example, to the rate of growth – for example, they lower the net rate of return of private investment, making investment activities less attractive and lowering the rate of growth. Endogenous growth models have also stressed the long run role of fiscal policy as a key determinant of growth[45]. Recent cross-country studies also provide evidence that the causation runs from good macroeconomic policy to growth (Fisher 1993, 1991, Easterly and Rebelo, 1996, Barro 1997).

The link between short run macroeconomic management and long run growth, however, remains one of the most controversial areas in the cross-country literature. Though there are a number of studies revealing significant correlations with the expected signs, it has been difficult to isolate any particular policy variable and demonstrate a robust correlation with growth, irrespective of endogeneity concerns and other variables. Much of this is attributable to the fact that things do tend to go wrong at the same time – inflation accompanies bad fiscal discipline, political instability and exchange rate crises. Thus, the common conclusion is that policy is important, without much light on which elements of policy are crucial. With much still to be understood, this remains a fascinating area for further research.

The recent cross-country literature mostly deals with 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 macroeconomic indicator (other than investment ratio) is fragile, Fischer (1991)

[45] See Barro (1990), Rebelo (1991), Jones et al (1993), Ireland (1994), Stokey and Rebelo (1995)

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 (1996) also find convincing evidence of fiscal deficits being negatively related to growth. Links between inflation and growth are particularly controversial. Levine and Zervous (1992) show that inflation is significant, though not robust and relates to only high inflation countries. Their composite indicator of macroeconomic 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 one inflation has been reduced. This may be the reason for the weak inflation and growth relationship.

4.3.2 Institutions and Governance

A lot of interesting thinking has been on the role of political and sociological factors in generating or inhibiting economic growth. This is significant as it recognises that political and social institutions and economic progress evolve jointly – that a good macroeconomic environment requires good institutions, and that economic growth nurtures and develops good institutions. Of the two, political factors are studied with greater detail in the empirical growth literature as they lend themselves better to measurement and also because the lines of causation are better understood. The most common approach has been to relate growth to indices of civil, political and economic rights. Economic freedom is noticed have a stronger observable link to growth than political rights – for example, indicators such as the ease of enforcing contracts and the risk of appropriation, are found to have a strong connection to growth. Institutional factors, such as good governance, are found to affect the growth process by increasing the rate of investment.

The bulk of the empirical studies in this area also encompass studies linking different political and social barriers to growth – the role of different political regimes is widely studied, though it has been difficult to isolate the effects of the respective regimes and growth. Results have been varied - casual empiricism suggests a wide variety of experiences under both autocratic and democratic regimes, and when found, (for example Barro (1997) finds some positive effects of political rights on growth), the correlations are weak. Far more encouraging are those reviewing the effect of political instability on growth. Alesina and Perotti's survey (1996) uses simple proxies for political instability and suggests that the more interesting insights are revealed when investigating for effects of political instability, rather than for a generalised indicator of political regime.

Recent years, however, have seen a focus on the role of governance in accounting for cross country growth differentials. The concept of governance[46] is assumed to include a number of factors, each considered either separately, or in aggregation in various studies – broadly, it is meant to encompass the following a) a process by which a government is selected, monitored and replaced, b) the capacity of a government to effectively formulate and implement sound policies, and c) the respect of citizens and the state for the institutions that govern economic and social interactions between them.[47] Malfunctioning government institutions, through inefficiencies like corruption, constitute a severe obstacle to investment, entrepreneurship and innovation, which all directly affect growth. That good governance is important for entrepreneurship and investment is also borne by the fact that the only quantitative data available on various aspects of governance has been developed by private firms such as Transparency International, Business International now incorporated into *The Economist Intelligence Unit*, or in the Indian case, Business India, and

[46] There appears to be no "accepted" definition of governance, broadly covered in common are those suggested by the IMF, IDEA and Institute for Governance.

CRISIL, selling these indices typically to banks, multinational organisations, and other multinational investors.

The availability of such indicators has led to a number of extensive studies on the effects of various aspects of governance on economic growth. While the literature is large and still growing, the underscoring conclusion of all is that bad governance spells bad news for growth. A large body of empirical cross-country literature quantifies the growth-promoting effects of superior institutions – the role of social infrastructure, bureaucratic quality and social capital, social capability, and different aspects of governance – voice and accountability, political instability and violence, government effectiveness, regulatory burden, and rule of law. (Hall and Jones, 1999; Knack and Keefer, 1995, 1996; Temple and Johnson, 1998; Kaufmann, Kraay and Zoido-Lobaton, 1999). Mauro (1995) discusses the detrimental effects of corruption on economic growth and investment, while Wei (1997) tracks the effects of corruption on foreign direct investment. Tanzi and Davoodi (1997) and Mauro (1998) discuss the effects of corruption on public investment in that it can particularly hit hard on social reform imperatives.

4. 4 Empirical Analysis

This section describes the data sets used for the study, presents further evidence for the lack of convergence of economic growth across Indian states, and reports new evidence on the relationship between macroeconomic instability and political governance, and economic growth for the Indian case.

4.4.1 Description of data

[47] Taken from Kaufmann et al 1999.

This paper uses two different data sets for its analysis.

(1)The first (and primary) data set has been compiled by the World Bank (2000). All our fiscal and income variables detailed below are derived from this data set for the period 1986 to 1998 for the 15 major Indian states, tabulated in the Appendix.

GDP per capita

Population

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

Expenditure on pensions as a ratio to GDP

We use two simple indices of political governance – the first one, based on a survey conducted by *Business India*, assessing Indian states on the basis of the risk of investing in these states, available for three years – 1995, 1997 and 1998. The second index is that of political instability measuring the number of changes in government in the states each year, from 1952 to 2000. This data has been collected by the author[48] from State Assembly publications.

[48] I thank Premansu K. Bandyopadhyay for help with collecting this data

(2)The second data set, covering a larger span of years, 1961 to 1998 is an extension of that used in an earlier study Aiyar (2000). The original data set[49] comprises of the following indicators for the following years (1961, 1966, 1971, 1976, 1981, 1986, 1991, 1996)

Per capita net domestic product

Literacy

Expenditure on social services.

Expenditure on economic services

Private capital base

We extend this database (except for private capital) for the following two years, 1997 and 1998 for our own analysis. The primary sources for all data sets are Government of India, Central Statistical Organisation publications and various issues of *Economic Surveys* published by the State governments.

(3)Data on prices, used to calculate inflation, is derived from the Dutt and Ravallion (1998) data base, and has been updated using various issues of the CMIE's *Monthly Review of the Indian Economy*. Price level data used to update the second data set has been derived from the Datt and Ravallion (1998) dataset.

4.4.2 Non-parametric results: the Distribution Dynamics Approach

The non-parametric tools which I will be using are those proposed by Quah (1995, 1997b). The methodology involved is identical to that used for conditioning in Chapter 3. See Section 3.2 for the details of the methodology.

[49] I thank the IMF for providing the data set

One, however, requires first to derive the "conditioned distribution" – the income distribution conditioned by the hypothesised auxiliary factor, and then observe the mapping of the unconditioned to the conditioned distribution. Let us deal with this now.

4.4.3 Obtaining the conditional distribution

Unlike many standard convergence regression analyses, here we do not assume the time varying auxiliary variables to be exogenous. Indeed, we have reason to expect all of our auxiliary variables - 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, expenditure on pensions as a ratio to GDP, to be endogenously related to economic growth. We will first deal with the endogeneity issue and derive the relevant conditioned distribution.

The conditional distribution is obtained by regressing growth rates on a two sided distributed lag of the time varying conditioning variables and then extracting the fitted residuals for subsequent analysis. This will result in a relevant conditioning distribution irrespective of the exogeneity of the right hand side variables. The method derives from that suggested by Sims (1972)[50], and is adopted by 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. This methodology was also used in an earlier exercise in chapter 3 and is elaborated in greater detail there in Section. 3.2.3.

We present the results for these two-sided regressions of growth of per capita income on capital expenditure in Table 1. 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[51]. Conditioning two sided projections are also derived for the other auxilliary variables – namely – inflation, fiscal deficits, interest expenditure, own tax revenue, and education expenditure.

4.4.4 The Results

Figures 3a to 3e present the stochastic kernels mapping the unconditioned to conditioned distributions, for the six conditioning auxiliary factors. Figure 3ai presents the stochastic kernel representing conditioning with capital expenditure. The appropriate conditioned distribution has been derived by extracting the residuals from the 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 plots, Fig 3aii. These clusters, running parallel to the original axis at very low and very high levels provide evidence of capital expenditure marginally explaining polarisation.

Figure 3bi, mapping the conditioning stochastic kernel with education expenditure as auxiliary variable, runs mainly along the diagonal, with the upper and lower tails tending to

---

[50] This method has been adopted by Quah (1996) to obtain the conditional distribution.

[51] Results are found to be unchanged if one uses residuals from other projections

run off parallel to the original axis, albeit very little. The conditioning exercise thus reveals that expenditure on education does not explain the observed polarisation.

Figure 3ci and 3cii maps the stochastic kernel conditioning with fiscal deficit. Though it predominantly lies on the diagonal, there appears to be an individual cluster at 0.5 of the national average running off parallel to the original axis. This is suggestive of fiscal deficit in explaining growth distribution dynamics for the cluster of States identified at the level observed, but not for the entire income distribution. Such localised conditional convergence was also observed in the earlier chapter, where infrastructure was observed to explain the polarization of the lower income states.

Conditioning on inflation and interest expenditure, reveals no interesting insights in how they explain disparate growth performances – Figures 3d and 3e have the probability mass running decidedly along the diagonal.

4.4.5 Transition probability matrices

The capital expenditure transition matrix (Table 2a) reveals no signs of any mobility. This adds to our findings of persistence revealed earlier in the stochastic kernel mapping. The education expenditure matrix also reveals similar signs of persistence in Table 2b – an economy at either tail of the distribution is most likely to remain in its own income state.

The transition matrix for fiscal deficits (Table 2c) exhibits signs of mobility at the middle income states. The cluster at around 0.5 of the national average, running parallel to the original axis observed in the stochastic kernel earlier is again revealed in the transition matrix – note that the probability that an economy moves from (0.4 to 0.55) of the national

average is almost 0.6. Fiscal deficits, hence, seem to explain the income dynamics for some middle income states.

Tables 2d and 2e represent estimates of intra-distributional mobility using inflation and interest expenditure as the conditioning variables. Here too one observes little evidence of either factor explaining the observed twin-peakedness. These results support standard parametric results where such inconclusive results are obtained as well, discussed in the following section.

4.4.6 Panel Regression Results

We will now complement the non-parametric results with standard parametric results. Our task is to exploit the rich cross section-time series variation in cross regional data using panel data regressions. The model we will be estimating is as follows:

$$lnY_t - lnY_{t-1} = \alpha_i + \beta X_{it} + \varepsilon_{it}$$

where, the dependent variable is the growth rate of state i in year t (of real GDP), α_i is a state specific effect, and X_{it} represents the vector of regional characteristics, comprising of initial conditions and trends in exogenous time dependent variables. The explanatory variables used in the analysis (both for panel and cross section averaged regressions) are stated below. The explanatory variables chosen are recognized in the macroeconomic literature, as described earlier in section 4.3 to be indicators of macroeconomic stability and political governance.

Fiscal deficit (measured as a ratio to the GDP)

Inflation (annual)

Own tax revenue (as a ratio to the GDP) of the state

Interest payments by state to centre and administrative expenditure (as a ratio to GDP)

Expenditure on pensions by the state

Index of political stability

We account for differences in the steady states across the states by a number of control variables - initial GDP (at constant prices), initial female literacy and population. We introduce a regional dummy, distinguishing between north and south states, and also test for the effect of a dummy signifying whether a state is one with a port, or without a port. One can specify the state specific effects as either fixed or random effects. The former specifies the regression intercept to vary across the states, while for the latter it is modeled as a time invariant error term for each state. The fixed effect specification has a drawback in that it reduces the number of degrees of freedom available, and also precludes the inclusion of dummy variables. Thus to test for the effects of our dummies specified above, we will be resorting to random effects specifications. Also, to test for the appropriateness of the random effects approach we will test for the orthogonality of the random effects and the regressors with Hausman's test. For all our tests (tests of significance and Hausman tests) we will be using the Huber-White estimate of variance which allows for different error variances across states as well as serial correlation for the states.

Our results consist of three separate sets regressions – first, using the new data set World Bank (2000), and second, over the period 1986-1998, we have two sets of regressions – panel regressions with various specifications, and OLS regressions for the different sub-periods 1986-91, 1991-95, and 1996-98. We extend our analysis to the period 1961 to 1998,

by using the Aiyar (2000)[52] dataset to derive cross section growth regressions over this period.

Estimation is by instrumental variables, where the instruments consist mainly of prior values of the regressors. For instance, our 1987 to 1998 panel regression includes the log of 1987 GDP on the right hand side and uses the log of 1986 GDP as the instrument. Estimation by instrumental variables should lessen the estimation problems caused by temporary measurement error in GDP. The right hand side also contains annual data for the variables discussed earlier, and period averages for the averaged panel and cross section regressions, and uses prior values (one year earlier values) of these variables as instruments. The use of lagged variables as instruments is problematic, although better alternatives are not obvious. One favourable element here is that the residuals from the growth regressions turn out to be virtually uncorrelated over time periods. In most respects, the instrumental results do not differ greatly from the uninstrumented panel estimates.

Tables 3 to 10 tabulate our results on the evidence of convergence, and the effects our various auxiliary factors on economic growth. Absolute convergence is not observed. We observe statistically significant cases of divergence. Conditional convergence is observed occasionally and very sensitive to specifications, which will be detailed in the following discussion. Figure 1 plots the standard deviation of income levels across states across the period 1981 to 1998, also revealing increasing divergences across states. The distribution dynamics of income, in Fig. 2 revealing the evolution of the income distribution also shows that there has been a gradual divergence in growth performance across states with the formation of two different income clusters - a high income group cluster and a low income group cluster, revealed in Fig. 2a to 2d.

We estimate the effects of various auxiliary factors using both panel regressions and cross section averaged regressions. Tables 3 – 7 list our results for the first detailed data set with annual data for all indicators from 1987 to 1998. We use initial level of income (lagged), initial level of literacy, and population as control variables. Table 3-7 lists the estimates of panel regressions of growth on various policy variables using both fixed and random effects specifications. A univariate regression of growth on initial level of income reveals significant divergent tendencies (column 1 and 2). Introduction of a number of control variables does obtain some instances of conditional convergence - we obtain conditional convergence with the inclusion of female literacy rates. Its associated sign, however, is negative, reflecting that the female literacy rate here represents the level of development, rather than education serving as an engine of growth. Population (in columns 5 and 6) too is negatively correlated with growth, revealing that the poorer states are indeed those with larger populations.

Regressions on a number of macro-indicators and political governance indices reveal mixed results. The effects of fiscal deficits on growth is not very clearly revealed here – columns 7 and 8 tabulate that it is positively associated with growth, though not significant. The effects are clearer when one isolates the effects of the high fiscal deficit states. Columns 9 and 10 list the regressions with a fiscal dummy – which takes value 1 if the state is a high deficit state (over 4%), and 0 otherwise. The fixed effects specification clearly highlights the negative (and statistically significant) effect of high deficits. The random effects regression too reveals similar results, though not significant.

We find that it is difficult to clearly isolate the effects of inflation on growth. A word needs to be mentioned. Given that monetary policy is centrally determined, this tends to reduce

the variation of inflation across the states. However, there is variation in inflation rates across states, reflecting other macroeconomic effects. Columns 7 to 18 highlight the effects of inflation on growth under various specifications. We observe that for both fixed effects and random effects, its influence on growth is not clearly highlighted. The results do not markedly differ on including squared inflation as a variable – inflation itself is observed to have a positive effect on growth (insignificant in random effects) while, inflation squared varies in its effect on growth, both however insignificant. Inclusion of instruments of inflation, (in our case simply the lagged values of the variables)[53] slightly improve the results, but with no great difference. Columns 15 and 18 tabulate results for fixed effects and random effects specifications using instruments of inflation indicators – the results are very much similar to those obtained earlier. Regressions run with a dummy specifying states with inflation greater than 10 % also fails to shed any light on the growth-inflation relationship – the results (not reported here) are again ambiguous and insignificant.

A key problem in the interpretation of results involving inflation is that they need not reflect the causation from inflation to growth. This is because of the endogenous nature of inflation, which may respond to growth or to other variables related to growth. It is possible that the endogenous nature of inflation may also result in a positive relationship with growth. This may occur because of output fluctuations being driven primarily by shocks to money or to the aggregate demand for goods. Omitted variables may also be correlated with growth and inflation. A common example is of better enforcement of property rights (data not available, see Barro 1991) – which is likely to spur investment and growth, and is also likely to accompany a rules based set up in which the monetary authority generates a lower level of inflation. Some of the explanatory variables in the

[53] Other popularly used instruments of inflation, such as central bank independence, prior colonial status, as used in Barro (1991) and Fischer (1993) could not be implemented in this study due to unavailability of data

system attempt to capture the degree of maintenance of rule of law. However, to the extent that these measures are imperfect, the inflation may proxy for the rule of law and thereby show up as a negative influence on growth. Our estimated coefficient on the inflation rate could therefore reflect an effect on growth that may have nothing to do with inflation per se.

States' own tax revenue is observed to have a positive and significant effect on growth. Columns 17 and 18 tabulate fixed effects and random effects results – for the fixed effects regression, own tax revenue has a statistically significant effect on growth. The results are just about significant for the random effects specification. Using lagged own tax revenue as the instrument, however, the results vary – it is found to be negatively associated with growth, though not statistically significant. Tax revenue is endogenous, and the extent to which it explains disparate cross-state growth will depend on what the revenues are being spent on and how distortionary are the tax rates. The first hand results (non-parametric and parametric together), hence do not reveal any strong relationships between tax revenue and the inter-state growth performances.

Public expenditure on education is found to strongly affect growth – Columns 23 and 24 show that growth is positively correlated with education expenditure, under both fixed effects or random effects specifications. This result is in affirmation with previous studies of Barro (1991), and in the Indian case, that of Dreze and Sen (1996), where expenditure on education has been advocated as an essential requisite to reduce differential growth performances. The non-parametric exercise undertaken earlier, however does not conform with this result. The non-parametric results reveal education expenditure to explain the observed polarization only at very low and high levels of incomes. While it is still not clear that education spending should have a positive association with growth in the

short/medium term, one can expect it do so for the long term. The panel results present a mix of short term and long term results. Clearer observations are obtained later for the OLS results.

The effect of interest and administrative expenditure on growth as documented in columns 27 and 28 is positive, but not significant. Instrumental regressions, however, though sensitive to specifications (columns 29 and 30), yield a significant negative relationship in a random effects specification.

The effects of capital expenditure ratio (to State GDP) on growth yield ambiguous results, columns 31 to 34. Capital expenditure is found to have a negative effect on growth under both random and fixed effects specifications, though we seldom find its effect as statistically significant.

Expenditure on pensions also exhibit a negative effect on growth, though not significant, columns 35 and 36, and columns 37 and 38. The results do not drastically change when using the instrumental variable, which again is the lagged value (by one period) of pensions.

To observe the effects of political governance, we use two indicators – one, an index of political instability constructed on the basis of the number of changes in government per year, and another compiled by a commercial journal, *Business India*, ranking the states on the basis of a "governance index" to reflect the extent of risk private investors are exposed to, for years 1995, 97 and 98. Thus, the better the level of governance, the higher the rank of a state. We construct a single ranking (combining three years data). Columns 39 and 40, of Table 4 tabulate the regressions revealing that the governance ranking indicator has a positive relationship with growth (i.e. higher the ranking, better the growth performance.).

The political instability index results are however ambiguous, as we obtain a positive association with growth (though) not significant. Table 7 provides estimates of an averaged panel (comprising of only three years) with similar results.

We now break up our period of study three sub-periods to observe the short run dynamics of inter-state growth – 1986–1991, 1992-1996 and 1997-1998. The sub-periods highlight the various policy regimes with earmark these different time periods. The early nineties saw a marked shift in the policy agenda of the Indian government, with a gradual move away from a closed economy to that of a more liberalised regime of trade and capital investment policies. This trend was reinforced as we moved further into the nineties. Table 8 presents the three sets of OLS regressions for these sub-periods - we present the corresponding regressions with instruments - there is no significant difference observed between the OLS and instrumental variable regressions. Here too, we do not observe statistically significant conditional convergence, except for the period 1992-96 in column 3. Female literacy appears to be positively correlated with growth, and is statistically significant for the years 1992-96. This is in contrast to our panel results where female literacy was observed to have a negative relationship with growth. Population, too, is again negatively associated with per capita income growth.

Our results for inflation are now what one would normally expect. Inflation and squared inflation are both significantly negatively related to growth. For the period 1987-91, columns 1 and 2, both are negatively associated with growth, with squared inflation statistically significant at the 5 per cent level. Similar results are observed for the following period, while those for 1996-1998 are negative, but not significant. Own tax revenue is positively related to per capita income growth, though it is significant only for the last period. Expenditure on education, as observed in the panel regressions is also observed to

have a positive and statistically significant effect on growth - the results are stronger for the last two periods, than for the first period. Interest expenditure is observed to have a significant negative effect on growth over all three periods - this is one of the most stable relationships observed. Capital expenditure also positively affects growth - though results are only marginally significant.

Fiscal deficit is observed to have a negative relationship with growth, but is not statistically significant. Once again, the indicator of political governance is found to be positively correlated with per capita growth. Our index of political instability, however, has a positive co-efficient though not significant.

4.4.7 Long run effects of fiscal indices and governance – 1961- 1998

A longer time horizon allows us to observe the more stable effects of the relations observed with the first data set. Our second data set, with a greater time horizon, also has a larger number of fiscal indicators and new political governance indicator. The results of our panel regressions are tabulated in Table 9. Table 9 presents the fixed effects panel regressions. Column 1 presents the univariate regression of growth of real per capita GDP – it clearly indicates significant divergence. Total literacy positively affects growth significantly when controlled by population (column 3). For other specifications, when controlled by other variables, total literacy positively affects growth, though the results are no longer significant at the 5 per cent level. Inflation, and inflation squared are both revealed to significantly have a negative impact on growth – all regressions from column 5 to 10 indicate that inflation works to the detriment for economic growth. Social capital expenditure negatively affects growth – just significant, revealed in columns 6 to 9. Expenditure on economic services, on the other hand, positively affects growth, though

the results are not significant at the 10 per cent level. Private capital expenditure, also, does not appear to significantly explain growth, and is revealed to negatively affect growth. What is encouraging that the indicator of political instability has a significant negative co-efficient.

4.5 Conclusion

This paper has examined correlations between distributions of macroeconomic stability and political governance and inter-state economic growth using an empirical model of dynamically evolving distributions. Chapter 1 revealed polarisation of economic growth across the Indian states, over 1965-1998. We found that the dominant cross-state income dynamics are that of persistence and immobility, with some cohesive tendencies in the 1960s, only to dissipate over the following three decades.

A conditioning methodology using the same non-parametric empirical tools reveals that such income dynamics are partially explained by the level of fiscal deficits. Unlike standard methods, this model allows us observe the income dynamics at different levels of the distribution – here we observe that fiscal deficits explains club formation at higher income levels. Other auxiliary factors of capital expenditure, expenditure on education, inflation and interest expenditure do not reveal any interesting insights.

The parametric short run panel results also show that these relationships are quite fragile and are very sensitive to different specifications. Short run panel regressions reveal that most of the relationships observed are not robust – the relationship between the macroeconomic variables and growth fluctuate in sign (hence, direction) and are only

occasionally significant. However, taking averaged OLS regressions over this period leaves us with encouraging observations. Female literacy is observed to have a significant and positive effect on growth, fiscal deficits are significantly and negatively correlated with growth, while both the short run and long run (1961-98) results reveal the negative impact of inflation on growth. Expenditure on education is also 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. Political instability is also observed to negatively affect growth in the long run results; better political governance is also observed to positively affect growth – both of these results are particularly significant for the averaged OLS regressions. Tax revenues, revealing unstable effects on the growth in the (annual) panel regressions, show up to have a significant positive relationship in the averaged OLS regressions too. The unstable nature of the relationships as showed up in the panel regressions, hence, can be attributed to the immense amount of volatility of these variables, which are smoothened out on averaging and OLS estimation.

The results thus indicate, as reiterated in many empirical and theoretical studies, that the macroeconomics do matter to a large extent to balance differential growth. We also derive preliminary evidence, using the most rudimentary of indicators, that the political atmosphere does play an important role in determining why one state grows better than the other. These growth empirics are directive, in the least, of a host of macroeconomic policies to arrest and even reverse polarising tendencies of economic growth across Indian states.

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.

Table 1. Conditioning regressions (two sided projections) of growth rate capital expenditure

State development expenditure		Co-efficients in two-sided projections		
Lead	4			-0.00 (0.003)
	3		0.010 (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)
	4			
Sum of co-efficients		-0.01	-0.04	-0.014
R^2		0. 10	0. 10	0. 11

Note: Numbers in parentheses are OLS and White heteroscedasticity consistent standard errors.

Table 2a. Inter-state conditioning on capital expenditure
transition matrix

Number	Upper end point 0.173	0.234	0.276	0.396	0.547
110	0.82	0.18	0.00	0.00	0.00
300	0.73	0.23	0.03	0.00	0.00
310	0.10	0.16	0.35	0.35	0.03
180	0.00	0.06	0.11	0.56	0.28
220	0.00	0.00	0.00	0.27	0.73
Ergodic	**0.731**	**0.179**	**0.015**	**0.036**	**0.038**

Table 2b. Inter-state conditioning on education expenditure, transition matrix

Number	Upper end point 0.190	0.227	0.273	0.400	0.572
170	0.76	0.12	0.06	0.06	0.00
220	0.36	0.36	0.23	0.05	0.00
290	0.21	0.38	0.14	0.28	0.00
230	0.04	0.09	0.14	0.28	0.00
210	0.00	0.00	0.00	0.05	0.95
Ergodic	**0.305**	**0.129**	**0.093**	**0.126**	**0.346**

Table 2c. Inter-state conditioning on fiscal deficit,
transition matrix

Number	Upper end point				
	0.172	0.235	0.272	0.388	0.536
100	1.00	0.00	0.00	0.00	0.00
320	0.72	0.19	0.09	0.00	0.00
250	0.08	0.20	0.48	0.20	0.04
220	0.00	0.09	0.18	0.50	0.23
230	0.00	0.00	0.04	0.30	0.65
Ergodic	**1.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 2d. Inter-state conditioning on inflation, transition matrix

Number	Upper end point				
	0.113	0.187	0.249	0.308	0.483
0	0.35	0.14	0.35	0.14	0.01
150	0.00	0.25	0.19	0.46	0.09
360	0.00	0.06	0.56	0.26	0.12
290	0.00	0.00	0.13	0.21	0.66
320	0.00	0.00	0.00	0.00	0.00
Ergodic	**0.400**	**0.212**	**0.116**	**0.144**	**0.128**

Table 2e. Inter-state conditioning on interest expenditure, *transition matrix*

Number	Upper end point				
	0.193	0.240	0.282	0.400	0.531
180	1.00	0.00	0.00	0.00	0.00
270	0.33	0.52	0.15	0.00	0.00
310	0.00	0.13	0.32	0.55	0.00
150	0.00	0.00	0.00	0.80	0.20
210	0.00	0.00	0.00	0.05	0.95
Ergodic	**1.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 3

Conditioning panel regressions of growth: 1986-1998

Dependent variable: growth rate of p c income	1 fe	2 re	3 fe	4 re	5 fe	6 re	7 fe	8 re	9 fe	10 re
log of gdp in 1986	0.84	0.22	-0.08	-0.006	-0.07	0.02	-0.04	0.01	0.04	0.02
t	(12.58)	(4.86)	(-2.24)	(-0.14)	(-1.88)	(0.57)	(-1.13)	(0.25)	-	(1.25)
log of fe lit 86			-0.35	-0.31	-0.35	-0.28	-0.34	-0.27	-0.02	-0.006
t			(-30.3)	(-13.7)	(-29.45)	(-12.85)	(-17.97)	(-9.98)	-	(-0.29)
log of popn					-0.006	-0.02	-0.005	-0.02	-0.13	-0.02
t					(-1.7)	(-2.14)	(-1.8)	(-1.76)	(-2.33)	(-1.61)
log of infl							0.009	0.002	0.006	0.002
t							(1.8)	(0.11)	(1.62)	(0.36)
log of fisde							0.003	0.01		
t							(0.59)	(1.21)		
log of fdummy									-0.001	-0.001
									(-3.93)	(-1.39)
R squared	0.39	0.34	0.57	0.5	0.45	0.6	0.58	0.6	0.6	0.66

Notes: 1. Figures in parantheses are t statistics.
2. re = random effects regression, fe = fixed effects regression. All fixed effects regressions are cross section weighted

Table 4
Conditioning panel regressions of growth: 1986-1998

Dependent variable: growth rate of p c income	11 fe	12 re	13 fe	14 re	15 Fe-IV	16 Re-IV	17 Fe	18 Re	19 Fe-IV	20 Re-IV
log of gdp in 1986	-0.05	0.02	0.03	0.02	0.8	0.007	-0.01	0.006	0.77	0.01
t	(-1.44)	(0.59)	(0.32)	(0.43)	(5.62)	(0.22)	(-0.35)	(0.13)	(6.59)	(0.39)
log of female literacy 86	-0.34	-0.29	-0.30	-0.28	-0.12	-0.3	-0.37	-0.32	-0.07	-0.03
t	(-27.25)	(-12.02)	(-7.03)	(-10.14)	(-2.00)	(-13.5)	(-24.9)	(-9.98)	(-1.79)	(-13.4)
log of population	-0.005	-0.02	-0.007	-0.01	-0.004	-0.01	-0.01	-0.01	-0.005	-0.01
t	(-1.74)	(-1.92)	(-0.33)	(-0.83)	(-1.16)	(-1.5)	(-2.06)	(-1.02)	(-0.72)	(-1.48)
log of inflation	0.009	0.003	0.002	0.01	0.004	0.006	0.008	0.02	0.005	0.006
t	(1.79)	(0.11)	(0.07)	(0.49)	(8.13)	(6.31)	(1.26)	(0.65)	(6.21)	(6.26)
log of infl squared			-0.001	-0.006			0.001	-0.001		
t			(-0.09)	(-0.57)			(0.01)	(-0.65)		
log of own tax revenue							0.14	0.1	-0.001	-0.001
							(7.25)	(1.95)	(-0.91)	(-1.05)
R2	0.95	0.61	0.92	0.62	0.95	0.74	0.81	0.69	0.8	0.71

Notes: 1. Figures in parentheses are t statistics
2. All fixed effects regressions are cross section weighted.

Table 5
Conditioning panel regressions of growth: 1986-1998

Dependent variable: growth rate of p c income	21 fe	22 re	23 fe	24 re	25 fe-IV	26 fe-IV	27 fe	28 re	29 fe-IV	30 re-IV
log of gdp in 1986	0.02	0.03	0.02	0.03	-0.05	0.03	0.19	0.01	-0.014	-0.07
t	(0.4)	(0.97)	(0.05)	(0.97)	(-0.47)	(0.95)	(1.24)	(0.16)	(-0.13)	(-0.64)
log of female literacy 86	-0.2	-0.2	-0.2	-0.2	-0.28	-0.29	-0.25	-0.32	-0.26	-0.27
t	(-9.01)	(-10.8)	(0.02)	(-10.85)	(7.28)	(14.02)	(4.06)	(12.4)	(7.22)	(7.48)
log of population	-0.008	-0.014	-0.008	-0.01	-0.013	-0.01	-0.14	-0.02	-0.005	-0.004
t	(-0.8)	(-1.32)	(-0.8)	(-1.32)	(-2.86)	(-2.65)	(-1.58)	(-0.83)	(-0.08)	(-1.48)
log of inflation	0.002	0.0007	0.002	0.0007	-0.001	0.0006	0.001	0.009	0.003	0.004
t	(0.12)	(0.03)	(0.123)	(0.03)	(-0.18)	(0.69)	(0.03)	(1.72)	(2.96)	(3.91)
log of infl squared	-0.004	-0.002	-0.004	-0.002			-0.002	-0.001		
t	(-0.72)	(-0.43)	(-0.71)	(-0.43)			(0.19)	(-0.65)		
log of own tax revenue	0.5	0.48			-0.001	-0.001			-0.07	-0.07
	(20.44)	(19.01)			(-2.71)	(-1.86)			(-5.65)	(-5.03)
log of expenditure edun			0.51	0.48	0.39	0.34			0.37	0.34
			(20.44)	(19.01)	(10.3)	(10.76)			(9.03)	(9.24)
log of interest exp							0.02	0.004	0.001	0.001
							(1.55)	(0.68)	(5.65)	(5.02)
R^2	0.91	0.91	0.92	0.84	0.95	0.87	0.9	0.85	0.82	0.71

Notes: 1. Figures in parentheses are t statistics
2. All fixed effects regressions are cross section weighted

Table 6
Conditioning panel regressions of growth: 1986-1998

Dependent variable: growth rate of p c income	31 fe	32 Re	33 Fe-IV	34 Re-IV	35 Fe	36 Re	37 Fe-IV	38 Re-IV	39 Fe	40 Fe
log gdp 1986	0.03	0.01	-0.027	0.196	-0.015	0.03	-0.02	0.02	-0.0007	-0.07
t	(0.31)	(0.27)	(-0.24)	(0.57)	(-0.00)	(0.00)	(0.001)	(0.001)	(-0.05)	(-0.64)
log of female literacy 86	-0.3	-0.29	-0.27	-0.29	-0.019	-0.02	0.02	0.02	-0.01	-0.27
t	(-6.961)	(-10.08)	(-7.4)	(-14.03)	(-0.00)	(-0.00)	(-0.001)	(0.001)	(-7.22)	(-7.48)
log of population	-0.005	-0.01	0.003	-0.002	-0.13	-0.119	-0.16	-0.019	-0.005	-0.004
t	(-0.24)	(-0.68)	(0.58)	(0.4)	(-1.43)	(-2.01)	(-1.36)	(-2.59)	(-0.31)	(-1.48)
log of inflation	-0.0004	0.013	0.012	0.01	-0.009	0.01	0.01	0.009	0.008	0.004
t	(-0.12)	(0.37)	(2.22)	(1.59)	(-0.8)	(2.21)	(1.94)	(1.85)	(1.37)	(3.91)
linfl squared	-0.0004	-0.002			-0.002	-0.002				
t	(-0.72)	(-0.33)			(-0.75)	(-1.43)				
logowntaxrev			-0.067	-0.053			-0.02	0.008	0.04	-0.07
			(-5.7)	(-3.92)			(-0.42)	(0.25)	(2.14)	(-5.03)
lexpedun			0.37	0.32			0.16	0.11	0.01	0.34
			(9.06)	(10.34)			(2.98)	(2.81)	(0.57)	(9.24)
loginterestexp			0.0001	0.0001			0.002	-0.0001	-0.001	0.001
			(4.55)	(3.92)			(0.46)	(-0.68)	(-2.14)	(5.02)
logcapital exp	-0.019	-0.03	-0.01	-0.012			-0.007	-0.01	0.006	0.002
	(-0.37)	(-0.85)	(-1.75)	(-1.24)			(-0.36)	(-1.29)	(0.5)	(0.56)
log pensions					-0.006	0.001	-0.005	-0.002		
					(-0.61)	(0.12)	(-0.54)	(-0.22)		
log of governance									0.0002	0.0001
									(2.01)	(1.3)
log of political instability										0.01
										(1.91)
R^2	0.95	0.62	0.92	0.72	0.69	0.87	0.65	0.72	0.82	0.71

Notes: 1. Figures in parentheses are t statistics
2. All fixed effects regressions are cross section weighted

Table 7
Conditioning panel regressions of growth: 1986-1998
Averaged panel (for 3 years)

Dependent variable: growth rate of p c income	1 fe	2 fe	3 fe	4 fe	5 fe	6 fe	7 fe	8 fe	9 fe	10 fe	11 fe
log of gdp 86	-0.44	0.06	-0.18	-0.185	-0.054	-0.03	-0.54	0.02	-0.27	-0.17	-0.45
t	(-0.31)	(0.05)	(-0.12)	(-0.12)	(-1.03)	(1.00)	(-0.41)	(0.39)	(-0.45)	(-0.64)	(-0.56)
log of femlit86		-1.34	-1.3	-1.37	-0.018	-0.02	-0.93	0.09	-0.11	-0.27	-0.28
t		(-2.73)	(-2.65)	(-2.73)	(-0.29)	(-0.00)	(-0.96)	(0.07)	(-0.22)	(-0.48)	(-1.03)
log of pop			0.0003	-0.002	-0.0001	-0.001	0.0008	-0.001	-0.001	-0.004	-0.003
t			(0.35)	(0.2)	(-1.08)	(-2.01)	(0.55)	(-0.5)	(-0.89)	(-1.48)	(-0.99)
log of inflation				0.749	-0.14	-0.01	0.01	-0.14	-0.208	-0.504	-0.66
t				(1.59)	(-0.21)	(-2.21)	(0.014)	(-1.01)	(-0.49)	(1.91)	(0.87)
log of infl squ					-0.39	-0.002	-1.05	-0.89	-0.31	-0.56	-0.45
t					(-1.22)	(-1.43)	(-2.02)	(-1.86)	(-1.59)	(-1.43)	(-1.67)
log of own tax						0.001	-0.02	0.008	0.004	-0.007	-0.006
						(1.3)	(-0.42)	(0.25)	(1.14)	(-1.03)	(-0.89)
log of exp edun							1.24	0.65	0.31	0.34	0.3
							(2.59)	(0.86)	(1.78)	(2.24)	(1.4)
log of inter exp								0.19	0.25	0.001	0.06
								(2.5)	(-12.14)	(5.02)	(4.22)
log of capit exp								0.11	-0.03	0.002	0.005
								(0.27)	(0.51)	(0.56)	(0.23)
Fiscal deficit									-0.49		-0.3
									(-1.89)		(-1.45)
log of govern										0.0001	0.0001
										(1.3)	(1.2)
log of pol inst											0.01
											(1.91)
R2	0.51	0.57	0.5	0.6	0.69	0.87	0.56	0.72	0.67	0.71	0.7

Notes: 1. Figures in parentheses are t statistics
2. All fixed effects regressions are cross section weighted

Table 8
OLS Conditioning Regressions for sub-periods 1987-91, 1992-95 and 1996-98

Dependent variable:	1	2	3	4	5	6
growth of per capita income	ols	iv	ols	iv	ols	iv
log of gdp86	-0.0002 (-0.77)	-0.0001 (-1.4)	-0.0007 (-2.75)	-0.0006 (-1.41)	-0.0004 (-1.5)	-0.0003 (-1.4)
log of femlit 86	0.01 (1.34)	0.081 (1.95)	0.085 (2.34)	0.111 (2.87)	0.08 (1.1)	0.101 (1.8)
log of pop	-0.017 (1.45)	-0.004 (-1.69)	-0.007 (-2.34)	-0.017 (-1.45)	-0.01 (-1.8)	-0.008 (-2.01)
log of inflation	-0.024 (-1.98)	-0.02 (-1.88)	-0.024 (-1.98)	-0.014 (-1.6)	-0.027 (-1.8)	-0.021 (-1.9)
log of infl sq	-0.016 (-0.983)	-0.02 (-3.78)	0.011 (0.94)	-0.02 (-3.18)	-0.01 (0.7)	-0.02 (-1.1)
log of own tax	0.039 (1.98)	0.028 (2.06)	0.041 (1.98)	0.034 (1.79)	0.04 (3.2)	0.042 (2.9)
log of exp on edu	0.04 (1.89)	0.038 (1.7)	0.04 (1.89)	0.037 (2.08)	0.03 (3.7)	0.031 (3.1)
log of interest exp	-0.119 (-4.914)	-0.105 (-3.4)	-0.119 (-4.92)	-0.12 (-4.2)	-0.1 (3.4)	-0.11 (-3.4)
log of capital exp	0.02 (1.49)	0.018 (1.67)	0.02 (1.49)	0.017 (1.9)	0.015 (1.33)	0.012 (1.44)
fiscal deficit	-0.005 (-0.55)	-0.0047 (0.69)	-0.003 (-0.39)	-0.004 (-0.7)	-0.005 (-1.7)	-0.005 (-1.3)
log of governance	0.005 (1.01)	0.003 (0.6)	0.002 (2.3)	0.002 (2.0)	0.0018 (1.7)	0.002 (1.8)
log of political instabilt	0.01 (1.91)	0.01 (1.89)	0.007 (1.8)	0.008 (1.4)	0.01 (1.7)	0.01 (1.9)
R^2	0.84	0.72	0.85	0.80	0.78	0.8

Notes: All figures in parentheses are t statistics

Table 9
Conditioning Panel regressions of growth: 1961-1998

Dependent variable: growth rate of p c income	1 Fe	2 Fe	3 Fe	4 Fe	5 Fe	6 Fe	7 Fe	8 Fe	9 Fe
log of gdp 61	1.85	5.06	-0.01	-2.82	-2.97	-3.3	-0.02	-0.02	-0.02
t	(3.47)	(2.71)	(0.38)	(-1.76)	(-2.08)	(-2.6)	(-1.81)	(-1.99)	(-1.2)
log of literacy		-0.0004	0.0003	0.0002	0.0002	0.0003	0.0004	0.0005	0.0004
t		(-1.79)	(2.1)	(1.8)	(0.98)	(1.66)	(1.73)	(1.8)	(1.8)
log of popn			-0.002	0.0368	0.0357	0.04	0.04	0.04	0.04
t			(-0.106)	(10.18)	(10.86)	(4.9)	(7.1)	(6.9)	(7.1)
log of inflation				-0.04	-0.04	-0.03	-0.02	-0.03	-0.03
t				(7.84)	(-5.72)	(-8.04)	(-5.28)	(-5.28)	(-5.1)
log of infl, SQ					-0.05	-0.01	-0.006	-0.0002	-0.0002
t					(-1.99)	(-4.89)	(-2.58)	(-3.6)	(-2.5)
log of soc						-0.02		-0.02	-0.02
t						(-2.93)		(-2.36)	(-2.16)
log of eco							0.95	0.73	0.73
t							(1.95)	(1.61)	(1.91)
log of pvk								-0.0002	-0.0002
t								(-1.01)	(-0.5)
log of gov									-0.0001
t									(1.85)
R^2	0.2	0.34	0.27	0.18	0.63	0.78	0.69	0.74	0.7

Notes: 1. Figures in parentheses are t statistics
2. All fixed effects regressions are cross section weighted.

Figure.1

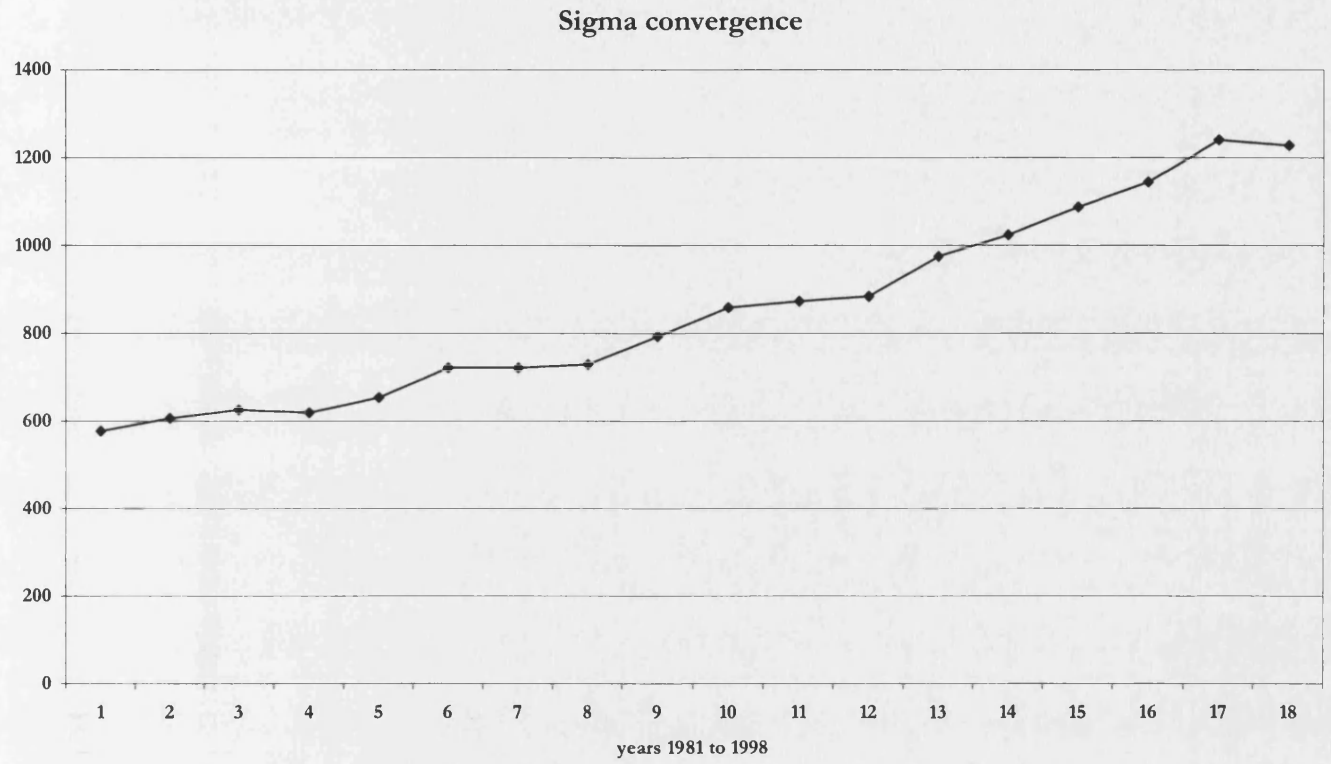

Sigma convergence
1400
1200
1000
800
600
400
200
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
years 1981 to 1998

Fig.2a: Relative Income Dynamics across Indian States, 1 year horizon, 1965-70

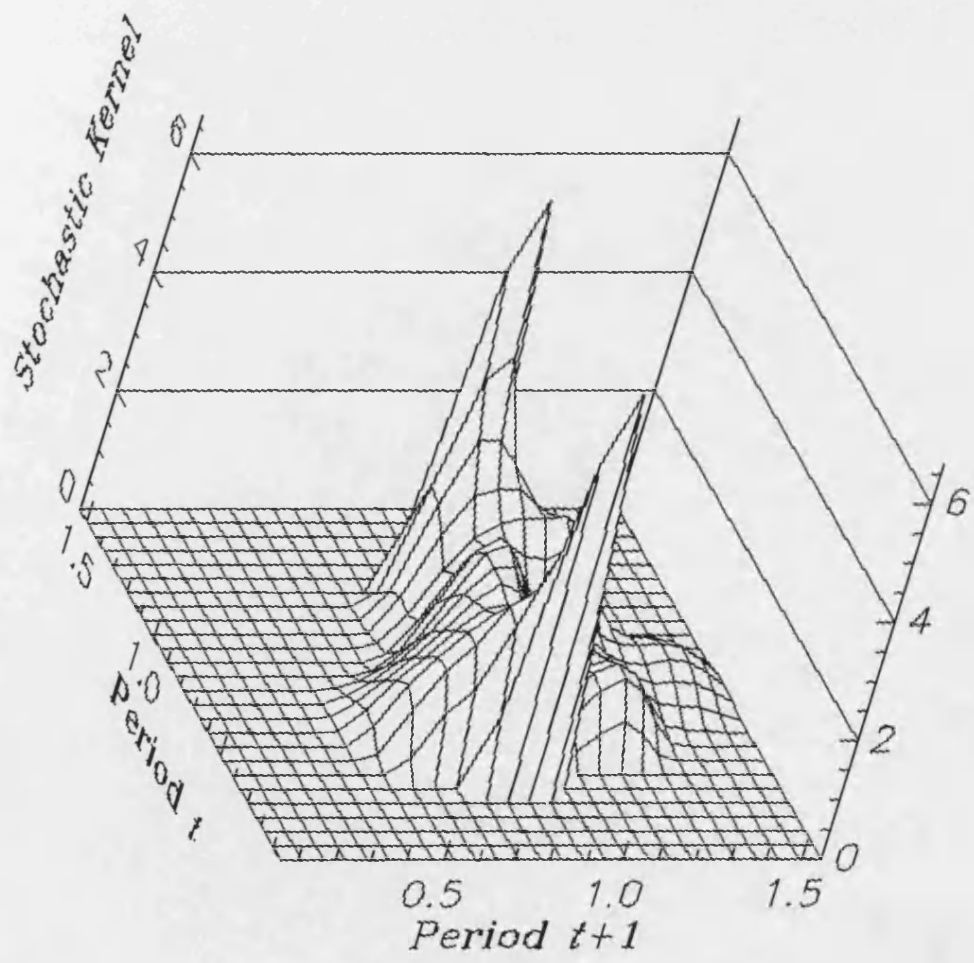


Fig. 2b: Relative Income Dynamics across Indian States, 1year horizon 1971-80

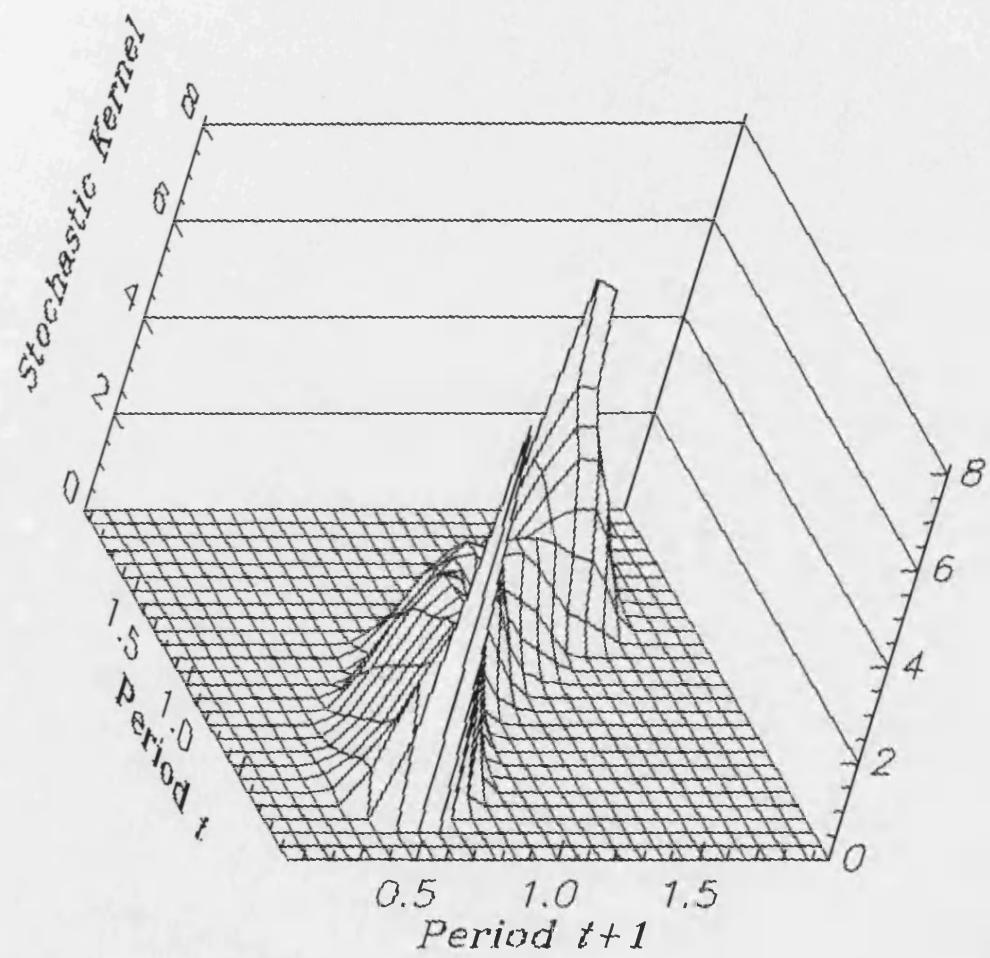


Fig. 2c: Relative Income Dynamics across Indian States, 1 year horizon 1981-89

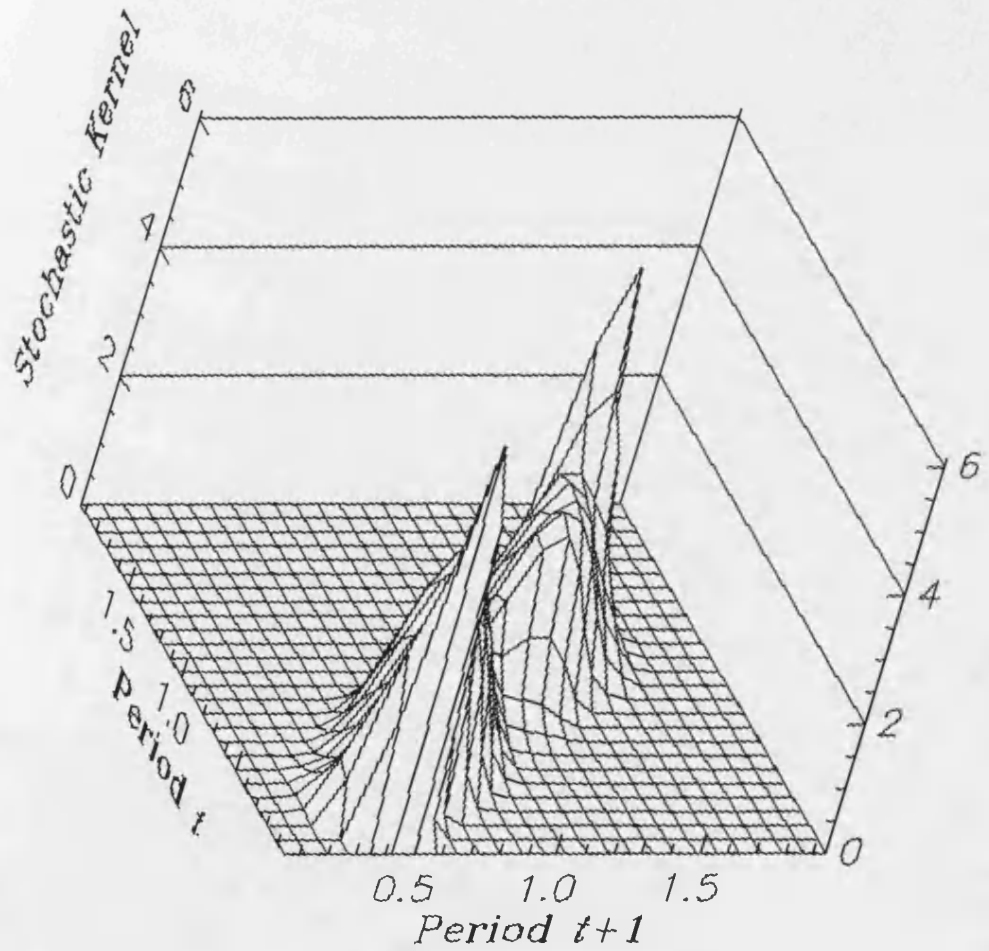


Fig. 2d: Relative Income Dynamics across Indian States, 1 year horizon
1989-96

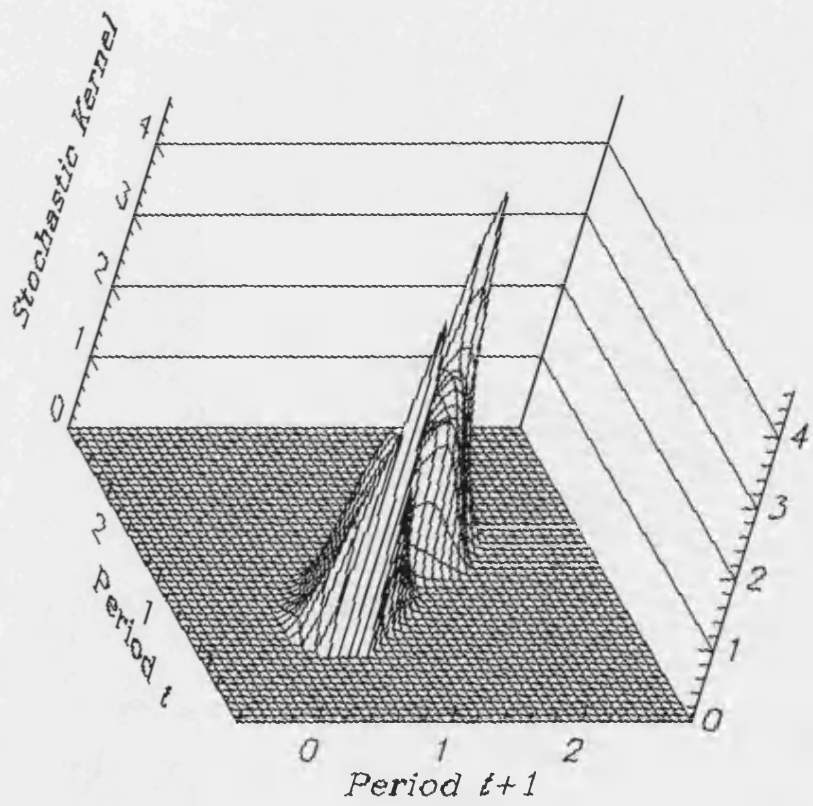


Fig.3ai. Relative per capita incomes across Indian states
Capital Expenditure conditioning.

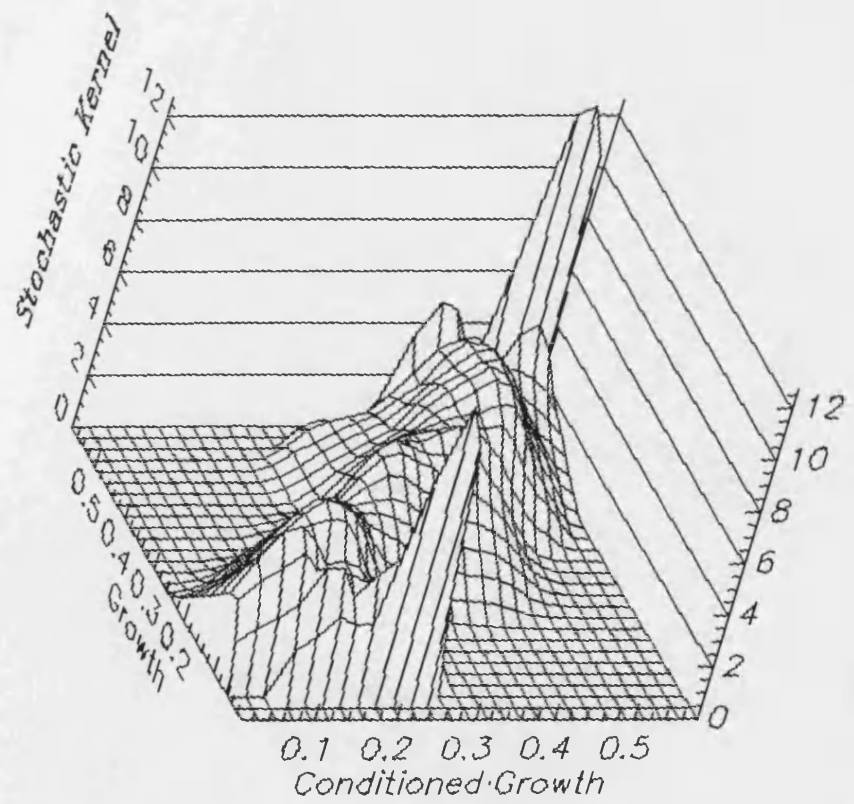


Fig.3aii. Relative per capita incomes across Indian states

Capital Expenditure conditioning, contour.

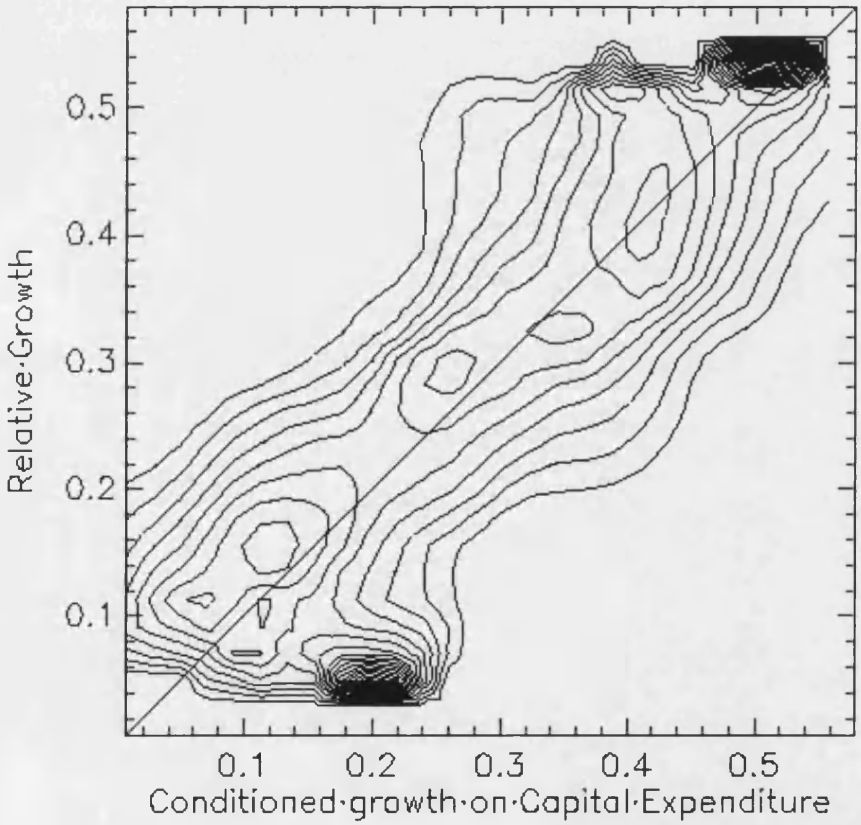


Fig.3b. Relative per capita incomes across Indian states
Education Expenditure conditioning

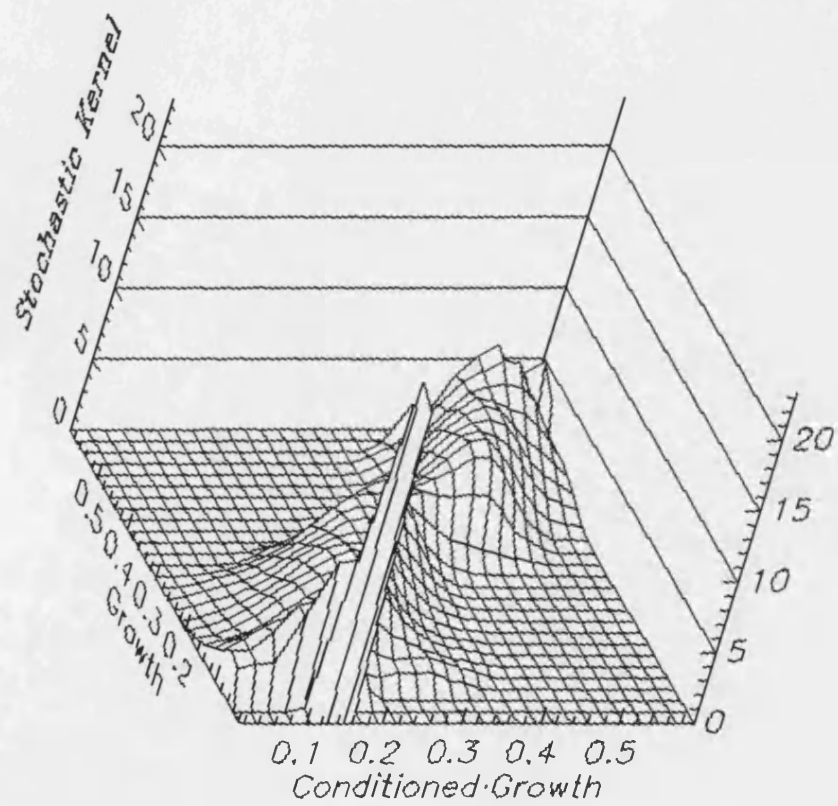


Fig.3bii. Relative per capita incomes across Indian states

Education Expenditure conditioning, contour

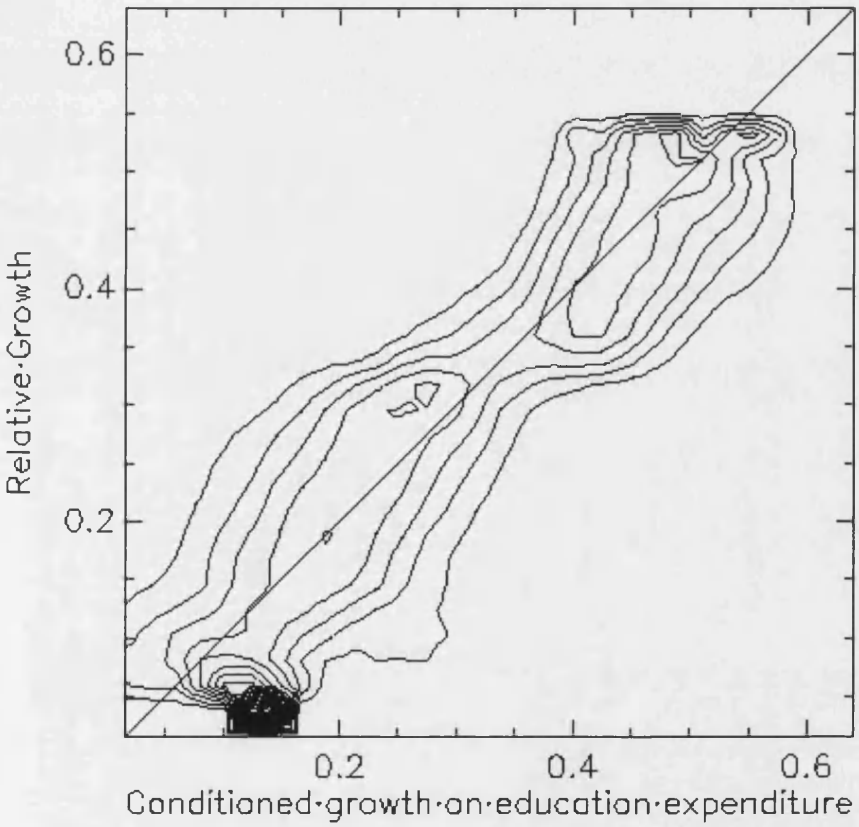


Fig.3ci. Relative per capita incomes across Indian states
Fiscal deficit conditioning

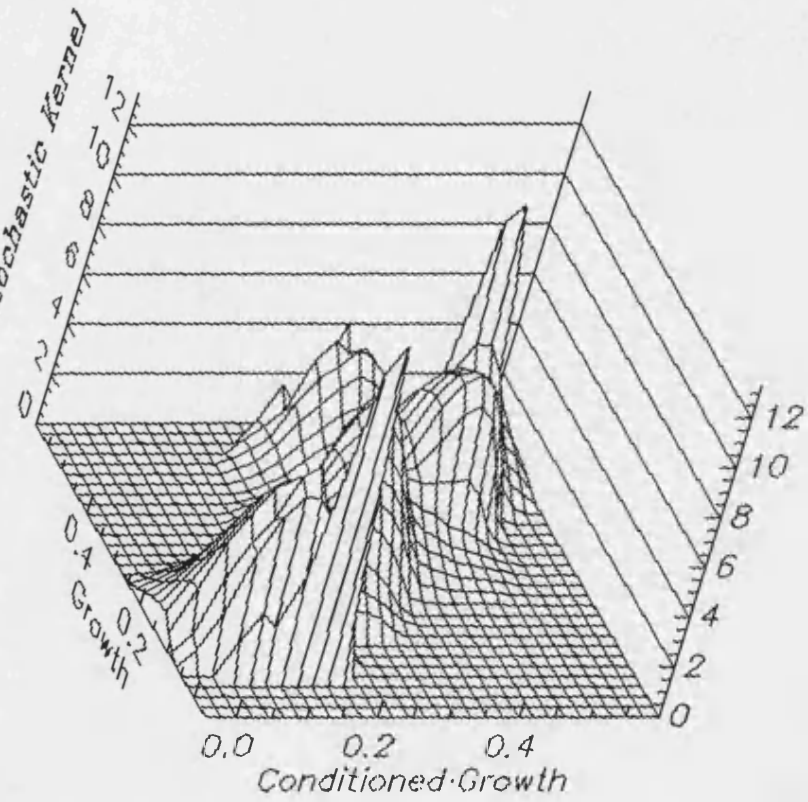


Fig.3cii. Relative per capita incomes across Indian states

Fiscal deficit conditioning, contour

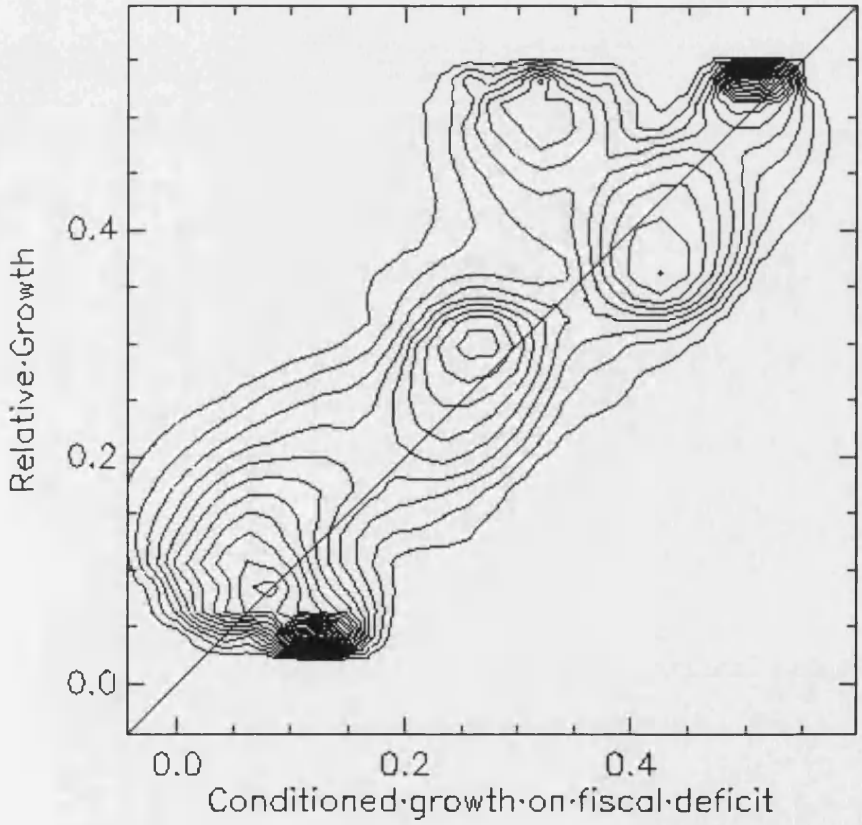


Fig.3d. Relative per capita incomes across Indian states
Inflation conditioning

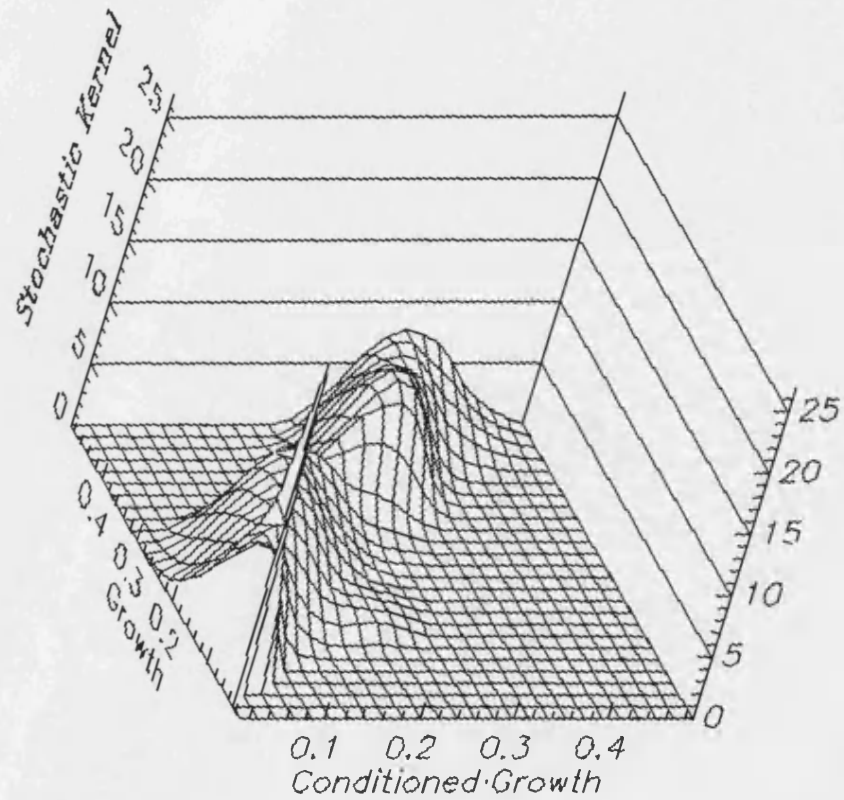
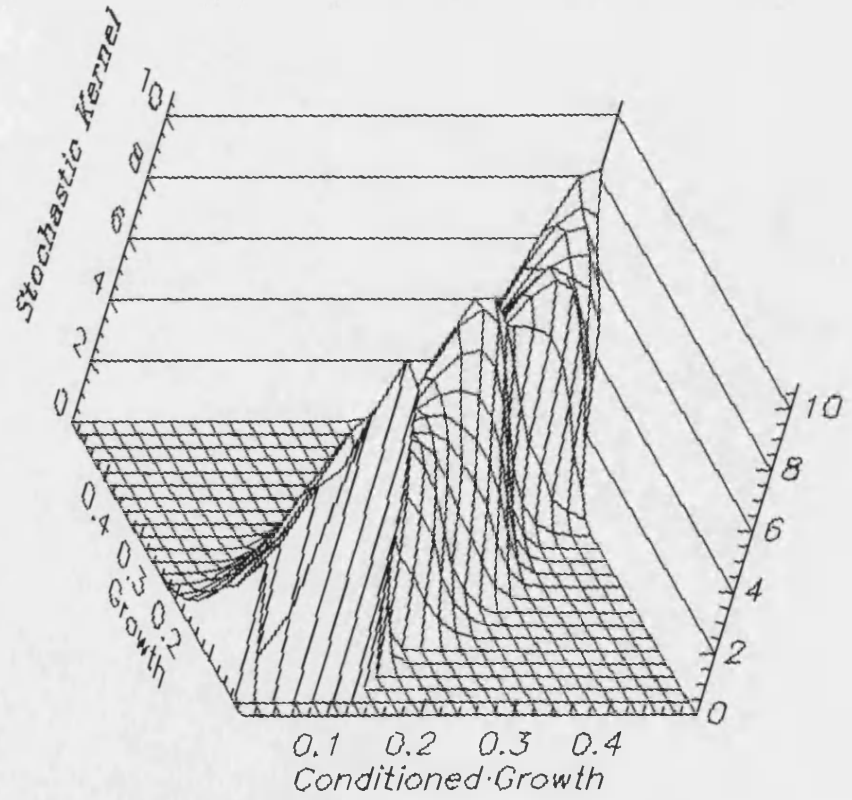


Fig.3e. Relative per capita incomes across Indian states
Interest expenditure conditioning



Chapter 5

Conclusion

This thesis documents some stylised facts of what sustains unequal economic growth across Indian states. We have adopted a new econometric methodology, developed by Quah (1996, 1997b,c) to document and explain income and growth dynamics across Indian states over the period 1965 to 1997. This methodology, the distribution dynamics approach, has given us an insight into the dynamics of economic growth hitherto not revealed in any study on the Indian case.

In this study, we are interested in a different, and more sensible notion of convergence. The traditional approach of convergence models only the behaviour of the average or representative economy. Here convergence pertains to convergence to one's own steady state income. However, we are more interested in convergence as a notion of catch-up. Are the poorer states catching up with the rich, or are they falling behind? Or are they polarising into income clubs? Such empirics provide direct measurements on the dynamics of relative well-being and income mobility across economies.

In adopting the distribution dynamics approach of Quah (1996, 1997b,c), we recognise that to address the question of catch-up one needs to explicitly model the dynamics of the income distribution itself. We move away from traditional approaches of standard regression or time series analyses to observe the evolution of the entire income distribution over time. It improves on existing approaches in that we are no longer looking at average-representative behaviour, as is the case with standard regression techniques. Neither do the

univariate dynamics of income using the time series approach inform us much, being silent on cross section information.

The method has allowed us to observe the evolution of the entire income distribution over 1965 to 1997 - we find that the dominant cross-state income dynamics are that of persistence and immobility, with some cohesive tendencies in the 1960s, only to dissipate over the following three decades. There is evidence of the formation of two income convergence clubs - one at 50 per cent of the national average, and another high income group at 125 per cent of the national average. Alongside such polarisation we find that states with intermediate initial incomes experienced mixed fortunes. Some had a marked improvement in their incomes, while some fell drastically, while still others saw it unchanged. The long term view on the basis of the above stylised facts suggest a gradual weakening of the forces of polarisation with the lower income group vanishing.

We have used two different kinds of models to estimate such dynamics – transition probability matrices and stochastic kernels. Both models – discrete and continuous, use Markov chains to track the evolution of the income distribution. Both models measure intra-distributional mobility of an economy; the probability with which an economy moves from it's initial "position" or "rank" among all other states to any other position or rank.

The rest of the thesis involves investigating which possible factors can explain the observed polarisation. In Chapter 3, we look at the role of infrastructure and state development expenditure over the period 1977 to 1993. In Chapter 4, we examine the role of macroeconomic factors and political governance over 1986 to 1996. In both studies, we use the (non-parametric) distribution dynamics approach, and standard parametric analyses using panel and cross section regressions to complement our non-parametric results. The

parametric results obtained mostly conform with those of the distribution dynamics approach.

Investigating factors which explain the lack of convergence (or any other pattern, as in our case - polarisation), otherwise known as conditional convergence, differs from conventional methods. In asking whether variable X explains Y, while standard methods (of regression analysis) compare expected values of Y and Y|X, we compare the entire distributions of Y and the conditional distribution of Y. For this, again, we use the same tools as used in comparing the distributions across time. The idea is simple - in the previous case we compared distributions across time, here we compare the unconditioned and conditioned distributions. Hence, to understand if a hypothesised set of factors explains a given distribution we can simply ask if the stochastic kernel transforming the unconditional one to the conditional one removes those same features.

In Chapter 2 we looked at the role of infrastructure and state development expenditure in explaining the regional distribution dynamics. We find that economic and social infrastructure drives the process of polarisation, particularly so in the lower income states. An index of infrastructure is constructed (by factor analysis) to observe the aggregate effect of infrastructure in explaining polarisation. The conditioning exercise reveals that (aggregate) infrastructure does explain the club convergence at the lower income levels. This, however, was not the case with state development expenditure, or any other individual infrastructure indicator (for example, education, or percentage of irrigated land etc). We also find that composition of state domestic product does not serve to explain the distribution dynamics. These results together suggest that higher investment in infrastructure for the lower level states, is essential to counter the forces of polarisation.

The role of neighbouring states, in that states follow their physical neighbours' outcomes, is not shown to have a significant role in explaining the observed polarisation.

Of the individual infrastructure indicators examined using standard parametric tests (i.e. panel regressions), we find extent of irrigation, roads, power consumption in industrial sectors, education and bank deposits significantly explain inter-state variation in growth. Conditional convergence is occasionally observed but is not robust to alternative specifications. Given that the distribution dynamics suggest that economic and social infrastructure explain the formation of the lower income club, the parametric results highlight the individual elements of infrastructure which explain the cohesive forces at the lower income convergence club. In other words, results obtained from the two methodologies (both non-parametric and parametric) together highlight specific infrastructure elements which explain the formation of the lower income club.

State development expenditure was observed not to have significant explanatory power either in non-parametric or parametric exercises, even after taking into account endogeneity bias. This, however, should not discount its vital importance in balancing inter-state economic growth. Other infrastructural indicators which are found to be strongly responsible in explaining cross state variation in growth are intrinsically determined by the level of state development spending.

In the following chapter, we look at the role of macroeconomic stability and political governance in explaining the polarisation of growth. This chapter examines the role of macroeconomic factors and political governance in explaining polarising inter-state economic growth using both the distribution dynamics approach and complements the results with those obtained using standard parametric specifications. A conditioning

methodology using the same non-parametric empirical tools reveals that such income dynamics are partially explained by the level of fiscal deficits. Unlike standard methods, this model allows us observe the income dynamics at different levels of the distribution – here we observe that fiscal deficits explains club formation at higher income levels. Other auxiliary factors, capital expenditure, expenditure on education, inflation and interest expenditure do not reveal any interesting insights.

The parametric short run panel results also show that these relationships are quite fragile, presumably as a result of the evolution of these relationships over time, as revealed in the non-parametric results. Short run panel regressions reveal that most of the relationships observed are not robust – the relationship between the macro-economic variables and growth fluctuate in sign (hence, direction) and are only occasionally significant. However, taking averaged OLS regressions over this period leaves us with interesting results. Female literacy is observed to have a significant and positive effect on growth, fiscal deficits are significantly and negatively correlated with growth, while both the short run and long run (1961-98) results reveal the negative impact of inflation on growth. Expenditure on education is also 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. Using the most rudimentary indicators, political instability is also observed to negatively affect growth in the long run results; better political governance is also observed to positively affect growth – both of these results are particularly significant for the averaged OLS regressions. Tax revenues, revealing unstable effects on the growth in the (annual) panel regressions, show up to have a significant positive relationship in the averaged OLS regressions too. The unstable nature of the relationships as showed up in the panel

regressions can hence be attributed to the immense amount of variation of these variables, which are smoothened out on averaging and OLS estimation.

The results thus indicate, as reiterated in many empirical and theoretical studies (for example Fischer 1993, Barro 1995), that the macroeconomics do matter to a large extent to balance differential growth. These growth empirics are directive, in the least, of a host of macroeconomic policies to arrest and even reverse polarising growth tendencies across Indian states.

5.1 What are the main contributions of this project?

The empirical findings in the thesis, thus, serve to contribute to the empirical literature on cross-country growth, and that across Indian states in two main ways. First, the growth empirics obtained using two complementary econometric methodologies have revealed different correlates which are directive of relevant policies. Much of the results obtained are in confirmation with those documented in the existing literature – the results hence serve to strengthen already established correlates. What is also observed, as revealed by the distribution dynamics is that we are able to identify different policies that are relevant at different parts of the distribution. While social and economic infrastructure explains polarisation at the lower income levels, macroeconomic stability explains cohesion of the higher income states. The empirics obtained serve to give deeper insight into how these factors work in balancing, or polarising cross-regional growth, as also done in Quah (1996, 1997b).

Second, from the point of view of its contribution to the Indian empirical literature, the study has entailed compiling a number of data sets, and has provided a detailed set of empirical results using two complementary econometric methodologies, hitherto not done in the Indian literature. The distribution dynamics of inter-state incomes reveals empirics of polarisation, on which conditioning schemes distinctly suggest different policies for the two income clubs. Standard parametric results only highlight the specific factors or correlates which explain inter-state growth, the distribution dynamics serve to clarify which factors are relevant at different income clubs.

5.2 What is not done in this thesis?

The thesis does not identify a nexus of causal "routes", or even individual routes, which are responsible for sustaining disparate growth. Indeed, such a task would be one of an immense order. What is attempted is to identify correlates which account for the observed growth pattern. We recognise that there is more to simply analysing convergence, or the lack of it, and that our object of investigation is of *patterns* of catch-up, not simply catch-up. Our chosen methodology, accordingly, is governed by the questions asked, and the distribution dynamics approach maps the evolution of the income distribution – we observe that persistence and immobility, leading to polarisation into income convergence clubs, were the dominant characteristics. The following two chapters identify a number of causal factors which do explain, using both distribution dynamics and standard approaches, the observed polarisation. We, however, refrain from extending for a detailed investigation.

To illustrate - a broad range of the evidence presented in this thesis supports the conventional view that for example infrastructure, and a stable macroeconomic framework is conducive to sustained economic growth. However, the thesis only undertakes to study such initial correlates – to identify factors which immediately explain the distribution dynamics. No further analysis is undertaken to identify further channels through which these factors affect growth; for instance, inflation reduces growth by reducing investment, and by reducing productivity; large budget surpluses are strongly associated with more rapid growth, through greater capital accumulation and greater productivity growth (Fischer 1993).

In undertaking the parametric investigations, we have also faced a formidable problem, faced by most researchers in empirical cross-country growth – that of endogeneity. We have undertaken the simplest, albeit useful, of methods to handle the problems of endogeneity in the Chapters 2 and 3. Though it has been difficult to deal with formally, the evidence observed under different tests (parametric and non-parametric) after having accounted for endogeneity reveals a general confirmation with each other.

To make progress in defining a stable and sustainable macroeconomic framework, and in clarifying the channels through which infrastructure, macroeconomic variables, and political institutions enhance economic growth, it will also be necessary to undertake detailed case studies for the individual states. This is necessary for two reasons. First, the federal democracy of Indian states allows for independent policy making under the state governments. The federal system has lent independent political and economic set ups within each state, leading to their different respective structures, each individually unique in their own right. Second, and related to the earlier argument, is that the states are quite distinctly different from each other, in that much of their prospects of economic progress

were founded under the imperatives of the colonial state prior to 1947, and that structurally very little has changed over the last 50 years. Indeed, the "initial conditions" which we observe as influential in explaining a lot of the variation across the states are the outcome of interventions of the colonial state. A number of analyses (Bharadwaj, 1982, Kohli 1986) studying regional differentiation in economic development have remarked upon the kind of vicious spiral which was established in these regions of the country, connecting public investment, agricultural growth, industrial development and 'the general level of well-being' – the states of the north-west and "the southern region around Madras and Bombay, and especially what later became the state of Gujarat, was better placed and had a better start in terms of both agriculture and industry".

More importantly, what needs to be addressed is the overwhelming economic power generated at the Centre owing to India's federal system, under the auspices of the Planning Commission and the quinquenially appointed Finance Commission which governs the allocation of public resources between the centre and the states. These two centrally appointed bodies generate a formidable nexus of power which has been rendered as responsible for generating constraints on the Centre's ability to impart progressiveness to its investment or transfers to the states.

Some simple funding statistics highlight the skewed distribution of state lending and credit provision. An important source of inter-governmental transfers are of subsidised lending to the states. These loans are determined by the Gadgil formula[54], and such loans comprise of 68% of the state's liabilities. Market borrowings constitute another 22 per cent, subscribed mainly by the banking system to fulfil the statutory liquidity ratio (SLR)

[54] The Gadgil formula is the official rule by which the amount of loans are determined to be given to the state. It postuates that the amount of loan/transfer granted is proportional to the population of the state

requirements. A number of studies (Rao, 1999, Lall 1999) have highlighted that per capita transfers in high income states were higher than both middle and low income states. In 1990-91, per capita transfers received by low income states was 18% lower than high income states – transfers were 43% lower in 1993-4. Rao (1999) calculates income elasticities for both such implicit and the explicit transfers from the Central Government to the states. While the elasticities of explicit transfers are negative, hence reflecting progressiveness, the elasticities of the implicit transfers are positive, hence significantly reducing the progressivity of the transfer mechanism over the entire period from 1980-81 to the mid-nineties.

Other such transfer systems lending to the regressivity of the transfer mechanism are inter-state tax exportation arising from the levy of origin-based progressive sales taxation along with the taxation of inter-state sale of goods. The sales taxes are levied at the state of origin and on inputs, outputs and capital goods alike. However, the oligopolistic nature of the market "pushes the tax fully forward" – a consequence of which is significant inter-state tax exportation from the affluent producing states to the consumers in poorer consuming states. Non-availability of inter-state trade data does not allow accurate estimation of the inter-state tax exportation. However Rao (1999) presents a rough estimate of the amount of inter-state tax exportation on the basis of estimates available of tax and consumption shares. Comparison of income tax shares and consumption shares reveal that high income states generally have a higher tax share than consumption shares. Assuming that 50 per cent of the difference is attributed to inter-state taxation, and the rest to differences in effective rates, they estimate that richer states collect almost 13% of their sales taxes from poorer states and that poorer states paid 19% of their sales tax payment to the richer states.

While the above two sources of implicit transfers circumscribe the ability of the states to raise sufficient revenue, the lending and financing practises by the banking system biased towards the high income states limit private investment in poorer states. It is estimated that the high income states of Punjab, Haryana, Gujarat and Maharashtra with only 19% of the total population have received 35% of priority sector lending for agriculture, small enterprises and exports; lower income states of Rajasthan, Orissa, Bihar, Madhya Pradesh, in that comparison, with over 44% of total population received only 15% of priority sector lending. The figures are similar for the AIFI lending – while the richer states received 43%, the poorer states received a meagre 22%.

The key to balanced regional growth to a large extent, thus, is dependent on addressing the regressive transfer mechanism of directing investments into states most constrained by poor infrastructure. This is a future direction of research deserving significant attention.

5.3 What policy conclusions can one derive from the empirical findings?

We can now string the different components of the story together. What is apparent from these empirical findings is that economic growth is circumscribed by the availability of what can be broadly termed as economic and social opportunities[55]. We find that economic growth is underpinned by the very opportunities that it seeks to provide. The lack of economic and social infrastructure, macroeconomic instability and weak political governance largely account for the disparate economic growth. The importance of social development looms large in our findings. Cursory attempts to highlight the severity of the gender divide (we have used the role of female literacy as our only indicator) reveal that

[55] Such an approach to development, i.e. in terms of increasing economic and social opportunities has also been used in Dreze and Sen (1995)

female literacy rates bear a strong correlation with cross-state growth. Other such social cleavages of caste, creed and religion, all add to the already complex and divided social structure, themselves varying across states in degree, which hinders and undermines prospects of economic development. Political instability, also using the most rudimentary of indicators in the analysis, is also revealed to hinder homogenous cross-state growth. While such instability is a hindrance in itself, frequently changing governments come with varying policies for economic development and growth. Harriss(1999) using a political economy approach, attributes much of the disparities in economic growth and development across Indian states to the diverse political regimes across the states. Factors thus, essential for catch-up, as observed, lies in the realm of an agenda entirely fashioned and driven by state action. The task for the Indian policy maker, it appears, is not simply an agenda of economic reform but, indeed, a mammoth task of political and social reform too.

What also should be noted is the elementary nature of the factors identified for catch-up, particularly for the low income club of states. Low incomes and tyranny, poor economic opportunities as well as systematic social deprivation, neglect of public facilities as well as intolerance or over-activity of repressive states are all perceived as major sources of "unfreedom"[56] by Sen (1998), is his book "Development as Freedom". While the empirical findings and indeed, the economic literature does recognise these as barriers to economic growth and those which sustain unequal cross-regional economic growth, it is also a more compelling imperative to view them as basic economic and social necessities, irrespective of any other economic agenda. Provision of economic and social opportunities should not be simply viewed as a means to an end of sustaining equal regional growth, but an end in itself.

[56] See Sen 1998 for a more elaborate exposition of the unfreedoms of deprivation.

Bibliography

Adelman, I and C.T. Morriss (1967): "Society, Politics and Economic Development – a Quantitative Approach", Johns Hopkins Press, Baltimore.

Aiyar , S (2000): "Growth Theory and Convergence Across Indian States: A Panel Study", in India at the Crossroads: Sustaining Growth and Reducing Poverty, edt. by T. Callen. P. Reynolds, and C. Towe.

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

Alesina, A. and R. Perotti, (1996), "Income Distribution, Political Instability, and Investment", European Economic Review, 40(6): 1203-1228.

Atkinson, A B (1995): Incomes and the Welfare State: Essays on Britain and Europe, Cambridge University Press

Bajpai, N and J.D. Sachs (1996), "Trends in Inter-State Inequalities of Income in India", Discussion Paper No. 528, Harvard Institute for International Development, Cambridge, Mass., May.

Barro, R.J. (1991): "Economic Growth in a Cross Section of Countries", Quarterly Journal 1996

----------(1995): Inflation and Growth, NBER working paper, No. 5326

Barro, R.J. and Lee, J.W. 1994. Sources of Economic Growth, Carnegie- Rochester Conference Series on Public Policy, No.40

Barro, R.J. and X. Sala-I-Martin (1991): "Convergence Across States and Regions", Brookings Papers on Economic Activity, 1:107-82.

Barro, R.J. and Xavier Sala-i-Martin (1992): "Convergence", in Journal of Political Economy, 100(2)

----------(1995). Economic Growth, MacGraw Hill, New York

Baumol, W(1986): "Productivity growth, convergence and welfare", American Economic Review 76(5), 1072-85, December.

Bell, C and R. Rich (1994): Rurao Poverty and Agricultural Performance I Post-Independence India", Oxford Bulletin of Economics and Statistics, 56, 111-33.

Benabou, R (1996): "Heterogeneity, stratification and growth: Macroeconomic implications of community structure and school finance", American Economic Review, 86(3), 584-609

Ben-David, B (1994) "Converging clubs or diverging economies", Working Paper 922, CEPR , London, February

Bernaud, A and S. Durlauf (1991): "Convergence of International Output Movements ", NBER Working Paper No. 3717

---------- (1996): Interpreting Tests of the Convergence Hypothesis", Journal of Econometrics, 71 (1-2):161-74

Bharadwaj, K (1982): "Regional Differentiation in India: A Note", Economic and Political Weekly, Annual Number, 1982 April.

Bianchi, M (1995): "Testing for Convergence: A bootstrap test for multimodality", Journal of Applied Econometrics, (21).

Blomstrom,M. Lypsey, R.E and Zejan,M. (1993): "Is Fixed Investment the Key to Economic Growth?" , NBER WP 4436

Borts, G H and Stein, J.L. (1964): "Economic Growth in a Free Market", Columbia University Press, New York

Bruno, W and W. Easterly(1998): "Inflation crises and long-run growth", Journal of Monetary Economics. 1998 (February); 41:1: pp.3-26

Campbell, J and G.Mankiw(1989): "International Evidence on the Persistence of Economic Fluctuations", Journal of Monetary Economics, March, 1989: 319-333.

Canova, Fabio and A. Marcet (1995): "The poor stay poor: Non-convergence across countries and regions", Discussion Paper, CEPR, November.

Carlino, G and L.Mills (1993): " Are US Regional Incomes Converging? A Time Series Analysis, Journal of Monetary Economics, Nov.1993 (32): 335 -346.

Cashin , P. and R. Sahay (1996), "Internal Migration, Centre-State Grants, and Economic Growth in the States of India", IMF Staff Papers, Vol. 43, No. 1.

Chamberlain (1984): "Panel Data", in Handbook of Econometrics, Vol II, eds. Zvi Griliches and Michael Intriligator (Amsterdam: Elsevier North-Holland) Chapter 22, pp 1247-1318.

Chaudhry, M. D., (1966): Regional Income Accounting in an Underdeveloped Economy: A Case Study of India, Calcutta: Firma K. L. Mukhopadhyay.

Cohen, D (1992): "The Test of Convergence Hypothesis. A Critical Note", CEPR Discussion Paper 691, August.

---------- (1992b): Economic Growth and the Solow model: Some further empirical results", CEPREMAP, August

---------- (1996): " "Tests of the Convergence Hypothesis: Some Further Results", Journal of Economic Growth, 1(3): 351-362, September

Cowell, F, S. Jenkins, and J. Litchfield, (1996): "The changing shape of the UK income distribution: Kernel density estimates", in New Inequalities: The Changing distribution of Income and Wealth in the United Kingdom, edt John Hills (Cambridge University Press) Chapter 3, pp 49-75

Das, S.K., Barua, A., Ghosh, M.N. (1993) "Inter-State Economic Inequality in India: Some Implications for Development Strategy". Discussion Paper, International Trade and Political Weekly, Bombay.

Datt, G (1997): Poverty in India and Indian states, An Update, International Food Policy Research Institute, Washington D.C.

Datt, G and M. Ravallion (1998): Farm Productivity and Rural Poverty in India, Journal of Development Studies, 34(4): 62-85

DeLong, J. B (1988) Productivity Growth, Convergence, and Welfare, American Economic Review: A Comment, 78(5):1138-55, December

Desdoigts, A (1994): "Changes in the world income distribution: A non- parametric approach to challenge the neo-classical convergence argument", PhD dissertation, European University Institute, Florence.

Dollar, D (2001): "Growth Is Good for the Poor", World Bank Policy Research Working Paper No.2587.

Dreze, J P and A. Sen (1995): India: Economic Development and Social Opportunity, OUP, Delhi.

Durlauf, S(1992): "A theory of consistent income inequality", Department of Economics, Working Paper, University of Wisconsin-Madison, October.

Durlauf, S and P. Johnson (1994) Multiple regimes and cross country growth behaviour," Working Paper, University of Wisconsin, May

Durlauf, S. N. and Quah, D T. (1998): "The New Empirics of Economic Growth", NBER Working Paper 6422, NBER, Cambridge, February.

Easterly, W. and Rebelo, S. (1993): "Fiscal policy and economic growth", Journal of Monetary Economics, 32(3), 417-58.

Estaban, J and D.Ray (1994): "On the measurement of polarisation", Econometrica, **62**(4): 819-851.

Everitt, B. (1978): Graphical techniques for Multivariate Data, New York, North Holland.

Fisher, S. (1991): "Macroeconomics, Development and Growth", NBER Macro-economic Annual, 329-364.

----------(1993): "Macroeconomic Factors in Growth," Journal of Monetary Economics, Vol 32, No.3, 485-512.

Friedman, M (1992): "Do old fallacies ever die", Journal of Economic Literature, 30(4): 2129-2132, December.

Galor, O (1996): "Convergence? Inferences from theoretical models", Economic Journal, 106(437) 1056-80, July.

Galor, O and J.Zeira (1993): "Income distribution and Macroeconomics", Review of Economic Studies 60(1): 35-52, January.

George, K.K. 1988 Centre State Financial Flows and Inter-State Disparities, Criterion Books, Delhi.

Ghuman, B.S. and D. Kaur (1993): Regional Variations in Growth and Inequality in the Living Standard: The Indian Experience, Margin, 25(3), 306-13.

Government of India (1999): Economic Survey, 1998-99, Ministry of Finance, New Delhi

Harriss, J (2000): "How Much Difference does Politics Make? Regime Differences across Indian States and Rural Poverty Reduction", LSE Working Paper Series, Development Studies Institute, February 2000.

Hausman, J.A.1978 "Specification Tests in Econometrics", Econometrica, 46(6), 1251-71.

Hsiao, C 1986. Analysis of Panel Data. New York: Cambridge University Press.

Ioannides, Y (1990)" Trading uncertainty and market form", International Economic Review **31**(3), 619-638

Islam, N (1995): "Growth empirics: A panel data approach", Quarterly Journal of Economics, 110(443), 1127-1170.

Jones, C.I. (1997): "On the Evolution of the World Income Distribution", Journal of Economic Perspectives, 11(3):19-36

Joshi, V. and Little, I.M.D. 1994. India. Macroeconomics and Political Economy: 1964-1991, The World Bank, Washington.D.C.

Kaldor, N (1963): " Capital Accumulation and Economic Growth" in Lutz, Frederich A. and Hague, Douglas C, . (edt), Proceedings of a Conference held by the International Economics Association. Macmillan.

Kaufmann, D., A. Kraay, P. Zoido-Lobaton (1999) Governance Matters, World Bank. Policy Research Working Paper 2196, October 1999.

Khan, M.S. and Kumar, M.S. (1997):. Public and Private Investment and the Growth Process in Developing Countries, Oxford Bulletin of Economics and Statistics, 59(1).

Kirman, A., C. Oddou, and S. Weber (1986) "Stochastic communication and coalition formation", Econometrica, **54**(1), 129-138, January.

Knack, S and P. Keefer (1997): "Why Don't Poor Countries Catch Up? A Cross National Test of an Institutional Explanation", Economic Inquiry, 35: 590-602

Kohli, A (1986): The State and Poverty in India, CUP, New Delhi.

Kumar Das, S and A Barua (1996): "Regional inequalities, economic growth and liberalisation: A study of the Indian economy", Journal of Development Studies, 32(3), February, 1996

Kundu,A.., Mishra, G.K., and Meher, R.K. (1986) Location of Public Enterprises and Regional Development, New Delhi, Concept Publishing Company

Lamo, A (1996): "Cross section distribution dynamics", PhD dissertation, LSE, 1996

Larch, M (1994): "Regional cross section growth dynamics in the European Community", Working paper, Economic and Social Cohesion Laboratory, European Institute, London School of Economics and Political Science.

Lee, K., H. Pesaran, and R. Smith (1997b): " Growth empirics: a panel data approach. A comment, ", Quarterly Journal of Economics, 1997.

---------- (1997a): "Growth and convergence in a multi-country empirical stochastic Solow model", Journal of Applied Econometrics, 12, 357-392.

Leung, C. and D. Quah (1996): "Convergence, Endogenous Growth and Productivity Disturbances", Journal of Monetary Economics, 38(3):535-547, December

Levine, R and D. Renelt: (1992) "A Sensitivity Analysis of Cross Country Growth Regressions", American Economic Review, 76, 808-819.

Levine, R and S. Zervos (1992): "Looking at the facts: what we know about policy and growth from cross country analysis", American Economic Review. 1993 (May); 83:2: p.426

Loewy, M and D. Papell (1994): "Are US Regional Incomes Converging: Some Further Evidence", mimeo, University of Houston, 1994.

Loury, G.C. (1981): "Intergenerational Transfers and the Distribution of Earnings", Econometrica, 49(4), 843-867, July.

Majumdar, G. and J. L. Kapur, (1980): "Behaviour of Inter-State Income Inequalities in India," Journal of Income and Wealth, Vol. 4.

Mankiw, G. N., D. Romer, D. N. Weil (1992): " A Contribution to the Theory of Empirics of Economic Growth", Quarterly Journal of Economics, 107(2): 407-37

Marjit, S and S. Mitra(1996): Convergence in regional growth rates: Indian research agenda", Economic and Political Weekly, August 17, 1996.

Mauro, P (1995) "Corruption and Growth", Quarterly Journal of Economics, Aug 1995

----------(1998) "Corruption and the Composition of Government Expenditure", Journal of Public Economics, 69, 263-279.

Myrdal (1957): Economic theory and underdeveloped regions, London: Duckworth, 1957.

Nagaraj, R (1990): "Industrial Growth: Evidence, Explanations and Issues", Economic and Political Weekly, October 22.

Nagaraj, R , A. Varoukadis and M. Venganzones (1997): Long run growth trends and convergence across Indian states", Technical paper 131, OECD Development Centre, Paris.

Nair, K. R. G, 1985, "A Note on Inter-State Income Differentials in India 1970–71 to 1979–80," in *Regional Structure of Growth and Development in India Vol. 1*, ed. G. P. Misra, New Delhi: Ashish Publishing House.

Nayyar , D (1994): Industrial Growth and Stagnation, Oxford University, New Delhi.

Nerlove, M (1996): "Growth rate convergence - fact or artifact?", Working paper, University of Maryland, June.

Neven, J N and C. Gouyette(1994) : Regional Convergence in the European Community", CEPR Discussion Paper No. 914, London.

Nickell, S (1981), "Biases in Dynamic Models with Fixed Effects", Econometrica, 49.

North, D (1991): "Institutions, Institutional Change and Economic Performance", Cambridge, Cambridge University Press, Cambridge

Overman, H G. and D. Puga (1999): "Unemployment Clusters across European Countries and Regions " CEPR Discussion Paper No. 2255

Özler, B, G Dutt and M Ravallion (1996): "A Database on Poverty and Growth in India", Poverty and Human Resources Division, Policy research Department, The World Bank

Paap, R and H van Dijk (1998): "Distribution and mobility of wealth of nations". European Economic Review, **42**(7): 1269-1293, July 1998.

Pesaran, H and R. Smith (1995): "Estimating Long Run Relationships from Dynamic Heterogenous Panels", Journal of Econometrics, 68(1): 79-113.

Quah, D. T (1990): "International Patterns of Growth I : Persistence in Cross Country Disparities", Working Paper, MIT, March, 1990.

---------(1992): International Patterns of Growth II : Persistence, Path dependence and sustained take off in growth transition", LSE Working Paper, Economics Dept.

---------(1993a) "Empirical cross section dynamics in economic growth", European Economic Review 37(2/3), 426-434, April

---------(1993b) "Galton's fallacy and tests of the convergence hypothesis", *The Scandinavian Journal of Economics*, 95(4), 427-443, December.

---------(1993c): "Exploiting cross section variation for unit root inference in dynamic data", Economics Letters, 44(1):9-19

-------(1996a) "Empirics for growth and convergence", European Economic Review, 40(6): 1353-1375, June

--------(1996b) "Convergence empirics across economies with (some) capital mobility", Journal of Economic Growth 1(1), 95-124, March

-------(1996c) Empirics for growth and convergence", European Economic Review, 40(6), 1353-1375, June

-------(1996d) "Ideas determining convergence clubs", Working paper, Centre for Economic Performance, London School of Economics, April.

-------(1996e)"Twin Peaks: Growth and convergence in models of distribution dynamics", Economic Journal 106(437), 1045-1055, July

-------(1997a) Empirics for growth and distribution: Stratification, polarisation and convergence clubs", Journal of Economic Growth, 2(1): 27-59, March.

-------(1997b) : "Regional cohesion form local isolated actions: I. Historical outcomes, Working paper, Centre for Economic Performance, London School of Economics, December 1997

------ (1997c): Regional cohesion from local isolated actions:II Conditioning., Working paper, Centre for Economic Performance, London School of Economics, December 1997.

Rao, G., R.T. Shand and K.P. Kalirajan (1999): Convergence of Incomes across Indian States: A Divergent View": Economic and Political Weekly, Vol17, No.13, March 27-2nd April 1999.

Rao, M.G. Proposal for State-level Budgetary Reform, Economic and Political Weekly, February.

Ravallion, M., Dutt, G. (1998): Why Poverty Differs in Some Indian States? Economica, 65, 17-38.

Rebelo, S.(1991) Long Run Policy Analysis and Long Run Growth, Journal of Political Economy, 99.

Reserve Bank of India (1993): Reserve Bank of India Bulletin, Examiner Press, New Delhi (1993 and earlier issues)

Rodrik, D (1999): "Institutions for High Quality Growth: What are They and How to Acquire Them", mimeo. Harvard University.

Schluter, C (1997): Topics in Distributional Analysis, PhD Dissertation, LSE.

Sen, A. K. (1998) Development as Freedom, OUP, New Delhi.

Sen,A.. and J. Ghosh (1993): "Trends in rural employment and the poverty-employment linkage." Unpublished paper, Asian Regional Team for Employment Promotion

Shiva Kumar, A.K. (2000): Poverty and Human Development in India: Getting Priorities Right, UNDP India, Occasional Paper No. 30

Silverman(1986): Density Estimation for Statistics and Data Analysis, Monographs on Statistics and Applied Probability

Sims, C. A. (1972): Money, Income and Causality, American Economic Review, 62(4), 540-552, September.

----------(1980) Macroeconomics and Reality, Econometrica, 48(1), 1-48, January.

Singer,B and S. Spilerman (1976): "Some methodological issues in the analysis of longitudinal surveys", Annals of Economic and Social Measurement, 5, 447-474

Solow, R (1956): "A Contribution to the Theory of Economic Growth", Quarterly Journal of Economics, 70(1): 65-94, February.

----------(1957): "Technical Change and the Aggregate Production Function", Review of Economics and Statistics, 39:312-320.

Stokey, N.L. and R.Lucas, E.Prescott (1989): Recursive methods in economic dynamics, Harvard University Press.

Stokey, N.L., and S. Rebelo (1995) Growth effects of flat-tax rates, Journal of Political Economy, 103.

Sutton, J (1995): "The Size Distribution of Business, Parts I and II", Discussion Paper EI/ 9, 10, STICERD, LSE.

Tanzi, V and Hamid Davoodi (1997): "Corruption, Public Investment and Growth", IMF Working Paper WP/97/139.

Temple, J. (1999): "A Positive Effect of Human Capital on Growth", Economics Letters, 65, 131-134

Wei, S-J (1997): "How Taxing is Corruption on International Investors?", NBER Working Paper, No. 6030

Easterly, W. and M. Kremer, L. Pritchett, L. H. Summers (1993): "Good policy or good luck?", Journal of Monetary Economics (32)3 (1993) pp. 459-483.

Williamson, J (1967): "Regional inequality and the process of national development: a description of the patterns", in Economic Development and Cultutral Change, **13**(2)

World Bank (1994). World Development Report, Oxford University Press, Oxford

---------- (1999) India – Reducing Poverty and Accelerating Development – A World Bank Country Study, OUP, New Delhi

----------(2000): India: Policies to Reduce Poverty and Accelerate Sustainable Development – A World Bank Report.

Yagci, F. (1998): "India: Narrowing Inter-state Disparities in Economic Growth and Social Development – A Reform Agenda", processed, World Bank.