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LONG-RUN GROWTH TRENDS AND CONVERGENCE ACROSS INDIAN STATES

by

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RÉSUMÉ

Ce document examine les performances de croissance des États Indiens sur la période 1970-94. Nous procédons tout d'abord à un regroupement des États en fonction de leurs dotations en infrastructures physiques, économiques et sociales, sur la base d'une analyse en composantes principales. Nous combinons ensuite cette technique et l'économétrie des données de panel, dans le but d'évaluer la contribution des divers types d'infrastructures à la croissance. L'analyse tient compte de l'endogénéité de certains types d'infrastructures par l'utilisation de variables instrumentales. Nos résultats permettent de mettre en évidence la convergence conditionnelle des États Indiens. Ce constat n'exclut pas la persistance des inégalités de revenu par tête entre les États, du fait de l'existence de différences dans le niveau d'équilibre de ces revenus. Ces différences s'expliquent par celles premièrement des structures de production, deuxièmement des dotations en infrastructures et, troisièmement, des effets fixes propres à chaque État, estimés dans nos régressions de croissance. En conséquence, des politiques visant à améliorer le niveau des infrastructures physiques, économiques et sociales peuvent avoir un impact important sur la croissance à long terme et la convergence des États Indiens. Une politique efficace implique, en premier lieu, de cibler l'investissement public vers les infrastructures qui, selon nos estimations, semblent avoir la meilleure rentabilité en termes de croissance. En second lieu, elle implique de cibler en priorité les États dont le faible potentiel de croissance semble être davantage lié au manque d'infrastructures.

SUMMARY

This paper examines the growth performance of Indian States during 1970-94. We, first, propose a grouping of States according to differences in the availability of physical, social, and economic infrastructure, using principal components analysis. Then, combining principal components analysis and panel data estimation techniques, we assess the contribution of various infrastructure indicators to growth performance. The analysis tackles endogeneity issues in the provision of infrastructure by way of instrumental variables estimation for many of the infrastructure indicators. We do find evidence of conditional convergence across States. This does not rule out persistent income inequalities due to the dispersion of steady-state income levels. Such disparities are accounted for by differences, first, in the structure of production, second, in infrastructure endowments, and, third, in State-specific fixed effects in the growth regression. Consequently, economic policy measures aiming at improving the availability of physical, economic, and social infrastructure can have a significant impact in promoting long-run growth, as well as convergence across Indian States. An efficient policy involves targeting public investment toward specific infrastructures which, according to our estimates, seem to have the highest pay-off in terms of growth. Such a policy also involves priority targeting in the States whose growth potential appears to be mostly constrained by lacking infrastructure.

PREFACE

Since the implementation of market-oriented policy reform in 1991, India has enjoyed an upsurge in growth, particularly when compared with the four decades since independence. Nevertheless, the Indian Government will need to tackle major economic challenges and maintain the pace of policy reform if the country is to continue on its path of economic development and make significant progress in poverty reduction. One such major challenge will be to achieve balanced growth and convergence across the States of the Union. This is far from being the case at the present stage of development, where the most populous and poorest areas of the country are still lagging behind the richest and more dynamic ones in terms of growth performance.

Low regional growth rates and rising regional disparities — which aggravate problems of poverty and inequality — may compromise efforts at economic stabilisation and reform. Increasing regional differences also entail a risk of political instability and weaken the much-needed consensus toward sustained reform. Moreover, the need to persevere with fiscal adjustment makes it necessary to allocate limited public resources at the regional level in a way which guarantees maximum efficiency of public investment.

In this paper, carried out in the framework of the Development Centre's 1996-98 research programme on "Economic Policy and Growth", the authors highlight the importance of differences in physical, social, and economic infrastructures in accounting for the observed differences in growth performance of Indian States. The empirical evidence they present suggests that public investment is most effective when it is both targeted towards specific infrastructures and towards States whose growth is largely constrained by lacking infrastructure. Such economic policy measures can have an important impact on promoting long-run growth, as well as convergence across Indian States.

Jean Bonvin
President
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SECTION I. INTRODUCTION

India's per capita income has increased only modestly since independence. This contrasts with the high growth of some other Asian countries, and occurred despite the existence of favourable preconditions such as a well-diversified resource endowment, a highly trained elite, experienced entrepreneurs, experience in public administration and, finally, a relatively stable political system. Until the mid-1980s, however, government policies followed an inward-looking development strategy: investment planning, industrial licensing to direct investment flows towards specific sectors and across states, import substitution and financial repression. The public sector was continuously expanded and the high level of trade protection discouraged production of exports and made the balance of payments vulnerable to external events (Joshi and Little, 1994). Partial economic reforms begun in the 1980s, were accelerated in 1992 in response to the severe balance of payments crisis of 1991, and with the objective of setting the stage for long-run sustained growth of the Indian economy (Ahluwalia, Mohan, and Goswami, 1996).

The factors accounting for long-run Indian growth trends are best understood from a regional standpoint, because of the big disparities in economic development and growth performance between States. Moreover, examining long-run growth trends and convergence across Indian States has considerable interest, not only analytically, but also from the standpoint of continuing policy reforms. Besides involving poverty and inequality, low regional growth rates and rising regional inequalities could compromise the efforts at economic stabilization and reform that have been undertaken since 1991.

First, regional disparities entail a danger of political instability because of the large social, cultural and political differences among states. This danger is even greater in the present situation with a central government, whose stability is highly dependent on support from small, local political parties. This support is all the more important because economic disparities seem to have been aggravated as an immediate consequence of economic liberalisation (Kumar Das and Barua, 1996).

Second, the present system of fiscal federalism gives rise to major pressures for increased transfers from the central government to the slow growing and "poorest" states, which have difficulties in raising sufficient revenue. This puts considerable strain on the federal budget and makes it even more difficult to reduce the federal deficit. Achieving fiscal adjustment is currently of importance for reducing real interest rates and ensuring long-run sustainable growth.

Finally, in the context of fiscal adjustment, the constraints on capital and maintenance expenditure in less developed regions aggravate disparities in growth of social and economic infrastructure between regions. If reform is to continue successfully, it will be necessary to allocate the limited public resources towards growth-oriented activities at the regional level with more balanced growth among the States.

Convergence across states or regions has now been widely studied for developed economies, for example, in the case of the US States, Japanese prefectures, regions of the European Union (see Barro and Sala-I-Martin, 1995), and Spanish regions (De la Fuente, 1996). Absolute convergence is actually easier to observe at the regional level than at the international level, because of similarities in preferences and technology, as well of the basic political and institutional environment. On the other hand, there are relatively few empirical studies for developing countries where differences in economic and social characteristics across regions may be greater. Absolute convergence has been observed in Mexico (Juan-Ramon and Rivera-Batiz, 1996), but Jian, Sachs, and Warner (1996) could not find any tendency towards convergence in China before the implementation of market-oriented reforms.

Significant natural, social and historical differences among the Indian States makes absolute convergence questionable. Indian economists have often highlighted regional inequalities in education, health and economic infrastructures, as well as in the level and growth of per capita income and consumption (Das, Barua and Ghosh, 1993). Such disparities exist despite the Indian government's concern for this problem since independence. Furthermore, these disparities have been increasing over time. In this context, convergence of the Indian States is a question of particular interest. Recent empirical studies by Cashin and Sahay (1996) and by Akkina (1996) failed to find any significant tendency towards absolute convergence in the case of India. Bajpai and Sachs (1996) were able to find evidence of convergence only during the 1960s, which they suggest could be the result of the agricultural sector's growth during the "green revolution".

Our analysis in the rest of the paper is organised as follows. In the next section, we present an overview of inequalities in per capita income and growth performance of Indian States. The third section extends this analysis to the disparities in the availability of infrastructure across States and gives information on institutional arrangements for the provision of infrastructure at the State level. Then, using principal components analysis, the Indian States are grouped according to growth performance, production structure and availability of infrastructure. Finally we construct a composite infrastructure indicator and present an overview of changes in its trends over time.

In the fourth section, we provide an empirical analysis of conditional convergence among Indian States using panel data estimation techniques. We assess the extent to which differences in endowments of physical, economic and social infrastructure give rise to differences in the steady-state output and, therefore, to differences in long-run growth trends. The analysis tackles endogeneity issues in the provision of infrastructures by estimation of instrumental variables for many of our infrastructure indicators. Our analysis, based on high frequency (annual) data, provides strong evidence of conditional convergence, at a high speed, across Indian States. This finding, of course, does not rule out the possibility of persistent income inequalities among States, since it does not involve a decline in the cross-section dispersion of the steady-state income levels towards which each State's income tends to converge.

In the fifth section we present a growth accounting exercise, which views the growth potential of each State as stemming from the existing gap between its steady-state output and that of a benchmark State exhibiting strong growth. This exercise makes it possible to explain these steady-state output gaps in terms of the differences in production structures and infrastructure endowments among States. Finally, we outline the implications of the analysis for economic policy in the area of public investment in infrastructure.

SECTION II. INEQUALITIES ACROSS INDIAN STATES: RISING OR FALLING?[1]

The Extent of Inequalities across States

In spite of the Indian government's constant concern for reducing regional inequalities since independence, there have always been major natural, economic and social differences among the Indian States. Moreover, in spite of some progress in public administration and the provision of infrastructure, British colonialism did not lead to a significant reduction of disparities in the country. Thus one of the first objectives of the Indian government at independence was to strengthen national unity and promote economic growth with equity. This explains why the Indian Constitution gives considerable economic power to the central government for allocating financial resources through an income-equalising system of state grants, amounting to a particularly strong version of fiscal federalism. From the Indian government's viewpoint, the existence of large regional differences of economic development and the potential to raise tax revenues justified interstate transfers, as well as economic intervention and investment planning at the State level.

Indian economists have always called attention to inequalities in real per capita State domestic product (SDP). Nowadays, the real per capita State domestic product ranges from 672 to 2 100 1985 international dollars[2], with real per capita income in Punjab, the "richest" State, being four times greater than in Bihar, the "poorest" one (Figures 1 and 2). In addition to revealing the substantial disparities across States, this indicator highlights the very low level of development of Indian States. In fact, the per capita income in the "richest" one is the same as in Egypt or in Indonesia, while the "poorest" State's income does not exceed Mali's (the tenth "poorest" country in the world out of a total of 115; see Heston and Summers, 1991). India as a whole is the thirteenth "poorest" country, just below China (Figure 3)[3].

These regional inequalities accompany disparities in human development. A recent study by Shiva Kumar (1996), who evaluated the UNDP's gender-related development index for Indian States, indicates that India performs poorly in this field too. While the human development of Kerala (the most favoured State in this domain) is equivalent to the Syrian Arab

Republic's (the 72nd country on a scale of 130), Bihar and Uttar Pradesh (the two more backward States) do not exceed Yemen's rank (117), this indicator being almost twice as high in Kerala than in these two latter States. India as a whole is in the 100th place, just before Nigeria, again confirming the country's low level of development.

Figure 1. SDP per capita
(1985 international dollars)

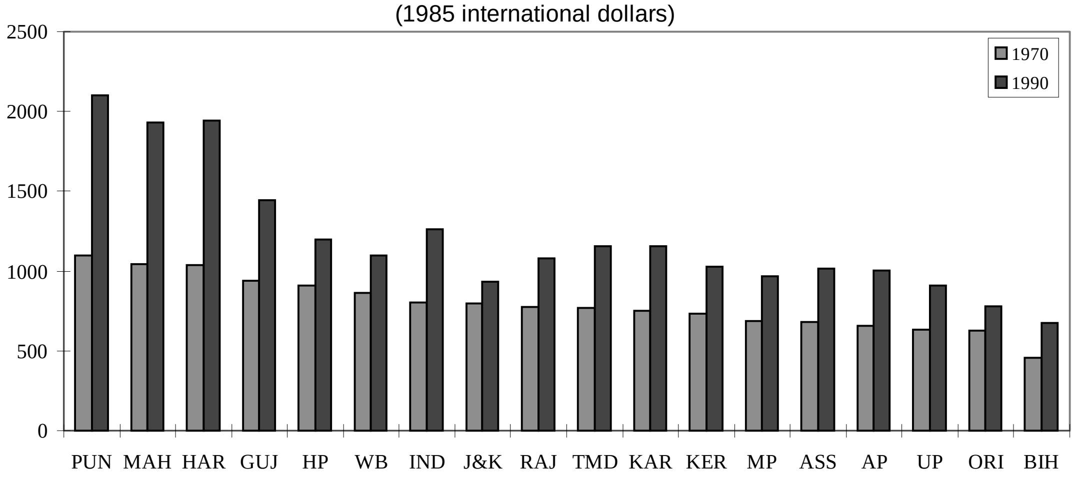


Figure 2. SDP per capita
(1985 international dollars)

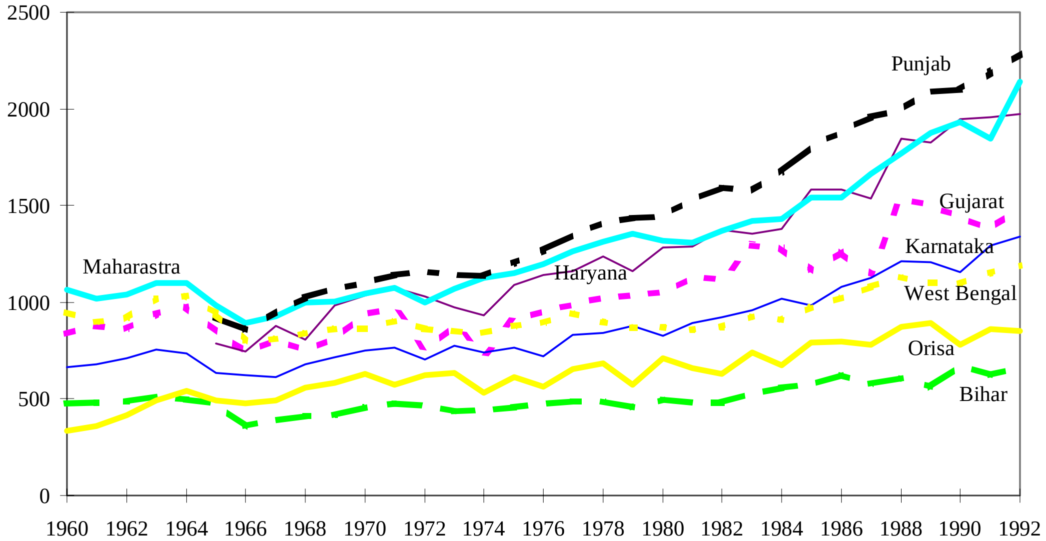
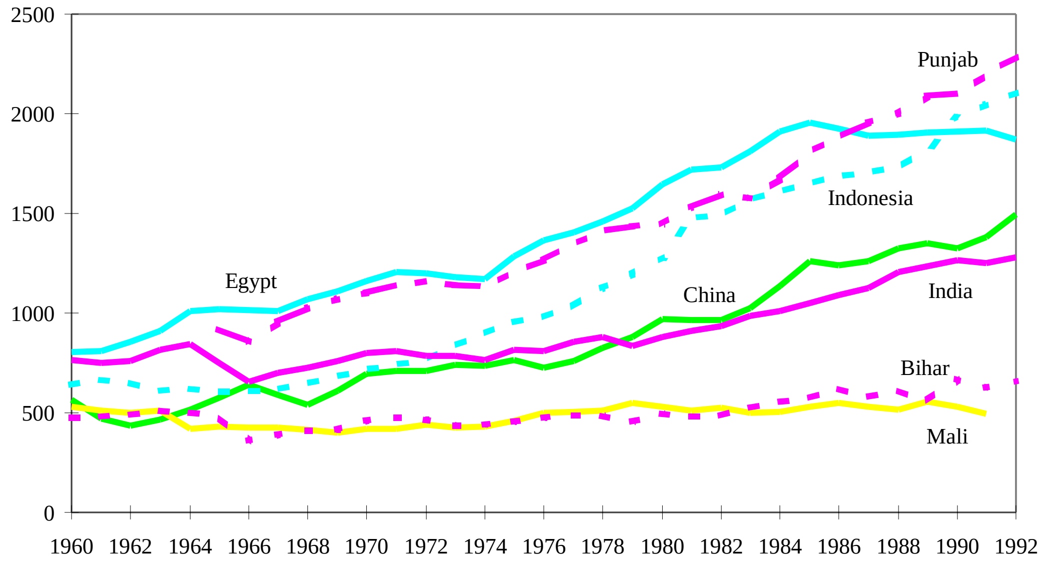


Figure 3. GDP per capita
(1985 international dollars)



Sources (Figures 1 to 3): Authors' calculation from CSO and Heston and Summers (1991).

Growth and Inequalities over Time

India's growth on a national level during the first 30 years after independence has been modest[4]. As shown in Table 1, per capita income increased by about 1 per cent per annum in the 1960s and the increase was even less in the 1970s. Growth improved markedly in the 1980s. This is widely believed to be due to attempts at partial deregulation of industry, to substantial real depreciation of the rupee and, most importantly, to expansionary fiscal policies (relying on a huge surge in public investment) that boosted aggregate demand. However, this demand-driven increased growth was unsustainable as it gave rise to double-digit inflation and to a large current account deficit, mainly financed by short-term capital inflows. The balance-of-payments crisis in 1991 led to the implementation of major steps towards market liberalisation which led to substantial growth after 1992 (Ahluwalia, Mohan and Goswami, 1996).

Table 1. **Average Annual Growth of SDP per capita (%)**

States*	1960-70	1970-80	1980-94	*1960-94*	Population (1994, in millions)	SDP (1993-94, % of India)
PUN	4.5 (1)	2.5	3.2	*3.2*	20.986	4.1
MAH	0.5	2.1	3.8	*2.3*	82.413	14.2
HAR	6.5 (1)	1.9	3.1	*3.3*	17.362	2.8
GUJ	1.9	0.9	3.6	*2.3*	43.155	5.1
HP	2.5 (2)	-0.1	2.4	*1.5*	5.409	0.6
WB	-0.2	0.8	2.3	*1.1*	71.515	6.8
J&K	1.2	1.6	0.2	*0.9*	8.187	0.5
RAJ	2.3	-1.9	3.6	*1.6*	47.446	3.8
TAM	0.4	0.3	4.1	*1.9*	58.013	6.6
KAR	2.0	0.6	3.6	*2.2*	47.277	5.1
KER	1.5	0.8	2.4	*1.7*	30.355	2.9
MP	-0.5	0.5	1.7	*0.7*	70.012	6.0
ASS	-0.4 (3)	0.0	2.1	*1.1*	23.967	2.2
AP	1.0	1.0	2.1	*1.5*	69.795	7.2
UP	0.7	0.7	1.9	*1.2*	147.907	10.8
ORI	7.1	1.0	1.3	*2.9*	33.261	2.4
BIH	0.3	0.6	1.1	*0.7*	92.097	5.2
IND	1.2	0.7	2.7	*1.7*	893.360	86.3

Notes: (1) = 1965-70, (2) = 1967-70 and (3) = 1968-70.
* States are sorted in decreasing order according to per capita SDP in 1970.

Source: Authors' calculation (see sources of variables in Appendix 1).

Moreover, an international comparison points to the poor growth performance of India as a whole, but also that the more dynamic Indian States lag behind other Asian countries. While Maharastra's per capita income in 1960 (in 1985 international dollars) was the same as in Thailand and Korea**,** it is now one-half and one-fourth theirs respectively. Similarly, Indonesia's real per capita income is now twice as high as India's, while China's real per capita income has been higher since the beginning of the 1980s (Figure 3).

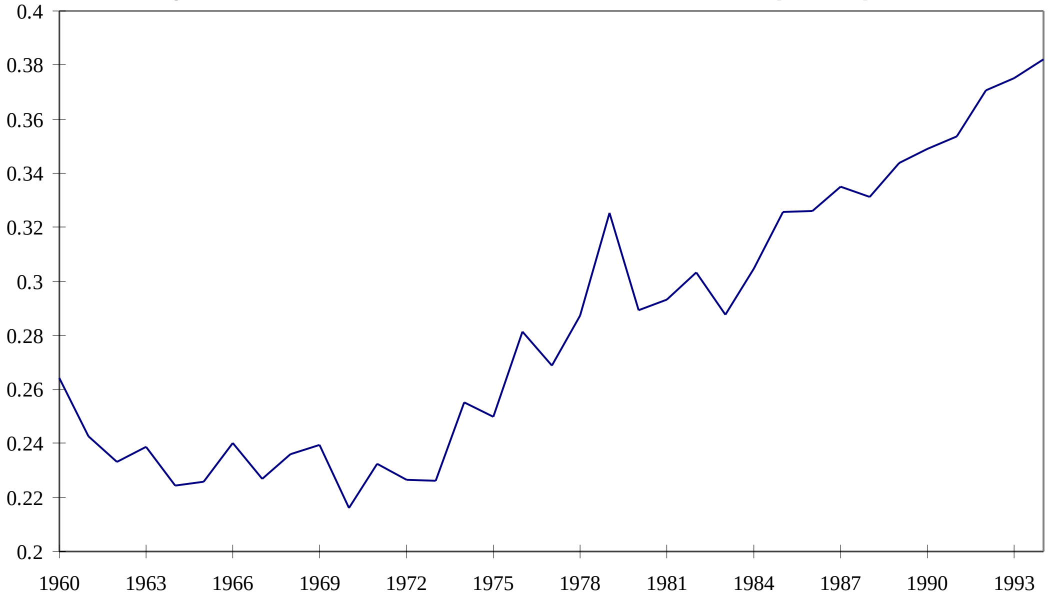
Furthermore, regional inequalities in India have being increasing over time. The 1960 per capita SDP was about three times greater in Maharastra, one of the "richest" States than in Orissa, one of the "poorest" (Figures 1 and 2)[5], compared to a fourfold difference now. As it can be seen in Table 1, which shows the average per capita SDP growth during three subperiods from 1960 to 1994, the "poorest" Indian States like Bihar, Uttar Pradesh, Assam, Madhya Pradesh, Andhra Pradesh, not only have been unable to catch up with the "richest" States, but on average had a growth rate less than the country as whole. On the other hand, the growth rate of Punjab, Maharastra, Haryana, Gujarat, the "richest" States, was significantly higher than the Indian average.

Moreover, the surge in growth in the 1980s mainly benefited these four States and Rajastan, Tamil Nadu, and Karnataka, whose growth was significantly greater than in the previous two decades. On the contrary, the growth of Madhya Pradesh, Assam, Andhra Pradesh, Uttar Pradesh, Orissa and Bihar, the six "poorest" States, as well as of Jammu and Kashmir was significantly below the national average.

As a result, four of the five initially "richest" States (Gujarat, Haryana, Maharastra, Punjab and West Bengal), remained at the top of the ranking at the beginning of the 1990s (Figures 1 and 2)[6]. Only West Bengal, which performed poorly, moved down from the second to the eighth place. Similarly, the "poorest" States in 1960 (Bihar, Orissa and Uttar Pradesh), remain the "poorest" today. Similar observations can be made for "intermediate income" States. It is worth noting that the population of the six low-growth States (Table 1) in 1994 was 437 million, which is about half the whole country's population, but they accounted for only 34 per cent of India's GDP.

The observed rise in inequalities over time, which has been stressed by several Indian economists (Das, Barua and Ghosh, 1993), is confirmed when computing the cross-sectional coefficient of variation of the real per capita SDP (known in the growth literature as *s* convergence, Figure 4). As can be observed, the dispersion decreased slightly at the beginning of the 1960s, probably because of the "Green Revolution" which introduced some technological progress in the "poorest" (generally rural) States. However, this indicator of inequalities increased sharply during the 1970s. This tendency persisted throughout the period under review, although somehow less markedly during the 1980s, thanks to the surge in aggregate growth. At the beginning of the 1990s, the dispersion was 1.6 times than in 1970.

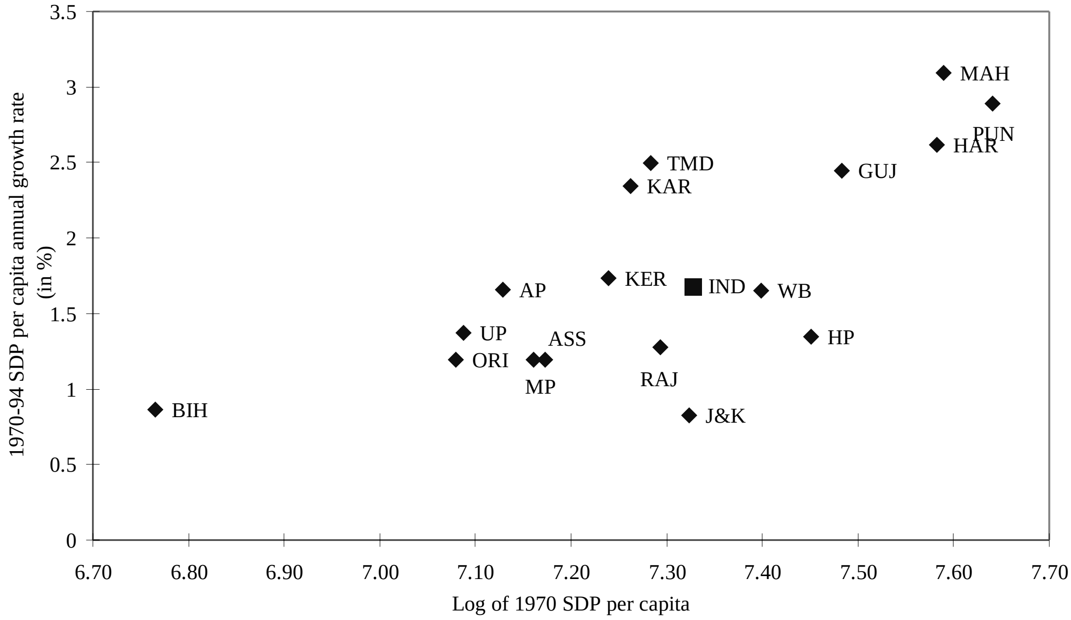
Figure 4. Coefficient of Variation of Real SDP per capita



Source: Authors' calculation.

Thus at first sight, these observations appear to contradict the neo-classical model which, in the present case, would predict that "poor" States should grow relatively faster and eventually catch up with "rich" ones. This is confirmed by comparing the initial real per capita SDP in 1970 with its annual growth rate during the 1970-93 period (Figure 5). The absence of any significant negative relationship between the initial per capita income and subsequent growth indicates that absolute convergence does not seem to have occurred in the case of Indian States.

Figure 5. Growth Performances of Indian States



Source: Authors' calculation.

SECTION III. ECONOMIC AND SOCIAL INFRASTRUCTURE OF INDIAN STATES

Trends in Infrastructure Investment

Most infrastructure in India is state-owned, and the responsibility of the public sector in that domain has been growing continuously and has not significantly decreased since the reforms began in 1991. 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 (Table 2.A). 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 the economic activity in transportation and telecommunications, as well as in other services, including health and education (Table 2.A).

Table 2.A. **Public Sector Share in Real GDP**
(totals and by sectors of activity in %)

	Agric.	Mining	Manufacturing (registered)	Electricity gas, and water	Construction	Transport, storage, communication	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.

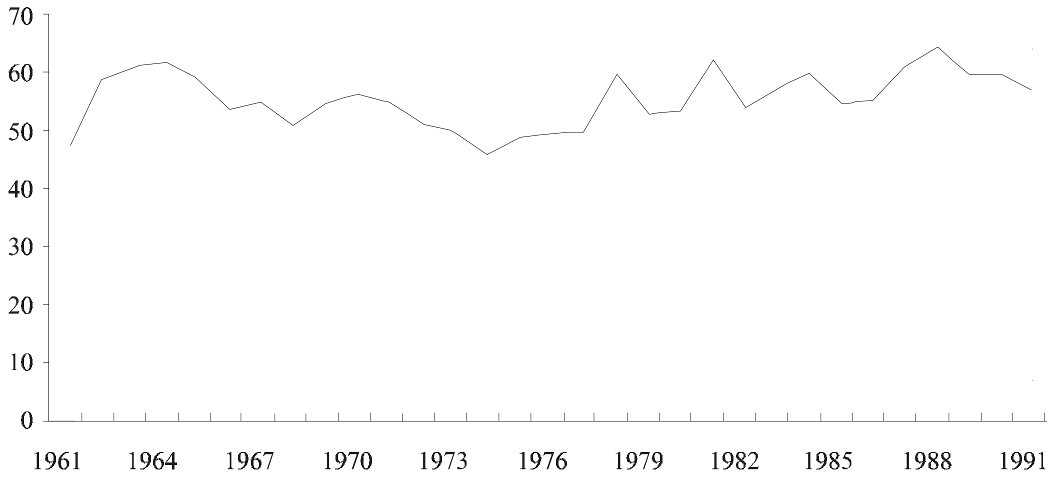
Table 2.B. **Shares of Infrastructure in Public Investment** (in %)

	Agriculture	Electricity and water	Construction	Transports	Communication	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).

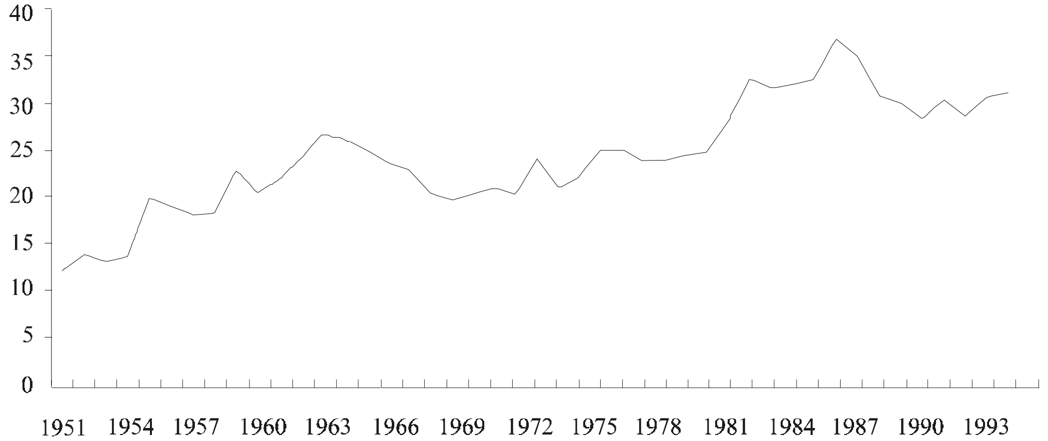
Actually investment in infrastructure forms the largest part of public investment, its share in total public investment having fluctuated between 50 and 70 per cent during the 1960-94 period (Figure 6). Moreover, a substantial part of the gross fixed capital formation in India consists of infrastructure (between 30 and 40 per cent in the 1980-94 period), showing in another way the effort made in this domain (Figure 7).

Figure 6. Share of Infrastructure in Total Public Investment (in %)



Source: National Account Statistics, various issues.

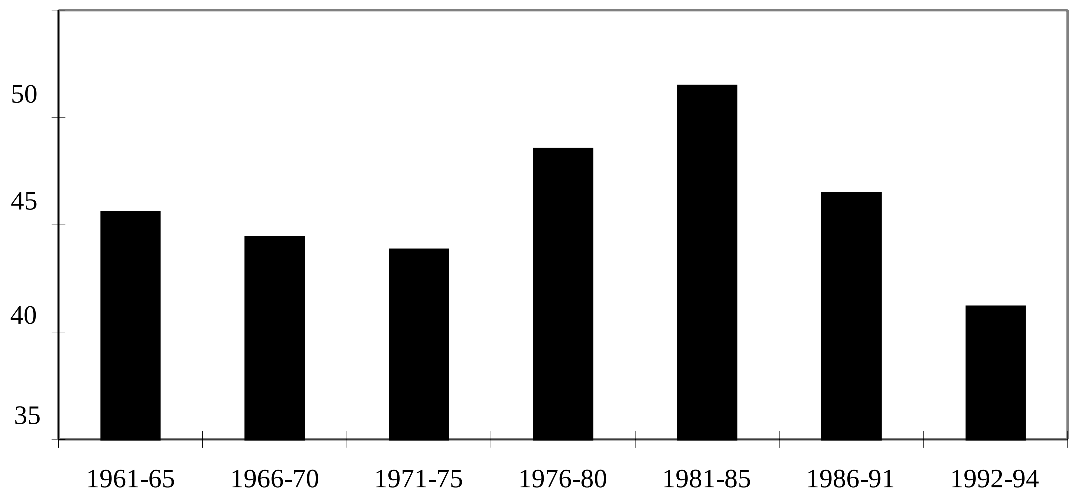
Figure 7. Share of Infrastructure in Total Investment (in %)



Source: National Account Statistics, various issues.

Public investment in infrastructure was high during the 1955-65 period, which roughly coincides with first three five-year plans, and again from 1975 to the late 1980s. This investment in the 1960s was mainly concentrated on agriculture (large irrigation works in particular), electricity and transportation (mainly railroads). In the 1970s and the 1980s, the shares of investment in electricity increased and the share in transportation declined in the total public investment in infrastructure (Table 2.B). The observed trends and composition of public investment are important in explaining India's macroeconomic performance in general and industrial growth in particular (Nayyar, 1994 and Nagaraj, 1990). In particular, higher growth in the 1980s can be partly explained by the acceleration of public investment in infrastructure. However, public investment has declined since 1991 (Figure 8), but infrastructure in different domains has not been affected uniformly. The public financial adjustment primarily affected transportation and telecommunications, and the banking and insurance system (Table 2.A). Despite encouragement of private investment in various fields, little has yet materialised.

Figure 8. Share of Public Sector in Gross Capital Formation (in %)



Source: National Account Statistics, various issues.

Legal and Institutional Arrangements for Providing Infrastructure

Taking into account that India is a large country with great regional disparities in economic development, as well as social and historical diversity, the Constitution provides for decentralised economic decision making, though perhaps it is not a strictly federal system. Actually Article 246 in the seventh schedule defines the authority of the Union and the State governments. In particular, the States have responsibility for the agricultural sector (including agricultural taxation and land reform), generation of electric power, education, health, sanitation, small industry and road transportation[7]. The Constitution also provides for a Finance Commission for determining how available financial resources will be divided between the central and State governments every five years. The Finance Commission's decisions are constitutionally binding on both levels of government.

In practice, however, there are many signs of the presence of a strong centralised state. The Constitution gives the centre considerable economic and political power to preserve national unity, since India was formed by merging of a large number of princely states, and because of the many separatist tendencies. The Union government not only holds a greater share of resources but determines the allocation between itself and the States. During the 1950-85 period, the central government on average accounted for more than 70 per cent of total public resources (Sarkaria Commission, 1988). In fact, most taxes are levied at the central level (primarily income, custom and excise taxes) while taxation by the States is low. Their revenue essentially consists of sales taxes. Resources at the central level are also constituted by domestic and international borrowing, not directly available at the State level.

The central government's redistribution system is explained by an imbalance between the power to raise resources and expenditure needs. The Finance Commission has the responsibility for tax sharing and "Grants-in-Aid", while the Planning Commission on the other hand determines Plan Grants. Finally, central ministries deal with "Discretionary Grants". Indirect financial channels include loans from the central government and public financial institutions (Table 3).

Table 3. **Structure of Transfers from Central to State Governments**

in %	Tax sharing	Grants	Loans
1961	24	30	46
1971	32	26	42
1981	39	29	32
1991	34	32	34

Sources: Reserve Bank of India (1993) and Government of India (1994).

Another significant reason for this centralising tendency is planned economic development. Centralised planning for capital for public overheads was considered a desirable objective because of externalities of large investment decisions, for co-ordination to minimise market failure and for balanced regional development.

Towards this end, the Industrial Development and Regulation Act was adopted in 1956, classifying all economic activities into three Schedules. In Schedule A are activities reserved exclusively for the public sector. In particular, they include generation and distribution of energy; air and railway transportation; and telecommunications. Schedule B activities are those in which entry of the public sector is encouraged. Road and sea transportation belong to this category. In Schedule C entry by private sector is unrestricted. The 1956 Act provided the basic legal framework for channeling public and private investment until the 1991 reforms. At first sight, this act appears to be very rigid, but its implementation has been largely pragmatic (Bhagwati and Desai, 1970).

Besides infrastructure investment via the planning process, the Union government initiated many centrally sponsored programmes to reduce regional imbalance and to induce the States to back national priorities. This development also contributed to reducing the States' initiative and increasing centralisation of financial power with the Union government.

India's planning process can be roughly summarised as follows: Usually about a year before a five year plan begins, the Planning Commission prepares an *Approach Paper* outlining the alternatives for economic growth, equity and self-reliance, and the requirements for the macroeconomic variables like the domestic saving rate, export growth, need for foreign saving during the period covered by the proposed plan. This document is discussed and approved by the National Development Council, the highest political decision-making body concerning economic development[8].

Based on this political consensus, the Planning Commission works out sectoral output and investment targets. While these targets for the private sector are largely indicative in nature, they have considerable operational significance for the public sector. Public investment and budgetary support, and decisions on location and technology are closely linked to the targets set by the planning process.

Having determined the basic magnitude and the financing pattern, infrastructure projects are classified into those executed by the central government and those by the States. Investments that for reasons of externalities are "supra-State", like railways and telecommunications, are mainly included in the central government Plan. The projects to be implemented by the States are included in "States' Plans", governed by the Dadgil (later, revised Gadgil) formula[9].

The planning process has sought to select public investment on the basis of national and strategic interests. In practice, however, political and economic interests contributed perhaps much to the allocation of the limited resources. For instance, economically powerful states like Maharastra may have secured disproportionate allocations as they had resources to “match” the centre’s resources. Moreover, a State like Uttar Pradesh secures substantial resources as it has been politically very important.

Concurrently with the central planning process, all State governments prepare “State Plans”, taking into account the national priorities, specific State requirements and the State’s financial position. In the formulation of the State Plan, a number of “working groups” are established for the development of specific sectors.

Similarly, all ministries (which have small planning cells) identify the projects that could be funded during the plan. In the final analysis, the decision on which projects get funded is determined by a complex bargaining process between ministries and the States, with the Planning Commission acting like a clearing house, even though its own technical advice is often ignored (Dandekar, 1994).

An Attempt at Grouping Indian States

The large regional disparities in the availability of infrastructure have been discussed by various Indian economists (Rao, 1992, on physical and economic infrastructure; Mundle and Rao, 1991, on health and educational expenditure). The availability of infrastructure could potentially play an important role in explaining long-run growth trends and differences in growth performance across States. Table 4 gives an outline of these disparities. It presents the average value during the 1970-94 period of some selected physical, social, and economic infrastructure indicators for Indian States, sorted according to their growth performance *(Gr)* for this same period.

As a first step towards achieving a deeper understanding of the differences or similarities among States with respect to the availability of infrastructure and economic performance, a more systematic treatment of their characteristics was attempted by using principal components analysis. Focusing on the 1970-94 period, the set of indicators shown in Table 4 was first enlarged by including the number of bank offices per 1 000 people *(Bk)*, and the primary school enrolment rate in the population aged 6-11 *(Pri).* To this enlarged set of physical, social and economic infrastructure indicators, we also added the average growth rate *(Gr)* and the average real per capita SDP as measures of the long-run economic performance, as well as the share of agriculture in the SDP *(Agri)*, roughly reflecting the production structure of each State.

Table 4. **Physical, Economic, and Social Infrastructure across States: 1970-94**

STATE	Gr	Agri	El	Ir	Rte	Rail	Lit	Mort	Bdep
MAH	3.1	25.6	236.6	9.7	506.3	17.2	52.7	80.1	46.1
PUN	2.9	52.1	303.9	80.4	809.3	42.5	46	87.8	39.6
HAR	2.6	54.2	197	57.5	499.5	33.4	39.2	93.9	20.7
TMD	2.5	29.5	177.8	43.5	1 068.8	29.5	50	93.7	29.1
GUJ	2.5	36.1	231.5	19	293.3	28.7	46.8	121.4	37.2
KAR	2.3	44.3	152.8	14.1	599	15.3	43.9	78.5	29.8
KER	1.7	37.4	103.9	13.7	2 786.3	23.3	76.9	41.8	36.7
AP	1.7	47.4	111.3	31.6	373.8	17.5	32.2	98.3	23.7
WB	1.7	32	122.8	29.4	930.2	42	45.8	73.1	42.1
UP	1.4	51.1	88.8	50.3	526.5	30	31.5	154.7	24
HP	1.4	48.3	78.2	16.5	303.9	4.7	45.6	96.4	29
RAJ	1.3	52.4	98.2	18.7	207.3	16.3	28.5	83.3	18.6
ASS	1.2	51	37.5	22.2	555.3	28.4	33	115.2	15.6
MP	1.2	47.2	116.7	12.9	239.3	13	34	131.8	17.4
ORI	1.2	53	120	20.6	721	12.6	38.2	129.9	11.6
BIH	0.9	53.2	82.5	33.3	460.5	30.7	28.3	61.1	24.4
J&K	0.8	50.2	82.9	42.2	55.1	0.2	30.9	54.1	33.2
India	1.9	45	162.2	28.1	466.6	18.6	41.9	106.6	27

Note: *Gr* is the average annual growth rate in real per capita SDP. See Appendix 1 for definitions and sources of the others variables.

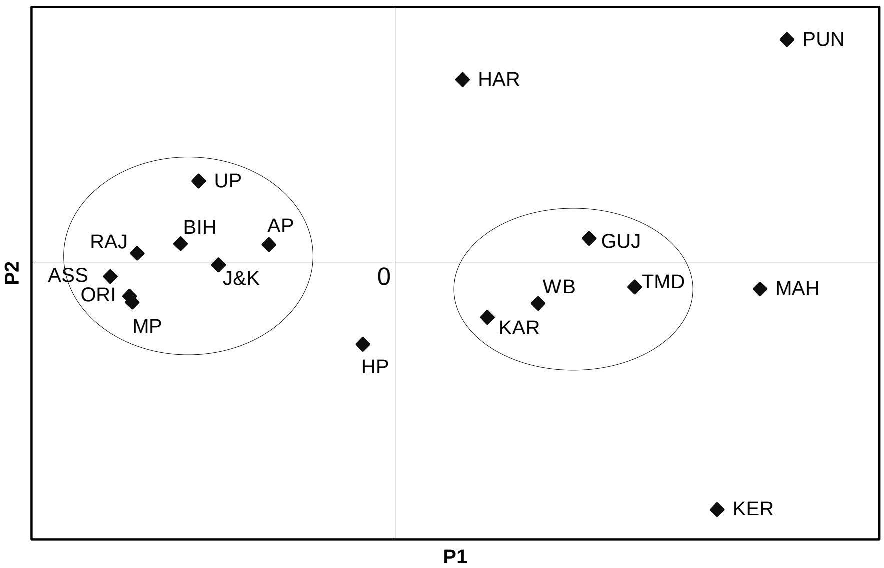
Source: Authors' calculation.

Next, we extracted principal components from this set of economic and infrastructure indicators for the 1970-94 period. The first two principal components account for 63 per cent of the total variation in this set of twelve variables (see Appendix 2.A). The analysis of the loadings of the individual variables reveals that the first principal component (*P1*) opposes States with a comparatively low share of agriculture in the SDP, which also had a relatively adequate level of physical, economic and social infrastructure (positive values on *P1* axes), to States with a predominant agricultural sector, characterised by poor infrastructure and, especially, poor health conditions, as measured by the infant mortality rate (negative values on *P1* axes)[10]. The former were also generally characterised by comparatively faster growth as well as by a relatively higher level of per capita SDP, while the later experienced slow growth and also had a lower level of per capita SDP.

The second principal component (*P2*) distinguishes between two groups of States: on the one hand, primarily agricultural-oriented, fast growing and "rich" States, which had an adequate level of physical infrastructure in power, railroad and, especially, irrigation (positive values on *P2* axes), and on the other hand, primarily industrial-oriented, slow growing States, with a relatively high educational level (negative values on *P2* axes)[11].

Plotting *P2* against *P1* (see Figure 9) can help to identify States which share common characteristics with respect to infrastructure and economic performance, as well as possible “outliers”. States which lie to the right of the horizontal axis can be thought off as fulfilling some necessary conditions for faster economic growth, insofar as they are primarily industrial-oriented and well endowed with economic and social infrastructure in relation to the national average. On the contrary, States located to the left of it have a poor infrastructure endowment and, also being predominantly agriculture-oriented, lack the conditions necessary for rapid economic growth.

Figure 9. Principal Components Analysis: Growth, Production Structure and Infrastructure



Source: Authors' calculation.

As can be observed, two groups of States, sharing common characteristics, can be singled out. One group includes four States of the former type (Gujarat, Tamil Nadu, West Bengal, Karnataka) which have experienced higher long-run growth and had a satisfactory infrastructure endowment in comparison with the national average. In the other group are eight predominantly agricultural States (Andhra Pradesh, Uttar Pradesh, Bihar, Rajastan, Jammu and Kashmir, Orissa, Madhya Pradesh, Assam) which had a low per capita SDP, poor economic and social infrastructure, and a weak growth that was considerably less in the States lying in the SW part of the diagram.

Moreover, the diagram reveals four obvious "outliers" with respect to the above patterns: Haryana, Punjab, Maharastra, and Kerala. The first three of them had the highest long-run growth rates of all Indian States (see Table 4). This is more surprising in the case of Haryana and Punjab, which are mainly agricultural-oriented. Their exceptional growth performance in comparison to the States belonging to the group on the left side of the diagram seems to be related to their satisfactory endowments in physical infrastructure. It is worth noting that per capita power consumption, the length of the railway network and the extent of irrigation in Haryana are clearly above the Indian average. Punjab has a similar advantage in this type of infrastructure and, in addition, has an educational level and health conditions that are above average, as well as a developed financial sector, as measured by the number of bank branches and ratio of the money supply to the SDP. In particular, the development of irrigation seems to have played an important role in promoting long-run growth in Haryana and Punjab. It should be recalled that these States experienced a "Green Revolution" and have benefited most from new technologies.

On the other hand, Maharastra is an industrial State that has achieved a far better growth performance than those belonging to the four-State group on the right side of the diagram. This seems also to be related to its above-average endowment in physical infrastructure, as well as to the high level of development of its financial sector and to its satisfactory educational level. The case of Kerala deserves special mention because of its exceptional level of social infrastructure. However, this high level is related to the particularly strong support for health. Comparatively, education seems to have been less favoured, although literacy rates have been the highest in India (Anant, Krishna and Roy Chaudhry, 1994; also see Table 4). Nonetheless, despite these favourable initial conditions, the State's growth was disappointing. This fact and its high educational level largely account for its position in the extreme SE of the diagram. Nevertheless, it should be noted that, because of the high educational level, Kerala is a State with very large rates of out migration (to other parts of India and abroad, especially to the Persian Gulf region) and a corresponding inflows of transfer incomes, which are not covered in the SDP.

Formulating an Indicator of Total Infrastructure

Thus far our analysis suggests a positive association between the existence of infrastructure and the growth performance of Indian States. Evidence for this was shown in the groupings of States in the diagram of the principal components (Figure 9). A better understanding of this relationship will require an empirical assessment of the contribution of each type of infrastructure to long-run growth which, in turn, can be helpful for making meaningful recommendations for public policy. This analysis is undertaken in Section 4. It should be noted from the outset that this task presents several difficulties stemming from the high multicolinearity that usually exists between the variables for the different types of infrastructure. This might be a source of considerable bias in the empirical estimation of the coefficients of individual variables in a growth regression.

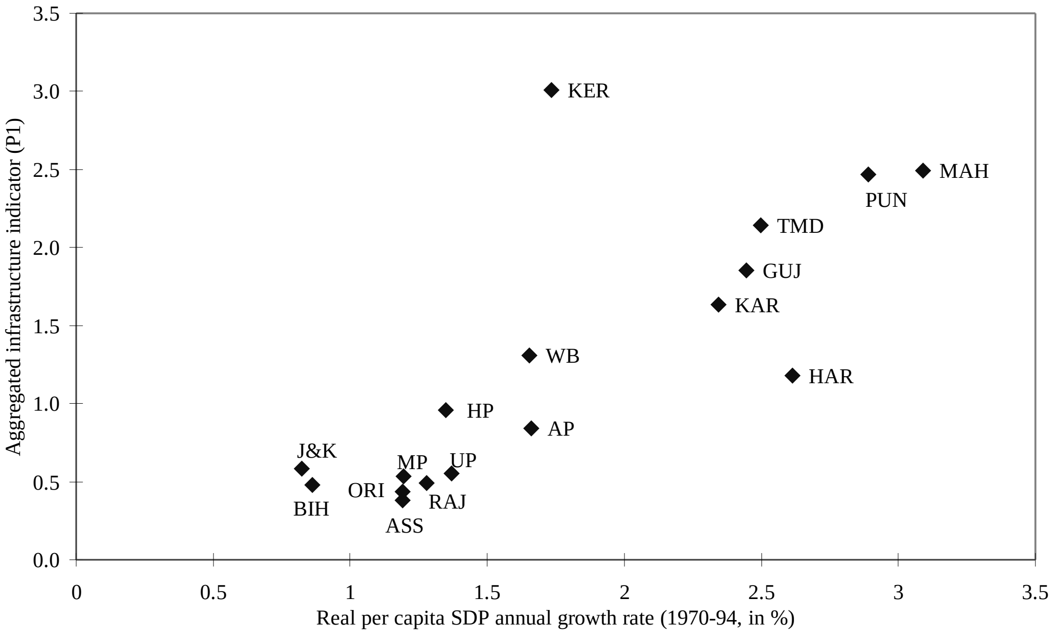
To overcome these problems, we used a research strategy based on the extraction of principal components from a broad set of infrastructure variables which are available for each State on an annual basis for the 1970-94 period. This data set comprises 14 indicators of physical, social, and economic infrastructure (see Appendix 1):

- *El* : per capita power consumption.
- *Eli* : per capita industrial power consumption.
- *Elv* : percentage of villages electrified.
- *Ir* : net irrigated area as a percentage of net cultivated area.
- *Rte* : road length per 1 000 square kms.
- *Veh* : number of motor vehicles per 1 000 population.
- *Rail* : length of railroad network per 1 000 square kms.
- *Lit* : literacy rate of adult population.
- *Pri* : primary school (6-11 years) enrolment rate.
- *Sec* : secondary school (12-17 years) enrolment rate.
- *Mort* : infant mortality rate.
- *Bk* : bank offices per 1 000 people.
- *Bdep* : bank deposits as a percentage of the SDP.
- *Bcre* : bank credit as a percentage of the SDP.

The principal components analysis has been performed after transforming the data into logarithms, on a panel data set comprising 408 annual observations for the 17 States during the 1970-94 period. As can be seen from the results reported in Appendix 2.B, the first four principal components (with Eigenvalues greater than or equal to one) can be retained for our subsequent econometric analysis. Together they account for 84 per cent of the total variation in the set of infrastructure variables. For illustrative purposes, the first of these principal components (*P1*) can be used as a rough measure of the availability of physical, social, and economic infrastructure ("total infrastructure indicator"). It represents a linear combination of the infrastructure variables listed above which, in our panel data set, accounts for 55 per cent of the total variation in these variables (the loadings are reported in Appendix 2.B).

An idea of the links between this infrastructure variable and growth performance is provided by Figure 10, which plots the average value of this indicator over the 1970-94 period for each State against the corresponding average annual growth rate. As can be observed, there is a significant positive correlation between total infrastructure endowment as measured by *P1* and long-run growth performance[12]. It is worth noting that all eight states identified in Figure 9 as belonging to the "group on the left side" of States that are poor, have low growth, are agriculture-oriented and are poorly endowed with infrastructure (MP, J&K, AP, UP, BIH, RAJ, ASS, ORI) are located in the bottom and to the left in Figure 10, confirming our initial conjectures. On the contrary, the four States belonging to the group on the right side of Figure 9 are found in the top part of Figure 10, exhibiting a significantly stronger growth performance, linked to their better infrastructure endowment (TMD, GUJ, KAR, WB).

Figure 10. Infrastructure and Growth



Source: Authors' calculation.

Given the close association between our total infrastructure indicator and average growth performance, it is instructive to examine changes in total infrastructure over time. Table 5 shows trends over two subperiods (determined on the basis of a break in the trend) in the total infrastructure indicator as measured by *P1* for the 17 States, which are listed in decreasing order of the initial value of the aggregate infrastructure indicator (*P1*) in 1970.

As can be observed, there is some evidence of convergence in infrastructure endowments across States, insofar as the growth rate of *P1* during 1970-86 tends to be inversely correlated with its initial level in 1970. Among the richest States, Punjab, Gujarat, and Haryana enjoyed comparatively high rates of growth in *P1*, which led to further improvement in their already good infrastructure endowment (by Indian standards).

Table 5. **Average Annual Growth Rate of the Aggregate Indicator of Infrastructure *(P1)***

States*	1970-86	1987-94
KER	8.4	5.4
MAH	9.0	5.3
TMD	8.7	6.6
PUN	11.0	3.7
GUJ	10.4	5.7
WB	7.7	6.0
KAR	9.9	3.0
HAR	12.0	5.1
AP	13.3	5.2
UP	9.4	6.9
HP	16.7	6.5
BIH	11.1	6.7
RJ	13.0	7.1
MP	13.8	10.8
J&K	13.9	11.2
ASS	13.0	10.7
ORI	14.6	7.1

* Sorted in decreasing order according to the initial value of *P1*.

Source: Authors' calculation.

On the contrary, the more recent period from 1987 indicates there has been a reduction in investment in infrastructure. This is mirrored by the fall in the share of infrastructure in total investment from 1987 that was previously observed in Figure 7. The rate of growth of *P1* clearly falls below its level in the previous 15 years, being reduced by more than half in Punjab, Karnataka, Haryana, Andhra Pradesh, Himachal Pradesh, and Orissa. However, quite surprisingly, there was less reduction of investment in infrastructure in Madhya Pradesh, Jammu and Kashmir, and Assam, which are among the States with the poorest infrastructure endowment. The observed slowdown illustrates the concerns recently expressed by various observers of the Indian economy about the impediments that poor infrastructure might impose on private sector productivity and efficiency. This situation is all the more alarming in the current period of relatively fast economic growth that followed economic reforms.

Hence, this initial analysis of growth performance in Indian States clearly shows that not only has India been characterised by significant economic and human disparities, but that these differences have been increasing over time. Another striking problem has been stressed by some Indian economists (Gulati and George, 1978; George, 1988; Cashin and Sahay, 1996). These authors discuss the inequalities in the inter-governmental and institutional financing transfers. Insofar as the largest transfers were received by middle income and not by low income states, central government intervention could have led to an aggravation of regional disparities.

SECTION IV. FACTORS IN THE LONG-RUN GROWTH OF INDIAN STATES

Our analysis has suggested some growth mechanisms that could have been at work in the case of Indian States. In this section we identify more precisely the contribution of various explanatory factors for the growth performances of Indian States. We have estimated a growth equation similar to one suggested by Barro and Sala-I-Martin (1992 and 1995), based on a log-linear approximation around the steady state of the Solow growth model. According to this model, the average growth rate of per capita GDP over a T-year time period depends inversely on its level at the beginning of the period:

$$\frac{1}{T}\, ln\left(\frac{y_{i,t_0+T}}{y_{i,t_0}}\right) = \alpha_i - \left(\frac{1-e^{-\beta T}}{T}\right) ln(y_{i,t_0}) + u_{i,t} \qquad (1)$$

where y stands for real per capita SDP, β is the convergence coefficient, α a constant term, i an economy index, T the length of the time period, t a time index, and u an independently distributed error term.

Due to the failure of empirical tests of this model, in particular with cross-country data, most of the existing empirical studies estimate an equation of conditional convergence which is obtained by adding to (1) various control variables that account for differences in steady-state income levels across regions or countries. Mankiw, Romer and Weil (1992) have introduced human capital into the Solow model. Differences in educational level can then account for differences in steady states and, therefore, for differences in rates of convergence. Other authors, among them Barro (1991), include other variables such as public expenditure, trade openness or economic and political instability. Moreover, Barro and Sala-I-Martin (1992) suggest that economies (and regions of a given economy) are subject to different external price or productivity shocks which have to be taken into account when examining convergence dynamics.

Conditional Convergence of Indian States

As a first step towards ascertaining potential differences in Indian States' steady-state per capita income, we accounted for differences in their production structure (see preceding section). As a proxy for such differences, we introduced the share of the agricultural sector in total SDP as a control variable in the standard equation of unconditional convergence. Presumably, the agricultural sector is characterised by a comparatively lower level of productivity growth. Contrary to the industrial sector, the agricultural sector benefits relatively little from technical progress related to product standardisation, from economies to scale, or from mechanisms of learning by doing. Consequently, the higher the share of agriculture in SDP, the lower the steady-state level of per capita income and the lower the expected growth rate, given the initial level of income[13].

In addition, we controlled for aggregate price shocks that might have affected Indian States differently because of differences in their production structure. Controlling for such shocks is important in growth regressions estimated on high frequency data. A large fall in the relative price of industrial commodities can be expected to have an adverse effect on growth, insofar as it leads to a shrinking industrial sector which could be considered the main engine of increasing productivity[14]. The negative impact on output could be amplified through multiplier effects spread to other economic sectors. Moreover, the impact of these relative price changes on growth presumably depends on the economy's production structure, being greater in the more industrialised States. We therefore introduced an additional explanatory variable in the regression, the nation-wide rate of change of the relative price of manufactured to agriculture goods, weighted by the percentage of the manufacturing sector in the total SDP of each State. The expected sign of the coefficient of this relative price shock variable in the growth regression is positive.

Thus the conditional convergence equation we estimated on panel data is as follows:

$$ln(y_{i,t}) - ln(y_{i,t-1}) = \alpha_i + \beta \, ln(y_{i,t-1}) + \gamma \, Agri_{i,t-1} + \varphi \, Dpma_{i,t} + \eta_t + u_{i,t} \qquad (2)$$

where y is the real per capita SDP and y_{t-1} its initial level (i.e. measured at the beginning of each time period), *Agri* the percentage of the agricultural sector in the SDP, *Dpma* the relative price shock. β, γ and φ are parameters common to all States.

The η_t terms denote time-specific effects which might be represented by a dummy variable for some time periods. They are intended to represent the effects of temporary shocks (oil shocks, droughts, etc.) which are supposed to affect the growth rate of all States at the same time and are not taken into account by the other explanatory variables in the regression. The α_i terms represent time-invariant State-specific effects. In theory, this constant term depends on the initial level of labour productivity (see Islam, 1995). However, differences in productivity may arise from various differing factors, including the characteristics of the production function, natural resource endowments, or the quality of institutions.

Equation (2) was estimated using panel data estimation techniques on an annual basis. The sample consists of 17 Indian States. The estimation period is 1970-94. The number of observations is 407, with one end-period observation missing for one State. The results of the estimated regressions are shown in Table 6. In all of our regressions the hypothesis of a common intercept across States has been rejected by Fisher tests. Therefore, differences across States were introduced through the estimation of a constant term for each State. As shown by Nickell (1981), the estimation of a dynamic model like the one represented by equation 2, using panel data with the fixed-effects method, yields asymptotically consistent coefficient estimates, provided the number of time observations tends to infinity. This justifies the use of a LSDV estimator here, given the large number of time observations (24) for each State[15]. Moreover, the heteroscedasticity bias of standard errors was corrected in all regressions by using White's estimator.

As can be seen from the negative coefficient of the lagged value of per capita SDP in equation 1, conditional convergence is validated in our data. It should be noted that a similar result has been already obtained by Cashin and Sahay (1996) as well as by Akkina (1996), using *cross-section* data for 25 Indian States during the 1960-92 and 1970-90 periods respectively. To represent differences in steady states, Cashin and Sahay used the agricultural sector's share of the total SDP while Akkina introduced a wider range of variables, such as per capita power consumption, power shortages, literacy rate, per cent of income arising from industry and services, and railroads per thousand of square kilometres. The effect of these variables will be considered in the next section.

Moreover, the coefficient of the agricultural sector's share of the SDP is significant and has the expected sign, showing that predominantly agricultural-oriented States had a lower level of steady-state per capita income. At the same time, nation-wide relative price shocks seem to have influenced growth of the States in the expected way. In addition, time-specific effects with negative signs (not shown in the table) are highly significant for 1974, 1979 and 1987, the two first dates obviously corresponding to the negative impact of oil shocks.

Infrastructure's Contribution to the Growth of Indian States

As noted in Section 3, physical, social and economic infrastructure seem to be closely related to differences in the growth performances of Indian States. Moreover, these phenomena have been emphasised in recent growth literature. Barro (1990) suggests that public investment could contribute to improved private sector productivity. By reducing production costs and by improving linkages between firms and economic activities, efficient infrastructure encourages investment and gives rise to economies of scale. On the other hand, poor infrastructure may inhibit the growth of the private sector.

Table 6. **Estimates of Growth Equations**

Dependent variable $ln(y_t)-ln(y_{t-1})$

Independent variables	Eq 1	Eq 2	Eq 3 (1)	Eq 4	Eq 5 (2)	Eq 6 (2)
ln (y_{-1})	-0.18	-0.45	-0.48	-0.30	-0.29	-0.29
	(6.8)	(10.2)	(9.8)	(8.1)	(7.8)	(7.9)
ln (Agri)	-0.25	-0.12	-0.12	-0.18	-0.18	-0.18
	(8.7)	(3.9)	(3.7)	(5.4)	(5.4)	(5.5)
Dpma	0.012	0.01	0.009	0.011	0.01	0.011
	(4.7)	(4.9)	(4.3)	(4.4)	(4.3)	(4.3)
El		0.25×10^{-3}	0.49×10^{-3}			
		(3.7)	(4.4)			
Ir		0.32	0.25			
		(4.8)	(3.7)			
Rte		0.26×10^{-4}	0.25×10^{-4}			
		(4.5)	(4.6)			
Prim		0.07	0.07			
		(2.4)	(1.0)			
Bdep		0.18	0.10			
		(5.2)	(1.5)			
P1				0.043	0.049	0.045
				(3.9)	(3.3)	(4.0)
P2				0.038	0.043)	0.045
				(2.0)	(1.9)	(2.0)
P3				0.005	0.014	
				(0.4)	(0.4)	
P4				-0.041	-0.063	-0.056
				(3.6)	(2.6)	(3.1)
Speed of convergence	0.20	0.60	0.65	0.36	0.34	0.34
Fisher specification test	5.4 (**)	9.5 (**)	9.1 (**)	6.3 (**)	6.3 (**)	6.8 (**)
Hausman specification test	33.1 (**)	37 (**)	69.2 (**)	47.5 (**)	34.1 (**)	34.1 (**)
Number of observations	407	407	407	407	407	407
R^2 adjusted	0.31	0.42	0.41	0.36	0.35	0.35

Notes:

Equations have been estimated using the fixed effects method. * (**) indicate that the specification tests were significant at 5 per cent (1 per cent) level. All regressions have been estimated with dummy variables for 1974, 1979 and 1987. Constant terms are not reported here for convenience. The heteroscedasticity bias of standard errors has been corrected by using the White's estimator. Student's tests are in parentheses. The estimation period is 1970-94.

(1) Eq 3 is estimated by the Two-Stage Least-Squares method with fixed effects (2S-LSDV), using the predicted values from equations in Table 7 for *El*, *Prim*, and *Bdep*

(2) Eq 5 and 6 are estimated by the Two-Stage Least-Squares method with fixed effects (2S-LSDV), using the predicted values from equations in Table 7 for *El*, *Eli*, *Prim*, *Sec*, *Mort*, *Bcred* and *Bdep*.

y = per capita State Domestic Product (SDP), *Agri* = agricultural sector as a share of SDP, *Dpma* = growth rate of manufacture to agriculture goods relative price, weighted by the percentage of manufacture sector in SDP, *El* = per capita electrical consumption, *Ir* = net irrigated area as a share of net cultivated area, *Rte* = kms of roads per square kms, *Prim* = primary school enrolment, *Bdep* = bank deposits as a share of SDP, *P1, 2* and *3* = infrastructure indicators calculated respectively from the first, second and third principal component of the logarithms of the infrastructure variables (see definition and sources of infrastructure variables in Appendix 1 and weights for the calculation of the aggregate indexes in Appendix 2.B and 2.C).

In a cross-country setting, physical infrastructure in particular such as transport and telecommunications or energy have been shown to affect growth (World Bank, 1994). Social infrastructure appears to play an important role as well. The significant impact of education on growth has been widely studied (Barro and Lee, 1994). Various studies also consider health as a major factor to be taken into consideration by developing economies (World Bank, 1993)[16]. Finally, the positive role of financial infrastructure in promoting growth is now well established in the empirical growth literature (see Berthélemy and Varoudakis, 1996).

We attempted to control for the impact of infrastructure on growth by introducing in our equation of conditional convergence infrastructure indicators to explain the differences in steady-state per capita income better. Three sets of regressions have been estimated.

— First, in addition to structural and price shock variables, we included in the regressions some basic indicators of infrastructure among those presented in the previous section.

— Second, to overcome the multicolinearity problems discussed earlier, we replaced the original infrastructure variables in the growth regression by the most significant principal components extracted from the annual panel data set of the infrastructure variables.

— Third, to overcome the two-way causality problems which may arise from the potential endogeneity of infrastructure, we used an instrumental variables estimation technique both for regressions with separate infrastructure variables and for regressions with principal components.

These approaches are in fact quite novel. Empirical estimates of the impact of infrastructure on private productivity or on growth generally use highly aggregated indicators. The indicator usually chosen is the ratio of public investment to GDP which excludes private investment in infrastructure but includes public investment in infrastructure as well as other domains, mainly in state-owned enterprises. Similarly, use of principal components analysis in growth empirics and systematic treatment of infrastructure endogeneity problems do not seem to have been extensively studied until now. As previously, these regressions have been estimated using panel data estimation techniques on the same annual data set.

Equation 2 (Table 6) has been estimated by separately introducing five infrastructure indicators which have a significant influence, according to successive tests of the significance of the various indicators included in our data set. The main types of infrastructure that seem to have been of importance are power consumption, irrigation, the density of the road network, the primary school enrolment rate and the ratio of bank deposits to the SDP. These last two indicators can be viewed as proxies for the educational level and depth of the financial sector respectively of each State. Conditional convergence is still validated by the results, although the estimated speed of convergence is now considerably higher. Moreover, the production structure and relative price shocks still have the expected influence on growth. The significant coefficients associated with these variables clearly show the positive role of infrastructure in promoting long-run growth of Indian States.

The role of irrigation in explaining differences in growth performances depends on the importance of the agricultural sector in the State's economy and on the "Green Revolution" initiated in the mid-1960s. The particularly strong growth performance of Punjab and Haryana that has been noted in previous sections is a good example of the importance of irrigation in promoting growth of regions that have a comparative advantage in agriculture. As far as electricity is concerned, per capita total consumption and per capita industrial consumption have been tested separately with success (only the results obtained with the first indicator are reported in Table 6). However, we were unable to show that the percentage of villages electrified or other physical infrastructure variables such as the length of the railway network and the number of vehicles *per* inhabitant were factors in growth. Only the density of the road network shows a substantial impact.

In the case of education, only primary school enrolment seems to have played a significant role in the growth performance of the Indian States. Our regressions failed to validate the impact of literacy rates, secondary schooling or health conditions, approximated by the infant mortality rate, despite large differences across States (Table 4).

Finally, bank offices per thousand people, bank deposits and bank credit as a share of SDP were tested as a proxies for financial development, but only bank deposits showed a significant impact on the States' growth performances. The positive influence of the development of the financial sector is an interesting finding in the case of India where the financial system has been repressed (see Demetriades and Luintel, 1996). These results suggest that financial development could become an important factor of growth in the future.

The difficulty in estimating separately the impact of each one of these indicators can be partly attributed to the multicolinearity problem. This difficulty can be overcome by introducing the aggregate infrastructure indicators computed as linear combinations of the original infrastructure indicators through principal components analysis. As explained earlier, the principal components have been extracted after transforming the initial indicators into logarithms, to be able to compute directly at a later stage the growth elasticity associated with each type of infrastructure. We included in the regression the first four most significant principal components (with Eigenvalues higher than one: see Appendix 2.B) which account for 84 per cent of the variance in our indicators.

The results of this estimation are shown in equation 4 (Table 6). They confirm that the whole set of infrastructure indicators have a strong influence on growth, since the estimated coefficients of the first two principal components are positive and highly significant. The fourth principal component is significant but has a negative coefficient. However, this does not mean that the infrastructure it represents has a negative impact on growth since some of the original infrastructure variables enter this principal component with negative loadings (see Appendix 2.B).

It should be also observed that our estimated speed of convergence is far higher than that found by Cashin and Sahay (1996) or by Barro and Sala-I-Martin, who, using various empirical tests at the cross-country as well as at the regional level, derived an estimated speed of 0.02-0.03[17]. Nevertheless, more recent studies on convergence with panel data, cast doubt on the robustness of these estimates and suggest a higher speed of convergence. Knight, Loayza and Villanueva (1993), by addressing the problem of correlated individual effects, obtain a speed of about 0.06. Caselli, Esquivel and Lefort (1996), by correcting in addition for the endogeneity bias, find a value of approximately 0.1. Moreover, by allowing heterogeneity among countries in the slopes of the growth regression, Andrés, Bosca and Doménech (1996) find a convergence rate as high as 0.3, which is quite close to our own estimates for the speed of convergence of Indian States, as will be shown in the fifth section.

Accounting for Infrastructure's Endogeneity

Before examining the contribution of various types of infrastructure to growth in greater depth, it is necessary to deal more directly with the issue of infrastructure's endogeneity, which could be the cause of bias in the results presented so far. Reverse causality between infrastructure investment and economic performance may arise in various ways.

— First, most infrastructure projects involve substantial fixed costs which cannot be undertaken unless income is higher than some threshold level which ensures economic efficiency.

— Second, economies or regions with a higher level of income can undertake more ambitious infrastructure investment programmes since they have more fiscal revenue to pay for them.

— Third, it is likely that new infrastructure (or improvements in infrastructure) are systematically located in areas where firms have more chances to be successful for reasons not directly related to infrastructure availability but to other characteristics of the economic environment. Proximity to markets, coastal areas, primary resources and labour can be factors that can attract productive investment and then give rise to a need for improvements in infrastructure.

Neglecting the fact that development of infrastructure is to some extent "demand-induced" can lead to upward bias in the estimated effects of infrastructure on growth. To estimate the coefficients associated with the infrastructure variables more consistently in the growth regression, we used a two-stage least-squares estimation method with fixed effects (2S-LSDV), for both equation 2 with separate infrastructure indicators and equation 4 with principal components. Due to the shortage of appropriate variables to use as instruments, we restricted the use of this estimation method to two sets of infrastructure indicators, first, to indicators which have a flow dimension (per capita power consumption, per capita industrial power consumption). These are more subject to simultaneity bias in a growth regression with annual data than indicators having a stock dimension (roads, railways, irrigation etc.), given that stocks build up gradually and quite independently of short-run changes in income. Second, the other indicators we used can be viewed as reflecting the interplay of various economic and social factors, and could serve as proxies for educational level, health conditions, and financial development, notably primary and secondary school enrolment, infant mortality, bank deposits and bank credit as a share of the SDP.

The regressions for these seven infrastructure variables *(El, Eli, Prim, Sec, Mort, Bdep, Bcred)* are logarithmic and have been estimated on the same panel data set for the 17 States from 1970 to 1994. The results are presented in Table 7. The Fisher tests strongly reject the hypothesis of a common intercept of the regressions across States. As explained earlier, given the large number of time observations for each State, the fixed-effects estimation method was systematically selected. In all regressions we used variables which were assumed to be exogenous in the growth equation. Moreover, when per capita income is used as an explanatory variable, it is lagged twice in order to avoid correlation with the variable on the left side of the growth equation.

As can be seen in Table 7, the estimated equations explain a remarkably high proportion of the variance of each indicator and have satisfactory statistical properties. Power consumption (total and industrial, Eq. 1 and 2) is positively influenced by the share of industrial and transportation sectors in the SDP, the density of the road network (insofar as it contributes to the integration of economic activities, thereby increasing production and the use of energy), and educational level for which the literacy rate serves as a proxy. Per capita income also exerts a strong positive influence on total per capita power consumption. It is worth noting that, according to our estimate of the income elasticity of power consumption, 5 per cent annual growth of the per capita SDP, which is equivalent to the currently projected growth rates, would give rise to a 2.7 per cent annual growth in per capita power consumption. This would lead to a 30 per cent increase in per capita power consumption in the first decade of the 21st Century, which indicates the magnitude of India's infrastructure requirements in this area in the near future.

Table 7. **Estimates of Infrastructure Variables**

Dependent variables: logarithms of *El*, *Eli*, *Prim*, *Sec*, *Mort*, *Bdep Bcred*
(see Appendix 1 for sources and definition of variables)

Independent variables in logarithms	Eq 1: *El*	Eq 2: *Eli*	Eq 3: *Prim*	Eq 4: *Sec*	Eq 5: *Mort*	Eq 6: *Bdep*	Eq 7: *Bcred*
$y_{(t-2)}$	0.53		0.14	0.33	-0.67		
	(6.5)		(2.6)	(5.6)	(7.8)		
Agri			-0.09	-0.26	0.08	-0.27	
			(2.1)	(3.5)	(1.3)	(3.9)	
Ind							0.17
							(1.3)
Indtr	0.21	0.34					
	(1.9)	(2.3)					
Elv			0.1	0.0.3			
			(7.2)	(1.3)			
Rte	0.29	0.29				0.24	0.25
	(8.2)	(6.7)				(6.9)	(5.8)
Rail			0.41		-0.85		
			(1.4)		(2.2)		
Lit	1.16	0.87	0.14	0.42	-0.20	0.38	0.49
	(15.1)	(10.3)	(2.2)	(6.5)	(3.2)	(2.3)	(2.7)
Bk						0.36	0.45
						(5.4)	(5.6)
Fisher specification test	132.1 (**)	85.3 (**)	14.6 (**)	215.8 (**)	48.9 (**)	51 (**)	42.2 (**)
Number of observations	408	408	408	408	408	408	408
R^2 adjusted	0.94	0.88	0.79	0.95	0.83	0.90	0.90

Notes:

All equations have been estimated using the fixed effect method. * (**) indicate that the specification tests were significant at 5 per cent (1 per cent) level. Constant terms are not reported here for convenience. The heteroscedasticity bias of standard errors has been corrected by using the White's estimator. Student's tests are in parentheses. The estimation period is 1970-94.

y = per capita State Domestic Product (SDP), *Agri* = agricultural sector as a share of SDP, *Ind* = industrial sector as a share of SDP, *Indtr* = industrial and transport sectors as a share of SDP, *El* = per capita electrical consumption, *Eli* = per capita industrial electrical consumption, *Elv* = percentage of villages electrified, *Rte* = kms of roads per square kms, *Rail* = kms of railroad network per square kms, *Prim* = primary school enrolment, *Sec* = secondary school enrolment, *Lit* = literacy rate, *Mort* = infant mortality rate, *Bk* = bank office per capita, *Bdep* = bank deposits as a share of SDP, *Bcred* = bank credits as a share of SDP (see definitions and sources of infrastructure variables in Appendix 1).

Primary and secondary school enrolment rates seem to be influenced by a set of common factors (Eq. 3 and 4). They are both positively related to the level of per capita income, with the income elasticity of secondary education being (as expected) much higher than the income elasticity of primary education. Both elasticities are lower in primarily agricultural-oriented States (the negative effect of agriculture being also higher for secondary education), but they seem positively influenced by the degree of rural development as evidenced by the percentage of villages which are electrified (although this effect is not very significant in the case of secondary education).

An interesting finding is that both variables are positively affected by the literacy rate of adult population (with the effect again being greater in the case of secondary education). This could be interpreted as evidence of externalities in the accumulation of human capital, insofar as the social returns to education can be assumed to increase with the educational level of the community. This would provide extra incentives for investing in education and could explain the positive coefficients of literacy estimated in our regressions. Moreover, primary school enrolment seems to be positively influenced by the length of the railway network. A better railway network could be considered a factor which increases the opportunities of labour mobility, therefore leading to greater incentives to invest in education.

Health conditions, using infant mortality as a proxy (Eq. 5), seem to improve with a rise in income or the educational level, using the literacy rate as a proxy, and with the availability of physical infrastructure, measured by the length of the railway network. As expected, health is comparatively poorer in agricultural-oriented States (although the effect is not highly significant) where a large fraction of the population lives in rural areas.

Bank deposits and bank credit as a share of the SDP also turn out to be related to a set of common factors (Eq. 6 and 7). They are both positively affected by the number of bank offices (in relation to population), measuring the degree to which financial intermediaries are able to mobilise bank deposits and, therefore, extend credit to the private sector. Moreover, they are both positively affected by the literacy rate and the density of the road network, insofar as a higher educational level or a better territorial integration of economic activities are likely to increase the demand for financial intermediation services. Finally, as expected, mobilisation of bank deposits is significantly lower in agricultural States, whereas credit extended to the private sector seems to be higher in predominantly industrial States.

Using the predicted values of the infrastructure indicators from the above regressions, the growth regression 2 in Table 6 was re-estimated by first replacing the three variables *El, Prim,* and *Bdep* with the appropriate instrumental variables. The results are shown in equation 3 in Table 6. As can be observed, the coefficient of per capita power consumption remains positive and significant, confirming that supply of power has a robust effect on the growth performance of Indian States. However, the coefficients of the primary school enrolment rate and of bank deposits as a share of the SDP turn out not to be significant, casting some doubt on the effectiveness of primary education and financial development as engines of growth.

To verify the robustness of these results we also re-estimated growth regression 4 with principal components extracted from the whole set of infrastructure indicators. In this case, we first carried out a new principal components analysis by replacing the seven infrastructure variables *El, Eli, Prim, Sec, Mort, Bdep,* and *Bcred* in the data set by their predicted values from the regressions shown in Table 7. The principal components extracted by taking into account these instrumental variables are shown in Appendix 2.C. Then using the first four principal components as independent variables, we re-estimated the growth regression and obtained the results shown by equation 5 in Table 6. As can be seen by a comparison with equation 4, where the coefficients of the first three principal components remain positive, the first two are significant. Dropping the third principal component which is not significant, we obtained the results shown by equation 6, which is used for further analysis and projections in the remainder of this paper.

These findings can be interpreted as confirming that, despite the likely endogeneity of investment in infrastructure, there is sufficiently strong evidence showing that development of infrastructure has a positive impact on growth performance. Thus it is possible to make a more precise examination of the contribution of various types of infrastructure to growth, by decomposing the global effect shown by the aggregate indicators of equation 6.

The Impact of Different Types of Infrastructure on Long-run Growth Potential

The impact on growth of each type of infrastructure can be computed from the estimated coefficients of the principal components included as independent variables in the regression and from the loadings associated with the various infrastructure variables in each principal component. Let us denote by $\boldsymbol{\delta}$ and $\boldsymbol{P}$, respectively, the (nx1) and (1xn) vectors of estimated coefficients and of the selected n principal components. Moreover, the n principal components can be expressed as a linear combination of the individual variables by $P = A X$, where X stands for the (kx1) vector of the k infrastructure variables and A denotes the (kxn) matrix of the loadings associated to them. Obviously, in our case n=3 and k=14. The growth regression can then be written implicitly as follows:

$$ln(y_{i,t}) - ln(y_{i,t-1}) = \alpha_i + \beta\, ln(y_{i,t-1}) + \gamma\, AGRI + \varphi\, DPMA + \delta\, A\, X + \eta_t + u_{i,t} \quad (3)$$

The (kx1) vector (E) expressing the impact of the individual variables of infrastructure on growth can then be simply computed as $E = \delta A$. These coefficients, computed from equation 6 in Table 6 and the loadings shown in Appendix 2.C, are reported in the first column of Table 8. However, it should be recalled that the usual procedure for computing principal components involves transforming the initial variables into standardized variables [$x_{i,t}=(X_{i,t}-\mu_i)/\sigma_i$] (i.e. measured as deviations from their respective means, and then divided by the corresponding standard deviations). The contribution of changes in the *levels* of each infrastructure variable to growth is therefore expressed by the corresponding coefficient (e_i) divided by the standard deviation of that variable (e_i/σ_i). These "level-coefficients" are reported in the second column of Table 8. The third column of Table 8 shows the elasticities of the steady-state *level* of output with respect to each type of infrastructure. These long-run elasticities are computed by dividing the elasticities shown in column 2 by the estimated coefficient of the lagged value of the per capita SDP in the growth regression, which determines the speed of convergence to the steady state.

Table 8. **Impact of Infrastructure Variables on Growth and Steady-State SDP**

Variables * (logarithms)	Short term elasticities		Long term elasticities
	standardised variables	level variables	
El	0.03	0.04	0.15
Eli	0.02	0.04	0.13
Elv	0.04	0.05	0.17
Ir	0.04	0.07	0.22
Rte	0.07	0.08	0.28
Veh	0.03	0.03	0.11
Rail	0.06	0.05	0.18
Lit	0.04	0.14	0.46
Prim	0.04	0.21	0.70
Sec	0.04	0.09	0.29
Mort	-0.04	-0.11	-0.37
Bk	0.02	0.03	0.11
Bdep	0.03	0.06	0.21
Bcred	0.04	0.05	0.18

* See Appendix 1 for definitions and sources of variables.

Source: Authors' calculation.

Our analysis focuses specifically on the long-term elasticities of the steady-state output level. With respect to the physical infrastructure variables, per capita total power consumption, industrial power consumption, and the percentage of villages electrified turn out to exert an equally large impact. According to our estimates, an increase in per capita industrial power consumption by 10 per cent would lead to a 1.3 per cent increase in the steady-state level of per capita income. Irrigation has an even larger coefficient, implying that a 10 per cent increase in the irrigated cropped area would lead to a 2.2 per cent increase in steady-state per capita income. The density of the road network turns out to have a similar affect on growth and long-run income. This effect is greater than the impact of the number of vehicles (mainly trucks in the case of India) or the length of the railway network.

Among the indicators of social infrastructure, adult literacy has a major impact on steady-state income, having an elasticity of 0.46. Health conditions, as measured by infant mortality, have an equally significant impact. A 10 per cent drop in infant mortality would lead to a 3.7 per cent increase in the steady-state level of income. It is particularly interesting to observe that, according to our findings, the positive effect of education on growth is much greater for primary school enrolment. Moreover, the estimated elasticity is exceptionally high, implying that a 10 per cent increase in the primary school enrolment rate could induce a 7 per cent rise in the steady-state level of income. Although high in absolute value, the long-run elasticity of income with respect to secondary school enrolment turns out to be less than half the primary school enrolment elasticity. In terms of growth, the impact of funds invested in education would therefore be maximised by giving priority to primary education.

Finally, the indicators of financial system's depth, as measured by the shares of bank deposits and bank credit in the SDP, turn out to have a significant impact on growth and long-run income, which is equivalent to the effect of various types of physical infrastructure. The influence of the size of the banking network (as measured by the number of bank agencies per 1 000 people is somewhat smaller. It should be recalled, however, that *Bk* also has an indirect positive influence on growth by increasing the shares of bank deposits and bank credit in SDP (see Eq. 6 and 7, Table 7), which has already been taken into account in the growth regression by the instrumental variables for *Bdep* and *Bcred*.

SECTION V. SOURCES OF DIFFERENCES IN GROWTH PERFORMANCES ACROSS STATES

Our finding of a particularly high rate of convergence (see Table 6) implies that the Indian States were on average quite close to their steady-state level of income during the observation period. This means that the observed large differences in growth rates across States cannot easily be explained by transitional dynamics, arising from unequal distance of each State's income from its steady-state level. As suggested by Caselli, Esquivel and Lefort (1996), such differences in growth rates could be better understood as arising from shifts, of unequal size across economies, in the steady state itself over time. Such shifts are represented by changes in the control variables of the growth regression, that is, by changes in the share of agriculture in SDP and in the indicators of physical, social, and economic infrastructure. States with comparatively high growth rates can be expected to have experienced repeated upward shifts in their steady-state level of income during the review period.

Decomposition of Steady-State Differences

If change in the steady-state SDP is the main mechanism affecting growth, it is interesting to examine how various explanatory factors may account for differences in the steady-state levels of the SDP of Indian States and, therefore, of differences in their growth potential. To perform this growth-potential accounting exercise we first chose Maharastra as the benchmark State whose steady-state SDP level would be compared to the corresponding time series of the other. Maharastra is a "rich" State (like Haryana), and it has high growth and is industrially developed, with a comparatively good infrastructure endowment (see Figure 9). This makes it a good benchmark to highlight the importance of relative differences in production structure, as measured by the share of agriculture in the SDP, as well as of differences in the availability of infrastructure, as explanatory factors of differences in growth potential across States.

As a first step in this accounting exercise, we computed time series of the steady-state level of per capita SDP for each State $y^{*}_{i,t}$ over the 1971-94 period. This was done by solving equation 3 for the logarithm of $y^{*}_{i,t}$, after dropping out the relative price shock variable ($DPMA_{i,t}$) and the three time fixed effects (for 1974, 1979 and 1987) which are proxies for influences linked to the business cycle. Our measure of the steady-state per capita SDP is obtained using the coefficients of regression 6 in table 6, as follows[18]:

$$ln(y^{*}_{i,t}) = -\frac{1}{\beta}\left(\alpha_i + \gamma\ AGRI_{i,t} + \delta_1 P1_{i,t} + \delta_2 P2_{i,t} + \delta_4 P4_{i,t}\right) \quad (4)$$

where δ1, δ2 and δ4 are the estimated coefficients of the first two and the fourth principal components respectively included in the growth regression[19].

Then we computed time series for the gap between the steady-state SDP of each State and the steady-state SDP of Maharastra. Finally, these gaps were decomposed into the three components suggested by equation 4:

— A first component arising from differences in the magnitude of the State-specific fixed effect compared to the fixed effect associated to our benchmark *(GAPFIX)*.

— A second component arising from differences in production structure: the greater the share of agriculture in the SDP, the larger the (negative) gap of a State's steady-state SDP with respect to our benchmark (*GAPAGR*).

— A third component corresponding to differences in the steady-state SDP arising from differences in "global infrastructure" endowment with respect to our benchmark State. This effect is incorporated in the differences in the values for each State of the three principal components of the infrastructure indicators included in our equation *(GAPINF)*.

Average gaps over the 1970-94 period with respect to Maharastra's steady-state SDP (GAP) and their decomposition into these three components for the remaining 16 States are reported in Table 9.

Table 9. **Decomposition of Average Steady-State SDP Gaps with respect to Maharastra: 1971-94**

	GAP	GAPFIX	GAPAGR	GAPINF
PUN	6.9	-1.9	-45.7	54.4
GUJ	-31.4	-10.4	-13.1	-8.0
HAR	-40.6	-1.9	-35.2	-3.5
TMD	-44.8	-68.2	-3.6	27.0
KER	-48.1	-71.1	-18.0	41.0
KAR	-50.4	-14.5	-23.3	-12.6
WB	-54.0	-43.9	-10.6	0.5
HP	-71.1	-1.9	-22.3	-46.9
AP	-72.3	-23.4	-21.1	-27.9
MP	-78.6	-6.3	-18.6	-53.7
RAJ	-79.0	-5.4	-22.9	-50.7
UP	-80.7	-32.9	-20.6	-27.2
ORI	-80.9	-11.2	-22.1	-47.6
ASS	-84.1	-25.8	-18.6	-39.6
J&K	-85.1	11.8	-18.0	-78.9
BIH	-86.6	-37.5	-18.6	-30.5
Average	*-61.3*	*-21.5*	*-20.8*	*-19.0*
%		*-35.1*	*-33.9*	*-31.0*

Source: Authors' calculation.

As it can be observed, the average steady-state SDP gap from the benchmark State was 61.3 per cent over the whole period. Our two sets of explanatory factors (that is, production structure and broad infrastructure) explain almost two-thirds of this gap. The remaining unexplained part is accounted for by the differences in fixed effects associated with the various States. Obviously, further investigation is needed to understand the factors accounting for the variation in fixed effects across States. Differences in production structure account for 34 per cent of the average gap, while differences in infrastructure endowments account for 31 per cent. Punjab turns out to have a slightly higher steady-state level of per capita income than Maharastra, while Gujarat, Haryana, Tamil Nadu, and Kerala exhibit a level of potential per capita SDP which is slightly more than half of Maharastra's.

This broad picture of growth potential accounting looks quite different when viewed from the standpoint of individual States. More specifically, the importance of differences in the magnitude of fixed effects in explaining the steady-state SDP gaps is much higher in the case of five States: Kerala, Uttar Pradesh, Bihar, West Bengal, and Tamil Nadu. In Tamil Nadu and Kerala in particular, differences in fixed effects account for more than the entire gap in the steady-state SDP with respect to Maharastra. The good infrastructure endowment in these two States compensates for a large part of the handicap induced by their weak "structural" growth potential which remains to be explained by further studies.

Lack of an adequate infrastructure endowment is important for explaining the low growth potential of six States: Assam, Orissa, Madhya Pradesh, Rajastan, Jammu and Kashmir, and Himachal Pradesh. In these States poor infrastructure accounts more than for 40 per cent of their steady-state SDP gap with respect to Maharastra. Andhra Pradesh, Bihar and Uttar Pradesh also seem to have been severely constrained by inadequate infrastructure, since this factor accounts for between 30 and 40 per cent for their gap with Maharastra.

Punjab and Haryana exhibit a specific pattern. Their agricultural-oriented production structure implies a low steady-state SDP and, therefore, a weak growth potential. However, this initial handicap is mostly overcome by their good infrastructure endowment. This effect is particularly strong in the case of Punjab where good infrastructure has more than compensated the potential handicap with respect to Maharastra.

Policy Implications for Public Investment

The empirical evidence suggests that economic policy measures aiming at the improvement of physical, economic and social infrastructure can have an important impact in promoting long-run growth potential, as well as convergence across Indian States. Our results suggest that targeting public investment in infrastructure for some specific States could improve the overall returns from this investment in terms of better growth performance. On the basis of our results, the States that should be targeted in priority are the nine States whose steady-state SDP gap with respect to the benchmark State is mainly accounted for by inadequate infrastructure. Improving the amount of infrastructure in these States could increase their growth potential considerably and have a greater impact on the growth of the aggregate economy than a public investment policy which did not take into account differences in infrastructure constraints faced by States.

As shown by our results revealing highly unequal infrastructure endowments of Indian States, the planning process for public investment in infrastructure has not been successful enough in promoting balanced growth across India. Investment planning in infrastructure could be improved by determining budget allowances in a way similar to the present analysis of the growth constraints imposed by poor infrastructure in different States.

Targeting public investment towards specific infrastructure could also help to improve regional and nationwide growth prospects. As shown by the point estimates of the elasticities reported in Table 8, the contribution to growth of various types of infrastructure can be expected to be quite different. In the domain of physical infrastructure, increasing the capacity of power production, increasing irrigation capacity and extending the road network appear to have the most powerful impact on growth performance. Furthermore, a better road network appears to promote more growth than a better railroad system.

With regard to economic infrastructure, extending the availability of credit to the private sector and achieving a better mobilisation of bank deposits seem to have an equally strong growth impact. Reforms which would increase the size and the efficiency of the financial system could therefore be an effective and relatively inexpensive way of promoting growth, as shown by the large impact of financial indicators on growth performance. Finally, on the side of social infrastructure, both a higher educational level and better health conditions appear to be major factors for growth. In this respect, investing in primary education seems the most promising way to achieve a high return in terms of growth potential.

SECTION VI. CONCLUSION

The empirical evidence presented in this paper has highlighted the importance of differences in physical, social and economic infrastructure endowments, as well as of differences in production structure, in accounting for the observed variation in growth performance of Indian States. Our analysis makes it possible to identify States that appear to be comparatively more constrained by the lack of infrastructure, in the sense that poor infrastructure largely explains their steady-state output gap with respect to a fast-growing benchmark State, which serves as a proxy for lack of growth potential. Moreover, the use of principal components analysis and panel data estimation techniques helps to overcome multicolinearity problems and makes it possible to assess the contribution of various types of infrastructure to growth performance.

On the analytical side, the finding that differences in State-specific fixed effects play a significant role in accounting for gaps in steady-state output with respect to a benchmark State, underscores a need to understand better the explanatory factors of these fixed effects. Fixed effects are supposed to reflect differences in institutional and political environment, differences in technology, in the availability of natural resources, as well as in other factors that may exert an influence on productive efficiency, and thus on growth. A natural further analytic step would be to estimate separate regressions for these fixed effects, along the lines suggested by Islam (1995). Then it could be checked whether these differences in fixed effects can give rise to "convergence clubs" of distinct low- or high-growth equilibria. The main constraining factor for such a cross-section econometric analysis is the limited number of States included in our sample. The possibility of the existence of multiple equilibria is suggested by our analysis of the characteristics of the two groups of Indian States we identified through principal components analysis.

With respect to economic policy, our analysis suggests that the overall effectiveness of public investment and growth prospects could be improved by focusing investment efforts on the physical infrastructure that appears to exert a comparatively stronger impact on growth (electrical power capacity, irrigation and roads). A similar improvement could be achieved by promoting the development of the financial system, by improving health conditions and by raising the educational level, since all of these factors were shown to exert a significant impact on growth. However, a major economic policy issue of fiscal federalism needs to be addressed in this respect. It is related to the sharing of responsibility between the central government and the States for implementing public investment programmes in the most growth-enhancing infrastructure, as well as the development of a transfer mechanism that will direct investments to the States most constrained by poor infrastructure.

NOTES

1. India had 25 States and 7 union territories in 1991; in 1961 there were 15 States and 12 union territories. Because of the difficulties in aggregating data and making it uniform as a result of these changes, only 17 States which account for 86 per cent of India's gross domestic product (see Table 1) are considered here. These States are as follows: 1. Andhra Pradesh *(AP)*; 2. Assam *(ASS)*; 3. Bihar *(BIH)*; 4. Gujarat *(GUJ)*; 5. Haryana *(HAR)*; 6. Himachal Pradesh *(HP)*; 7. Jammu and Kashmir *(J&K)*; 8. Karnataka *(KAR)*; 9. Kerala *(KER)*; 10. Madhya Pradesh *(MP)*; 11. Maharashtra *(MAH)*; 12. Orissa *(ORI)*; 13. Punjab *(PUN)*; 14. Rajasthan *(RAJ)*; 15. Tamil Nadu *(TMD)*; 16. Uttar Pradesh *(UP)*; 17. West Bengal *(WB)*.

   Delhi, which is an union territory, was excluded because its uniqueness would have biased the sample.

2. The national data have been converted into 1985 international dollars using Heston and Summers (1991) PPP estimates. See Appendix 1 for an explanation of and sources of the national data

3. In terms of real per capita income, Bihar is quite similar to the "poorest" African countries (Mali, Madagascar, Guinea Bissau), while India is closer to the "richest" African countries (Côte d'Ivoire, Senegal, Cameroon). A comparison with China is problematic since unofficial calculations suggest that Chinese growth performances have been underestimated (Ren Ruoen, 1997).

4. For a detailed account interpreting the macroeconomic policy and growth performance of India, see Joshi and Little (1994).

5. This result is exaggerated by the particularly poor growth performance of Bihar, which has been characterised by low agriculture productivity, insufficient infrastructure and political uncertainty (Cashin and Sahay, 1996). This ratio remains around three if we consider the difference between Punjab and Orisa (the second "poorest" State after Bihar).

6. Delhi, which is not taken into consideration here, remains the "richest" state of India.

7. Ninety-seven categories are under the exclusive authority of the Union Government, 66 are under the exclusive authority of State governments, and for 47 the Union and the States have concurrent powers.

8. The National Development Council consists of the Union cabinet and chief ministers of all States of the Union.

9. This formula sought to take into account some objective criteria to reduce arbitrariness and bring about greater equity.

10. It should be noticed that the irrigation indicator does not contr ibute significantly to the first principal component of these variables. The detailed results of this analysis are given in Appendix 2.A.

11. The two financial sector development indicators do not contribute to the second principal component of the data. Moreover, the length of roads contributes negatively to that principal component. However, this is mainly because of the exceptional density of the road network of Kerala.

12. The correlation coefficient between the two variables is 0.63.

13. Moreover, the share of agriculture in the GDP is presumably negatively correlated with initial per capita GDP. Omission of this variable would therefore lead to a biased estimation of the speed of convergence. For an analysis of the patterns of structural change of States' economies in relation to the overall growth process in India see Mitra (1989).

14. In India such relative price shocks originate mainly from changes in agricultural production due to climatic variations.

15. In addition, a fixed-effects estimation for the constant term seems preferable to a random-effects estimation, as shown by the Hausman specification tests reported in Table 6.

16. A good account of the contribution of physical and social infrastructure to growth is given by Jimenez (1995). More recently, Khan and Kumar (1997) have studied the contribution of public and private investment to growth in a broad sample of developing economies, and find a comparatively stronger effect for private investment.

17. According to Cashin and Sahay (1996), the estimated speed of convergence (0.017) is even lower than that found by Barro and Sala-I-Martin.

18. This steady-state per capita SDP is calculated by using the observed values of agriculture and infrastructure variables from 1970 to 1994. Steady-state revenue remains constant when the level of these variables is constant.

19. The steady-state levels of the per capita SDP were computed using the observed values of the infrastructure variables and not the predicted values from the regressions in Table 7, as in the estimation of equation 6.

APPENDIX 1. DEFINITIONS AND SOURCES OF THE DATA

The state domestic product (SDP) represents value added originating in each State, and not income accruing to the residents of each State. This is due to lack of data on flows of factor incomes across States. This is a limitation as some States like Kerala receive substantial transfer income not only from other parts of India but from abroad, mainly from the Middle East.

The SDP data used in this study come from the Central Statistical Organisation (CSO) where inter-State comparable estimates have been derived from the series published by the State Statistical Bureaus (SSBs). The role of CSO is to present the States' data in a uniform way because of methodological differences, but because of differences in source material, data availability or statistical competence. In particular, because of differences in the importance of the "unorganised sector" (which accounts for a large part of value added), the comparability of the States' estimates can be biased. Moreover, since the SDP figures are being used for distribution of central government financial assistance, they may be subject to some manipulation.

Comparable SDP estimates are available from 1960 to 1994 for most of the States (from 1965 in the case of Haryana and Punjab and from 1967-68 in the one of Assam and Himachal Pradesh).

Using these data, we have generated time series at 1980 prices for the per capita SDP and SDP by sector of activity. The SDP has been decomposed as follows: *Agriculture* (agriculture; forestry; fishery), *Industry* (mining; registered and unregistered manufacturing; construction; electricity; gas and water) and *Services* (transportation, storage and communication; trade, hotel and restaurants; banking and insurance; real estate; public administration; other services). In addition, we have computed series of implicit deflators for agriculture, industry and services from national data, in order to construct an indicator of *price shocks* (taking into consideration the production structure of each State).

Population data are issued by the Registrar General, Census of India

As far as *physical, social and economic infrastructure indicators* are concerned, long time series have been constructed on an annual basis from national data. Basic indicators used are as follows:

1. Power

El: Per capita electrical consumption (in kilowatt hours).
Eli: Per capita industrial consumption of electricity (in kilowatt hours).
Elv: Percentage of villages electrified.

Sources: Central Electricity Authority's General Review: Public Electricity Supply. *All India Statistics*, annual publication.

2. Irrigation

Ir: Percentage of gross cropped area irrigated.

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

3. Roads

Rte: Road length (in km./1 000 km^2).
Veh: Number of motor vehicles/1 000 population.

Source: Ministry of Shipping and Transport, published in CSO's *Statistical Abstract of India* (SAI).

4. Railways

Rail: Track length (in km./1 000 km^2).

Source: Railway Board, Ministry of Railways, published in SAI. Rail.

5. Education

Lit: Literacy rates (in percentage of the age-group).
Prim: Primary school enrolment (age 6-11, in percentage of the age-group).
Sec: Secondary school enrolment (age 11-17, in percentage of the age-group).

Source: HRD Ministry's Educational Statistics, CMIE.

6. Health

Mort: Infant mortality (in percentage).

Source: Director General of Health Services, Ministry of Health and Family Welfare.

7. Banking

Bk: Number of bank offices/1 000 population.
Bdep: Bank deposits as a percentage of the SDP.
Bcred: Bank credit as a percentage of the SDP.

Source: Reserve Bank of India: *Statistical Tables Relating to Banks in India*, annual publication.

APPENDIX 2.A

Principal Components Analysis
(17 States, 1970-94 average values)

Component	Eigenvalue	Cumulative R-Squared
P1	5	0.42
P2	2.56	0.63
P3	1.36	0.74
P4	1.18	0.84
P5	0.81	0.91

Infrastructure variables *	Loadings **	
	P1	P2
El	0.76	0.50
Ir	0.19	0.80
Rte	0.51	-0.52
Rail	0.41	0.44
Lit	0.80	-0.51
Prim	0.78	-0.35
Mort	-0.39	0.32
Bk	0.62	-0.07
Bdep	0.83	-0.09
SDP	0.74	0.49
Gr	0.70	0.57
Agri	-0.67	0.42

* See Appendix 1 for definition and sources of variables.
** Loadings larger than 0.45 in absolute value are significant at a 5 per cent level.

APPENDIX 2.B

Principal Components Analysis
(17 States, 1970-94 annual data)

Component	Eigenvalue	Cumulative R-Squared
P1	7.6	0.55
P2	1.7	0.67
P3	1.3	0.76
P4	1.0	0.84

Infrastructure variables *	Loadings **			
(*in logarithms*)	P1	P2	P3	P4
El	0.83	0.06	0.44	0.22
Eli	0.78	0.18	0.31	0.41
Ev	0.85	-0.16	0.13	-0.12
Ir	0.10	-0.06	0.68	-0.69
Rte	0.53	0.71	-0.25	-0.25
Veh	0.86	-0.14	0.19	0.06
Rail	0.20	0.09	0.14	-0.13
Lit	0.90	0.006	-0.28	-0.005
Prim	0.77	0.25	-0.21	0.11
Sec	0.69	-0.20	-0.33	-0.32
Mort	-0.67	0.19	0.46	0.26
Bk	0.86	-0.32	0.08	-0.008
Bdep	0.86	-0.23	0.02	-0.03
Bcred	0.87	0.01	0.03	0.15

* See Appendix 1 for definition and sources of variables.
** Loadings larger than 0.10 in absolute value are significant at a 5 per cent level.

APPENDIX 2.C

Principal Components Analysis[1]
(17 States, 1970-94 annual data)

Component	Eigenvalue	Cumulative R-Squared
P1	8.04	0.57
P2	1.7	0.70
P3	1.4	0.79
P4	1.0	0.87

Infrastructure variables *	Loadings **			
(*in logarithms*)	P1	P2	P3	P4
El	0.84	0.06	0.45	0.22
Eli	0.80	0.18	0.30	0.40
Ev	0.86	-0.17	0.13	-0.11
Ir	0.10	-0.08	0.69	-0.68
Rte	0.53	0.71	-0.25	-0.27
Veh	0.85	-0.14	0.21	0.08
Rail	0.20	0.90	0.15	-0.14
Lit	0.91	0.06	-0.27	-0.004
Prim	0.84	0.26	-0.21	0.12
Sec	0.70	-0.22	-0.33	-0.33
Mort	-0.71	0.20	0.45	0.27
Bk	0.87	-0.32	0.08	0.02
Bdep	0.89	-0.23	0.01	-0.05
Bcred	0.91	0.02	0.02	0.12

1. This principal component analysis uses the fitted value of *El*, *Eli*, *Prim*, *Sec*, *Mort*, *Bdep* and *Bcred* calculated from equations in Table 7.

* See Appendix 1 for definition and sources of variables.

** Loadings larger than 0.10 in absolute values are significant at a 5 per cent level.

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