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STATE INFRASTRUCTURE AND PRODUCTIVE PERFORMANCE IN INDIAN MANUFACTURING

by

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RÉSUMÉ

Dans ce document sont présentées des estimations au niveau des États de l'Inde, de la Productivité globale des facteurs (PGF) et de l'éfficacité technique (ET) dans l'industrie manufacturière, à partir de l'estimation de fonctions de production pour 17 branches industrielles sur la période 1976–92. Notre analyse fait dépendre la PGF et l'ET de la disponibilité en infrastructures. Nous élaborons un indicateur composite d'équipement en infrastructures à partir de 12 indicateurs désagrégés d'infrastructures physiques, sociales et économiques. Nos résultats montrent que les différences régionales de PGF et d'ET dans l'industrie manufacturière sont expliquées de façon très significative par les disparités d'équipement en infrastructures selon les États. Nos estimations permettent, en outre, de quantifier l'impact productif des divers types d'infrastructures, de même que les branches manufacturières les plus contraintes par leurs insuffisances. Nos résultats visent à la mise en place d'une politique d'investissement en infrastructures qui soutienne les réformes économiques récentes, notamment en matière industrielle, ainsi que les efforts de réduction des inégalités régionales.

SUMMARY

We present estimates, at the State level, of Indian manufacturing Total Factor Productivity (TFP) and Technical Efficiency (TE) from the estimation of production functions for 17 manufacturing industries from 1976 to 1992. Our analysis relates TFP and TE to the availability of infrastructure. We construct an aggregate infrastructure indicator from 12 indicators of core, social, and economic infrastructure. According to our findings, differences across States in manufacturing TFP and TE performance are accounted for, to a significant extent, by differences in infrastructure endowments. Our estimations make it possible, moreover, to measure the productive impact of the various types of infrastructure, as well as to identify the manufacturing industries where productivity gains are relatively more constrained by inadequate infrastructure. The findings could help in designing an effective policy of infrastructure investment, supporting both recent economic reforms towards industrial restructuring and efforts aiming to promote regional convergence in India.

PREFACE

Although India has weathered the East Asian economic storm thus far surprisingly well, it still needs to tackle major economic policy challenges to sustain strong growth over the long-term. India has progress to make on the path towards a more open-market economic system and needs to better integrate into the world goods and capital markets. At the same time, major restructuring is needed in central and local governments' spending to focus more on social sectors and to prioritise investment in core infrastructure.

Capacity constraints in manufacturing, due to poor core infrastructure, are a main factor threatening the sustainability of economic take-off in India. Moreover, weak social infrastructure and lack of skilled labour impede productivity improvement in manufacturing and weaken the responsiveness of production to incentives created by reform. Improving productivity in manufacturing is an important challenge in India on many counts. Without an adequate level of productivity, the country could remain a supplier of cheap-labour goods in global markets. This would hamper advances in living standards and could slow down progress towards poverty alleviation. An adequate level of manufacturing productivity is needed both to attract more foreign direct investment and to increase domestic investment so that industry may be developed in more backward areas. This, in turn, would ensure a more balanced growth performance in the country and improve convergence across Indian states.

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 impact of core social and economic infrastructure on the productivity and efficiency of manufacturing industries across Indian states. The empirical evidence they present complements the findings of previous Development Centre research on growth policy in India and helps to identify the industries where productivity and efficiency depend more strongly on the availability of infrastructure. This analysis will contribute to the formulation of more effective structural policies in order to integrate global markets successfully and, at the same time, to make progress towards the much needed reduction of regional disparities in India.

Jean Bonvin
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I. INTRODUCTION

Since the implementation of economic reforms in 1991, India has become increasingly integrated into the world economy. By promoting deregulation of domestic industry, liberalising rules for foreign investment, and reducing tariff and non tariff barriers on imports, the authorities engaged deliberately on an outward looking development strategy, in which strengthening of export capacity is called upon to play a dominant role. The supply–side response of the economy to the structural reforms undertaken has been surprisingly good by international standards. After experiencing a slow–down in growth during 1992, the economy recovered quickly, reaching average annual GDP growth of 6 per cent in 1993–94 which accelerated further at above 7 per cent during 1995–97 (World Bank, 1996 and 1997)[1].

Recovery in industrial production has been an important factor behind the observed resumption of GDP growth. After being relatively sluggish in 1993–94, growth in industrial production reached 10.8 and 12.7 per cent in 1995 and 1996 respectively. At the same time, trade flows responded positively to liberalisation of foreign trade, the sum of exports and imports as a share of GDP rising from 16 per cent in 1990 to 21 per cent in 1996. Export performance has been particularly strong, the average annual rate of growth in total exports approaching 20 per cent during 1994–96. However, the sustainability of such an export–led growth pattern has been called into question by the more recent performance of the Indian economy. In 1997, the pace of both industrial production and exports declined, reaching respectively 6.8 and 4 per cent. This raised concerns about the feasibility of the 7–8 per cent target range for annual GDP growth in the medium run.

The break in the growth momentum of industrial production and exports may indicate that Indian industry is being constrained both by capacity bottlenecks and by institutional obstacles to further restructuring. Institutional barriers to restructuring that remain to be removed include reform of the industrial licensing system and further progress in lowering the anti–export bias of the still high–protection (especially for consumer goods) trade regime. Capacity bottlenecks could, first, arise from lacking core infrastructure. The tremendous infrastructure problems faced by the country have been singled out by many observers as a main factor threatening the sustainability of economic recovery. Among core infrastructure, power is the sector offering more cause for alarm. The estimated average shortfall of power supply (by largely state–run utilities) to demand was estimated at 11 per cent in 1996. Such bottlenecks create significant impediments to the expansion of industrial output. They considerably weaken the supply–side response and the export capacity of Indian industry. Moreover, weak social infrastructure, leading to a lack of skilled labour may be another factor limiting productivity of Indian manufacturing and weakening the responsiveness of production to incentives created by reform (World Bank, 1996).

The role of distortions related to the inward–oriented industrial policy of the earlier period in explaining the weak productivity performance of Indian manufacturing industries, as well as the existing institutional barriers to further market–oriented restructuring, have been underlined by many observers (see Goldar, 1986 and Ahluwalia, 1995). In the present study we assess the role of (both core and social) infrastructure as a factor of Total Factor Productivity (TFP) and Technical Efficiency (TE) improvement in Indian manufacturing.

In addition to contributing to the debate on the productive role of infrastructure in developing countries (World Bank, 1994; Jimenez, 1995), understanding the factors which affect industrial performance bears important policy implications in the case of India.

— India has — given its level of development — a highly diversified industrial sector which, in terms of size, ranks fifth among developing countries and eleventh in the world including developed economies (Ahluwalia, 1995). During the import–substitution period, the loss of international competitiveness of Indian industry resulted in a steady fall of the country's export share in world exports of manufactures (0.45 per cent in 1990, compared to 2 per cent in 1950). Successful integration of the Indian economy in the world goods markets involves realising sustained TFP gains in the industries in which the country appears to have a dynamic comparative advantage[2] In this context, it is important to identify the industries in which TFP growth — hence competitiveness — is particularly dependent on infrastructure availability, in order to be able to implement relevant structural policies.

— Improved productivity in manufacturing is a powerful factor for convergence for labour productivity — and, hence, per capita income — at the regional level (see Bernard and Jones, 1996, for the United States). In the case of India, not only do wide regional growth and per capita income disparities exist, but they have increased with time. Given India's enormous diversity, this growing inequality contains a risk of instability that could jeopardise efforts at reform and adjustment. Targeting public investment towards infrastructure that most strongly promotes convergence of industrial productivity could be a key component of a balanced regional growth policy.

In this study we examine the effects of infrastructure on manufacturing industries' TFP and TE at the level of Indian States. Using the spatial dimension of the data — which reveal marked disparities in infrastructure endowments across Indian States (see Kumar Das and Barua, 1996) — we hope to identify more accurately the impact of productive public expenditure on industrial productivity. Our analysis builds on existing empirical cross–region work on the productive influence of infrastructure (Munnell, 1990; Garcia–Milà and McGuire, 1992; Evans and Karras, 1994; Holtz–Eakin, 1994; Garcia–Milà, McGuire and Porter, 1996). These studies focused however, exclusively, on industrialised countries (mostly the United States) and have produced inconclusive results. Our analysis extends previous studies in several ways:

— The effects of infrastructure on manufacturing productivity and efficiency at the regional level are for the first time (to our knowledge) studied in the context of a developing country.

— We have created a large regional database for Indian manufacturing. It contains annual data for the 1976–1992 period for 17 industries in 15 States. Working at a lower level of aggregation should improve the accuracy of our estimates as, in all probability, the various industries benefit to varying degrees from the availability of infrastructure.

— Our analysis looks at infrastructure in a wide sense: physical, economic and social. Our approach consists of using 12 disaggregated infrastructure indicators, for which we have built up an annual database for 15 States. In this way, we hope to identify separately the impact of each type of infrastructure on the productivity of the various industries, so as to increase the relevance of our results for the design of more effective policies to enhance infrastructure.

— Finally, in the area of methodology, we have developed a composite indicator of infrastructure availability, using principal components analysis. This composite indicator is then used as an independent variable in our panel data regressions. This approach overcomes the problems of multi–collinearity that arise when estimating with a large number of disaggregated indicators.

The remainder of this paper is organised as follows. The second section provides a broad overview of industrial policy in India, of the structure of manufacturing across Indian States, and of their differences with regard to infrastructure. The third section provides our panel data estimates of the production function of the different industries. In the fourth, we compute TFP by manufacturing industries and assess differences in productivity trends across States. The fifth section examines the effects of infrastructure on TFP of the various industries, using a conditional convergence framework for TFP across States. The sixth section completes this analysis by studying the role of infrastructure as a predictor for differences in TE in various industries across States. The last section concludes.

II. INDUSTRIAL DEVELOPMENT AND INFRASTRUCTURE ENDOWMENTS OF INDIAN STATES

a. Industrial Policy in India

During the first 40 years after independence, India applied an ambitious planning policy designed to spur industrial development. This policy emphasised public–sector intervention in mobilising productive resources and regulating activities. It was based on four key principles[3]:

a) Priority given to heavy industry. The industrial development strategy gave priority to investment in heavy industry, seen as the main engine for the country's economic growth. The internal coherence of this industrialisation strategy was based on the belief that domestic consumption could be compressed over time so as to produce sufficient savings to absorb the output from the capital goods sector. The relatively restricted supply of consumption goods and control of foreign trade were also to contribute to this. The increase in savings generated by this special structure of productive investment would then accelerate growth.

b) Strategic control of industry by the public sector. The lack of private initiative in the priority industrial growth sectors, given the massive investment and long gestation period required to develop heavy industry, led to the implementation of a policy of strategic control of industry by the public sector. Firstly, some industrial sectors were reserved exclusively for the public sector, especially metal products, mining, energy, chemicals, and defence industries. In practice, the State assumed an active entrepreneurial role in many other industries, such as machine tools and non–metal products.

Secondly, a complex industrial licensing system was set up to orient private sector investment in the desired direction. It meticulously controlled entry into various industrial activities, location, capacity expansion, and even choice of technology and content of imports of intermediate goods. These barriers to input were accompanied by barriers to output, which took the form of equally constraining labour market controls aimed at protecting the interests of employees. However, industrial stagnation between 1965 and the late 1970s clearly showed that this regulatory system was hampering industrial growth. In particular, it had encouraged the creation of an informal sector and increased the number of enterprises in difficulty. It was eased in the mid–1980s, although the principle of State intervention in the industrial sector was maintained.

c) Policy in favour of Small and Medium Enterprises (SMEs). The priority given to heavy industry had two disadvantages in terms of development policy. Firstly, given the indivisibility of investment, heavy industry offered few prospects for regional dispersion of its activities. Secondly, given its capital–intensive nature, heavy industry provided few opportunities for expansion of industrial employment. Expanding employment is highly desirable in a country such as India, with such strong population pressures. In this context, strengthening the role of SMEs — which produce consumption goods, are labour–intensive and accounted for 35 per cent of industrial value added in 1988 — was seen as a means of ensuring a more balanced regional deployment of industry and more rapid expansion of industrial employment.

This policy was initially based on systematically developing infrastructure in the most backward regions in the country. This should have made these regions more attractive to industrial enterprises. Subsequently (in the 1960s), action in favour of SMEs was increasingly based on protective measures and financial incentives. Protective measures were introduced within the framework of an industrial licensing system. Some industries have been restricted to SMEs by setting a ceiling on investment and limiting access. Financial incentives took the form of preferred loans, investment subsidies, subsidies for transporting raw materials and finished products to and from backward regions (representing not less than 70 per cent of the country). The policy of financial incentives failed to promote the sought–after regional spread of industrial activities. In the 1980s, more than 50 per cent of subsidies were concentrated in only 5 per cent of the regions deemed underdeveloped. The policy was abandoned in 1988 in favour of a policy promoting investment in productive infrastructure.

d) Import substitution strategy. Industrial self–sufficiency has been a perennial objective of India's development strategy since independence. Whereas self–sufficiency is not *a priori* incompatible with increasing openness of the economy and a simultaneous increase in exports and imports, this strategy was transformed in India into a firm policy of import substitution. The main instruments of this policy were:

— a set of quantitative restrictions in the form of import licences which for all intents and purposes prevented imports of consumption goods and made importing intermediate and capital goods subject to very strict criteria concerning non–substitution for domestic output;

— a strong tariff protection for industry as a whole, mainly targeting consumption goods, for which the average tariff, prior to the 1991 reforms, was 60 per cent higher than that for capital goods.

The percentage of industrial value added covered by these quantitative import restrictions was 90 per cent before the 1991 reforms, and had fallen to 51 per cent in 1995 (Ahluwalia, Mohan and Goswami, 1996). Moreover, the average nominal tariff for industry as a whole was 137 per cent in 1985 (129 per cent in 1990, on the eve of reforms), higher than in other countries in the region at a comparable development stage (China, 91 per cent; Bangladesh, 100 per cent; Pakistan, 90 per cent). This average tariff was gradually lowered to 55 per cent in 1995.

b. Industrial Performance in India

The planning policy doubtless contributed to the diversification of Indian industry. Whereas production of consumption and capital goods represented respectively 48.5 per cent and 12.1 per cent of total value added for manufacturing in 1960, this had changed to 41.3 per cent and 20.5 per cent in 1989. Nevertheless, Indian industrial performance has fallen far short of initial expectations on three fronts:

— TFP experienced negative growth until the 1980s, especially in the intermediate and non–durable consumption goods sectors, which account for 73 per cent of total industrial value added (Ahluwalia, 1991). The increase in apparent labour productivity was therefore primarily linked to the increasingly capital–intensive nature of production. Distortions introduced by the licensing policy and protectionism explain low performance and productivity gains. Starting in the 1980s, TFP improved in all industries.

— A consequence of the industrial licence system is that Indian manufacturing industries are fragmented into a vast number of small enterprises, by international standards. These are technically inefficient, and unable to take advantage of economies of scale and to develop new products.

— In spite of planning efforts, Indian manufacturing has not been able to avoid persistent fluctuations in activity levels. After sustained expansion in the early 1960s (annual growth rate of value added of 9.1 per cent from 1960 to 1965), industrial output plummeted until the late 1970s (annual growth rate of 5 per cent from 1966 to 1979). This slow down — the subject of intense discussion amongst Indian economists (Nayyar, 1994) — can be attributed to the restrictive regulatory framework, but also to the considerable drop in infrastructure investment over the same period (Ahluwalia, 1991). It is noticeable that, after rising at an average annual rate of 15 per cent in the first half of the 1960s, infrastructure investment rose by an average of just 5 per cent in the late 1970s. After the easing of domestic market regulations in the 1980s and thanks to the increase in public sector investment, industrial output gradually revived, growing at an average annual rate of 8 per cent between 1980 and 1990. After a decline to 1.1 per cent growth in 1991 due to the balance of payments crisis, following the reforms implemented in 1992 industrial growth resumed strongly up to 1996 (World Bank, 1996 and 1997).

Industrial Structure of Indian States

Our analysis is based on the 15 largest Indian States[4], which account for 85 per cent of the country's GDP. The manufacturing industry has been broken down into 17 industries[5], for which data on production, capital, employment, consumption of semi–finished products and of energy, and are available at the State level, from 1976 to 1992 (see *Appendix* 1 for the breakdown by industry, data sources, and methodological issues).

Indian States show marked inequalities in per capita income and productive structure. Real per capita income for the richest State (Punjab) is three times higher than for the poorest State (Bihar, see Table 1). The richest States are generally those that have a relatively developed industrial sector. Notable exceptions to this are Punjab and Haryana, where agriculture predominates. These two States benefited particularly, after the 1960s, from the "green revolution"; their exceptional agricultural productivity stems in large part from heavy investment in irrigation.

Table 1**. Industrial Structure of Indian States**
(1976–92 average)

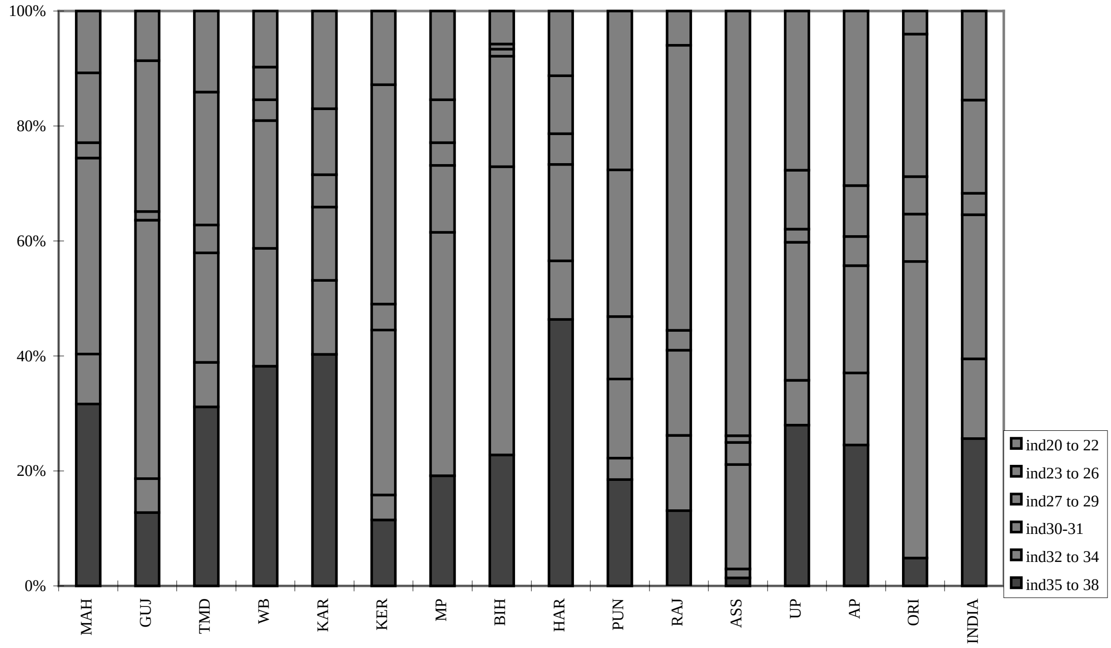
States	SDP per capita	Industrial VA/ SDP (%)	State manuf / India manuf (%)	States' Manufacturing Production Structure (%)		
(1)	1985 Dollars PPP	(2)	(3)	Consumption Goods	Intermediate Goods	Equipment Goods
MAH	2 879	35.0	23.6	44	31	25
GUJ	2 307	32.6	11.1	79	20	1
TMD	1 880	31.9	10.9	8	69	23
WB	1 941	30.8	6.5	36	51	13
KAR	1 837	26.3	5.2	27	27	46
KER	1 584	24.1	4.3	34	26	40
MP	1 438	22.7	4.5	55	33	11
BIH	1 030	22.0	5.7	26	43	32
HAR	2 819	20.9	3.0	27	54	19
PUN	3 243	20.0	4.1	35	60	5
RAJ	1 510	19.6	3.6	64	18	18
ASS	1 447	19.1	2.6	59	28	13
UP	1 418	18.3	7.1	42	27	31
AP	1 593	17.6	5.6	40	32	28
ORI	1 390	17.3	2.2	19	43	38

1. States are classified in decreasing order of industrial Value Added (VA) in total State Domestic Product (SDP).
2. State industrial VA as a share of SDP (in per cent).
3 Average share of State manufacturing in India manufacturing VA (in per cent).
Source: Authors' calculations (see *Appendix 1* for sources and definition of variables).

As shown in Table 1, the most industrialised States (industry — including mining, energy and construction — accounting for more than 30 per cent of their domestic product) are Maharashtra, Gujarat, Tamil Nadu and West Bengal. These States have 255 million inhabitants (1994), and account for 28 per cent of the total population of India. Their domestic product corresponds to 33 per cent of the country's GDP and, on their own, these four States generate 52 per cent of the value added for India's manufacturing as a whole (as it appears in our sample). The States where the industrial sector is the least developed (less than 20 per cent of domestic product) are Rajasthan, Assam, Uttar Pradesh, Andhra Pradesh and Orissa. Their population (322 million in 1994) represents 36 per cent of India's total but their domestic product only 26 per cent of that of the country. The value added for the industries in these five States amounts to 21 per cent of nation–wide manufacturing value added. The six States (Karnataka, Kerala, Madhya Pradesh, Bihar, Haryana and Punjab) with an industrial sector of between 20 and 30 per cent of the domestic product count for 27 per cent of India's manufacturing value added.

The contribution of heavy industry — intermediate (30 to 34) and capital goods (35 to 38) — to the States' industrial value added correlates positively with the size of their industrial sector. It represents 70 per cent of the value added in the four most industrialised States, 64 per cent in the six intermediate States, and 48 per cent in the five less industrialised States. The value added from production of capital goods as a percentage of that from production of consumption goods (20–21 to 29) is 92 per cent for the four industrialised States, but falls to 73 per cent for the six "intermediate" States and just 29 per cent for the five less industrialised States.

Figure 1. Industrial Structure of Indian States



Source: Authors' calculations (see *Appendix 1* for sources and definition of variables).

This pattern is depicted in Figure 1, which shows the industrial structure of States — compared with the nation–wide average — after grouping the 17 industries into five industrial sectors. Compared with the national average, the food products and beverage industries (20 to 22) are dominant in the less industrialised States, especially Punjab, Assam, Andhra Pradesh and Uttar Pradesh. The textile products and cotton textiles industries (23 to 26) are particularly developed in Rajasthan and Kerala, and also occupy a significant position in Gujarat, Tamil Nadu, Punjab and Orissa. The wood, paper and leather industries (27 to 29) are relatively more important in Punjab. Basic chemicals, plastics and petroleum (30 to 31) are particularly developed in Maharashtra and Gujarat. Basic metals–related industries and metals and non– metallic products (32 to 34) prevail in Madhya Pradesh, Bihar and Orissa, which are rich in natural resources. Finally, machine, transport equipment and other manufacturing industries (35 to 38) have a more substantial position than the national average in Maharashtra, Tamil Nadu, West Bengal, Karnataka, Haryana, and Uttar Pradesh.

A Composite Indicator for Indian States' Infrastructure Endowments

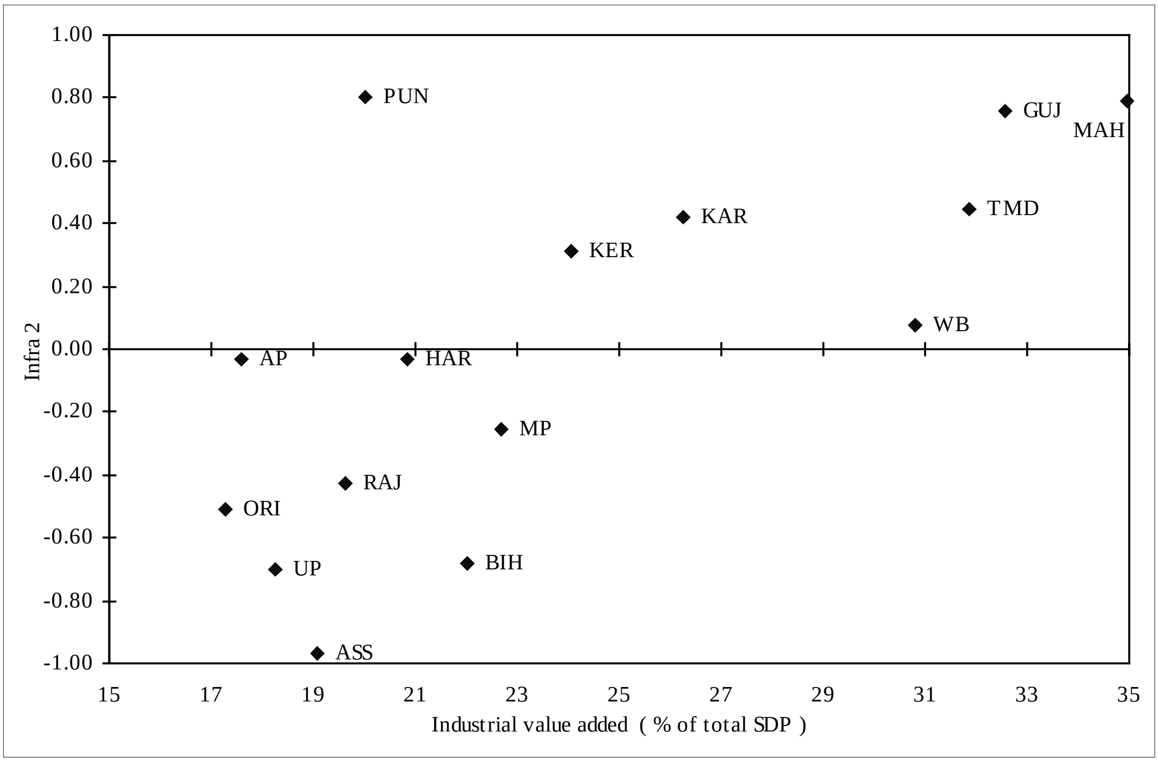
Indian States not only differ considerably in terms of economic performance and productive structure, but also display wide disparities in terms of physical, social and economic infrastructure. These differences have been assessed using 12 disaggregated infrastructure indicators (see *Appendix* 1 for definition of variables and sources of data).

Core infrastructure that can influence manufacturing productivity is proxied (subject to limits of available data) by per capita industrial electricity consumption (*Eli*), the density of the road (*Rte*) and rail networks (*Rail*), the number of vehicles per inhabitant (*Veh*) and the development of the postal system (*Post*). Social infrastructure indicators cover both educational development [literacy (*Lit*), primary (*Prim*) and secondary (*Sec*) school enrolment ratios] and health, as measured by the infant mortality rate (*Mort*). Finally, the three economic infrastructure indicators measure the density [bank branch offices per 1,000 inhabitants (*Bk*)] and the depth [deposits (*Dep)* and loans (*Cred*) as percentage of income] of each State's financial system. Existing empirical studies (see Berthélemy and Varoudakis, 1996 for a synthesis) have clearly established that the development of the financial sector can have a positive effect on productivity, as a result of better selection of investment projects and higher technological specialisation through diversification of risks.

To overcome the problems of multi–collinearity linked to correlation of these variables, we have developed a composite infrastructure indicator using principal–component analysis. The principal components were calculated, after logarithmic transformation, both from annual panel data (*Appendix* 2A) and from their average values for the 1976–92 period (*Appendix* 2B), with similar results. The composite indicator computed from annual panel data (*Infra1*) is used in the conditional convergence regressions for TFP (Section V); the composite indicator computed from averages (*Infra2*), in the regressions explaining differences in TE among States (Section VI).

These composite indicators are constructed as the weighted sum of the seven principal components that explain respectively 95 per cent (*Infra1*) and 98 per cent (*Infra2*) of the variance in the underlying individual indicators. The weight attributed to each principal component corresponds to its relative contribution to the variance of the disaggregated indicators (calculated from cumulative R^2)[7]. The contribution of each infrastructure type to the construction of the composite indicator can be computed as a linear combination of the weights associated with the seven principal components and the loadings of the individual indicators, as explained in Section V. This calculation shows that all of the indicators contribute as expected, i.e. negative for *Post* and *Mort* and positive for the other ten. Consequently, improved infrastructure availability (reduction in *Post* and *Mort* and increase in other indicators) results in an increase in the value of the composite indicator (*Infra1* or *Infra2*).

Figure 2. Infrastructure Level and Industrial Sector of Indian States



Source: Authors' calculations (see *Appendix 1* for sources and definition of variables).

These indicators reveal considerable disparities among Indian States. This is shown in Figure 2, which compares *Infra2* and the contribution of industry to State domestic product. As can be seen, the best equipped States, as far as infrastructure is concerned, are Maharashtra, Punjab and Gujarat, followed by Tamil Nadu, Karnataka and Kerala. Also significant is the positive relationship between the size of the industrial sector and availability of infrastructure. The mainly agricultural States have little infrastructure, with the notable exception of Punjab. This may reflect the influence of good infrastructure on the location of industrial activities, thereby exerting a positive influence on the size of the industrial sector.

III. THE PRODUCTION FUNCTION OF INDIAN MANUFACTURING INDUSTRIES: PANEL DATA ESTIMATES

We have chosen to estimate — using annual frequency panel data for each industry — a Cobb–Douglas production function, expressed as:

$$\ln(Y_{i,t}) = \alpha \ln(K_{i,t}) + \beta \ln(L_{i,t}) + \gamma_i \; T_i + \eta_t + \delta_i + u_{i,t} \quad (1)$$

where *Y, K, L* are, for each industry respectively, value added, capital and labour inputs; *T*, is a time trend specific to each State *i*, α and β are parameters common to all States.

The terms η_t represent fixed time effects. They reflect the impact of temporary events (oil shocks, etc.) that affect the growth rates of certain industries at the same time in all States and which are not accounted for by other explanatory variables. They are captured by a dummy variable for some specific time periods. The terms δ_i represent productivity factors specific to each State which do not vary over time. Differences in productivity levels can be related to factors (not taken into account in the regression), such as the characteristics of natural resources or quality of institutions.

Table 2 gives the results of the estimations. Samples are unbalanced, due to missing values in industrial survey data for some States. The maximum number of observations is 255 (i.e. 15 States $\times$ 17 years), most of the manufacturing industries having between 230 and 250 observations. The heteroscedastic bias in standard deviations has been corrected using White's estimator. The production functions were estimated using the fixed–effects method, except for industry 20–21, for which the hypothesis of an intercept common to all States could not be rejected by the Fisher test. Moreover, the Hausman specification tests show that the estimation of a fixed–effects model is preferable to that of a random–effects model, with the exception of industry 23, 25 and 32. However, as the capital and labour elasticities are only very slightly different for both types of models for industry 25 and 32, we preferred keeping the fixed effect estimation, with the aim of subsequently analysing the differences in fixed effects across States. The random effect model had to be used for industry 23. The estimation of the production function for this industry required, in addition, the use of time fixed effects. In the case of industry 27, we accept the fixed effects model at the 10 per cent level.

The Indian industries exhibit significant differences in production functions. The hypothesis of constant return to scale is accepted in slightly less than half of cases (eight out of seventeen: i.e. industries 20–21, 22, 23, 24, 25, 26, 27 and 34), whereas the other industries show decreasing return to scale (28, 29, 30, 31, 32, 35–36, 37 and 38). Increasing returns to scale are detected in just one industry (33). Interestingly, consumption goods industries show constant returns to scale, whereas heavy industries (intermediate and capital goods) show decreasing returns to scale (with the exception of metal products and parts and basic metal industries, which appear to have constant and increasing returns to scale respectively)[8].

Similarly, the estimated output elasticities with respect to production factors vary among industries. Capital elasticity is close to 0.3 (in almost half the industries). In the other cases, it is somewhat low (0.19–0.23) or very low (0.12–0.16)[9], capital elasticities are however best analysed in conjunction with those for labour. As the latter are generally higher for light industries (which show, as we have seen, constant returns to scale), the ratio of the two elasticities (capital to labour), is lower in light industries compared to heavy industries. This corresponds to the difference in capital intensity which is usually observed in the two types of industry (that is, light industries being less capital intensive than heavy industries)[10].

Our production–function estimates also reveal differences in the pattern of technical progress across States. The significance of such differences was tested by introducing a time trend specific to each State and was generally not rejected by Fisher specification tests (Table 2). Only industry 20–21, 23, 25, 31 and 32 show a trend common to all States (not significant in industry 23 and 25). These trends are also highly variable, their dispersion being particularly high for industry 27 and 38, and, to a lesser extent, 33. This finding raises the question of differences in TFP performance across States, to which some answers are provided later.

Finally, these time trends also allow us to check for differences in productivity growth among industries. The overall trend (directly estimated in the case of a trend common to all States, or calculated as the average of the State–specific trends, Table 2) turns out to be zero or negative for industries 22, 23, 24, 25, 26, 27, 33 and 34, and low for industries 28 and 35–36 — i.e. in consumption goods industries on the one hand and metal products and capital goods on the other. The overall trend, therefore, shows low productivity in Indian manufacturing as a whole, with the exception of a small number of industries where growth seems to be driven by productivity gains — food products (20–21), leather (29), basic chemicals (30), and, to a lesser to extent, rubber–petroleum (31), non–metallic mineral products (32) and transport equipment (37). Overall, heavy industry shows the highest productivity gains. This suggests the possibility of economies of scale in these industries. Such a potential could have been accentuated in the case of India, to the extent the industrial policy of the country led to a high concentration of capital in the heavy industry and to a dispersion in the case of the light one (see Section II.b).

Table 2. **Estimation of Production Functions of Indian Manufacturing Industries**
Dependent variable: logarithm of value added (y)

Independent variables	Manufacturing Industries[2]																
	20-21[2]	**22**[2]	**23**[2]	**24**[2]	**25**[2]	**26**[2]	**27**[2]	**28**	**29**	**30**	**31**	**32**	**33**	**34**[2]	**35-36**	**37**	**3**
k	0.52	0.22	0.31	0.16	0.34	0.23	0.36	0.12	0.03	0.43	0.32	0.34	0.19	0.14	0.32	0.16	0
	(5.2)	(4.3)	(5.9)	(2.5)	(2.7)	(2.0)	(2.2)	(1.6)	(0.4)	(6.4)	(6.2)	(4.8)	(1.7)	(2.3)	(4.4)	(2.4)	(3
l	0.48	0.79	0.69	0.84	0.66	0.77	0.64	0.61	0.62	0.25	0.51	0.45	1.36	0.86	0.43	0.55	0
								(3.5)	(3.6)	(2.6)	(5.4)	(3.0)	(8.8)		(2.9)	(4.4)	(2
Trend	0.07	-0.01[3]	0.00	-0.01[3]	0.00	-0.001[3]	-0.114[3]	0.01[3]	0.083[3]	0.053[3]	0.03	0.02	-0.074[3]	-0.012[3]	0.009[3]	0.021[3]	0
	(7.6)	*0.025*[4]	(0.32)	*0.046*[4]	(1.0)	*0.038*[4]	*0.08*[4]	*0.026*[4]	*0.054*[4]	*0.046*[4]	(3.0)	(1.8)	*0.05*[4]	*0.019*[4]	*0.014*[4]	*0.032*[4]	*0*
Fisher test[5]	0.5	2.0 **	1.8 *	3.9 **	1.3	3.5 **	2.2 **	2.3 **	5.6 **	6.0 **	1.0	0.1	3.3 **	1.6 **	2.3 **	2.7 **	8
Returns to scale	cst	cst	cst	cst	cst	cst	cst	*dec*	*dec*	*dec*	*dec*	*dec*	*incr*	cst	*dec*	*dec*	*de*
Fisher specification test	1.40	3.6 **	7.5 **	4.4 **	11.2 **	10.9**	1.8 *	6.0 **	10.6 **	7.5 **	8.2 **	15.7 **	21 **	4.0 **	6.1 **	5.8 **	7
Hausman specification test	0.01	14.4 **	0.36	13.4 *	0.02	14.6 **	18.8	44 **	362.4**	133.9**	99.6 **	0.7	30.8 **	75.7 **	71.9 **	104.7**	83
Number of observations	237	248	254	212	141	225	212	252	190	249	246	253	232	251	252	242	216
R^2 adjusted	0.41	0.73	0.53	0.68	0.53	0.75	0.33	0.92	0.95	0.93	0.90	0.95	0.90	0.51	0.98	0.96	0

Note : All equations have been estimated using the fixed effects method, except in the case of industry 21 for which the pooling model has been selected industry 23 where a random effect model has been used. Time dummy variables have been included in the estimate of equation 23. * (**) indicates that specification tests were significant at 5% (1%) level. Constant terms are not reported here for convenience. The heteroscedasticity bias of standard er has been corrected by using the White's estimator. Student's tests are in parentheses. The estimation period is 1976-92.

1. Definition of manufacturing industries is given in *Appendix* 1.
2. These equations have been estimated in an intensive form, after having accepted the hypothesis of constant return to scale.
3. The value reported here is the average of States' specific trends.
4. Standard deviation of States' trends.
5. We test here the hypothesis of a common trend across States.

y = logarithm of value added, k = logarithm of capital and l = logarithm of labour (see definition and sources of variables in *Appendix* 1).

IV. TOTAL FACTOR PRODUCTIVITY AND GROWTH ACCOUNTING

Industrial Total Factor Productivity of Indian States

Given our estimates of the production functions, TFP can be computed for each manufacturing industry and State as follows[11]:

$$\ln(TFP_{i,t}) = \ln(Y_{i,t}) - \alpha \ln(K_{i,t}) - \beta \ln(L_{i,t}) \qquad (2)$$

Table 3 shows differences in average TFP levels among States for each industry over the 1976–92 period, that are computed with respect to the average TFP level of the most productive State (set to 100). The most industrialised States and those which are better equipped with infrastructures, perform well in a number of manufacturing industries. This is the case of Maharashtra, which has the highest productivity level in heavy industries (with the exception of basic metals, 33) and paper (28). Performance is also satisfactory for light industries. The second most productive State is Tamil Nadu, followed by West Bengal, Karnataka, Gujarat and Uttar Pradhesh. Tamil Nadu performs especially well in several heavy manufacturing (with the exception of 33 and 38), and also in light manufacturing (except in 24 and 26). West Bengal, like Karnataka, performs well, especially in heavy industry, as does Gujarat in some light and heavy industries. Uttar Pradhesh performs comparatively well in light manufacturing.

Productive performances for the two rich agricultural States (Punjab and Haryana) are satisfactory in certain consumption goods industries (food products, 20–21, beverages, 22, textile products, 26, for Punjab; food products, 20–21, wood, 27, and paper, 28, for Haryana). Haryana also posted reasonable results for some heavy industries (metal and non–metallic mineral products, 32 to 34; capital goods and transport equipment, 35 to 37). Finally, a few special cases should be pointed out, such as the good performance of Assam in food products (20–21) and petroleum (31) and that of Bihar in beverages (22) and basic metal products (33). Kerala also shows a satisfactory level of productivity in some consumption goods industries (food products, 20–21; wool, 27; jute, 25; paper, 28).

Overall, the State with the best performance by far is Maharashtra, which has the advantage of being the most productive in the industries which show the highest productivity. The industrial nature of this State and its strong presence in the best performing industries explain its especially favourable position. The two States with next best performances, Gujarat and Tamil Nadu, are followed by West Bengal, Uttar Pradhesh and Karnataka. Except Uttar Pradhesh, these are again the States the most industrialised and best equipped with infrastructures. Finally, Haryana and Punjab fare poorly, despite satisfactory performance in certain industries.

Table 3. **Average TFP level of Indian States and Industries**
(period 1976–1992)

States	20–21	22	23	24	25	26	27	28	30	31	32	33	34	35–36	37	38
	Industries															
AP	69	18	63	23	38	20	33	66	34	49	73	22	46	60	26	29
ASS	98	30	68	22	17	18	35	20	10	93	29	32	56	18	10	7
BIH	49	**100**	52	11	26	9	30	40	17	72	56	17	38	44	66	13
GUJ	62	26	95	63	70	26	30	50	68	88	59	16	57	53	24	41
HAR	93	46	79	44	18	40	**100**	65	24	58	63	24	57	56	54	28
KAR	64	79	84	28	90	26	42	63	36	30	68	21	93	61	51	56
KER	77	33	91	65	**100**	38	25	64	38	81	48	**100**	55	36	24	47
MAH	75	37	91	66	36	53	51	**100**	**100**	**100**	**100**	14	**100**	**100**	**100**	**100**
MP	73	89	61	54	21	18	41	61	28	25	89	22	66	57	26	13
ORI	50	46	60	47	29	13	36	53	12	19	77	36	37	28	15	8
PUN	**100**	74	85	60	34	**100**	27	27	26	32	23	31	45	32	44	35
RAJ	70	45	94	41	32	48	35	26	29	47	66	28	64	41	22	28
TMD	73	76	**100**	50	76	32	50	88	50	83	95	14	73	73	71	45
UP	61	74	59	48	76	51	25	46	41	56	42	17	48	57	30	35
WB	58	70	58	**100**	76	38	27	56	33	62	63	7	67	62	51	64

Source: Authors' calculations (see *Appendix 1* for sources and definition of variables).

Accounting for Indian Manufacturing Industries' Productivity Performances

Indian manufacturing industries differ also considerably in terms of productivity growth. These differences can be analysed through a growth accounting exercise. Table 4 shows manufacturing average labour productivity growth, as well as contribution of changes in capital and in TFP. The opposite patterns between heavy and light industry noticed previously, can be observed again. Light industry generally records low to negative average growth rates in both labour productivity and TFP, with the exceptions of food products, and jute (20–21, and 25). Consumption goods industries therefore show, over the period studied, an absence of net productivity gains.

The findings for heavy industry are different. Several industries report quite strong productivity gains (30, 31, 32, and 38). Performances in other manufacturing industries (35–36 and 37) remain satisfactory. Only the metal products industries (33 and 34) showed no productivity growth[12]. Thus, our analysis shows that Indian heavy industry exhibited a higher growth potential, in terms of TFP, than the light industry.

Table 4. **Contribution of Production Factors and of TFP to Measured Labour Productivity Growth**

Manufacturing Industries	Y/L	αK/L	(β+α–1)L	TFP
	growth rate (%)			
20–21	10.2	3.4		6.8
22	0.3	1.4		-1.1
23	1.2	1.1		0.1
24	-0.3	1.1		-1.5
25	5.2	2.4		2.8
26	1.3	1.7		-0.3
27	-8.2	2.4		-10.6
28	1.0	0.6	-0.5	0.9
30	5.0	0.7	-1.1	5.4
31	4.0	2.8	-1.5	2.7
32	3.2	2.1	-0.9	1.9
33	-4.3	0.8	2.2	-7.3
34	-0.6	0.6	3.8	-5.1
35–36	1.1	1.1	-0.9	0.9
37	2.2	0.9	2.3	-1.0
38	9.4	1.4	-1.2	9.2

Source: Authors' calculation.

It is instructive to look at these results along with the export performances of Indian manufacturing industries. From 1985 to 1995, manufactured exports accounted on average for 73 per cent of total Indian exports, intermediate and capital goods representing half of these exports (Table 5). Manufacturing exports showed, in addition, the highest rate of progression (between 10 and more than 20 per cent of annual growth rates). The more dynamic industries were chemical products, engineering goods and other manufactures. These results clearly illustrate the link between TFP improvement and export performances of Indian industries. Therefore, the importance of implementing policies that improve manufacturing productivity so as to better integrate world goods markets comes out clearly.

Table 5. **Export Performances of Indian Manufacturing Industries**
(Average1985–1995)

	Exports (% of total)	Exports' growth (in %)
Primary exports	**27.3**	**6.0**
Agricultural products	12.8	5.3
Iron ore	3.5	1.3
Other primary	11.0	10.7
Manufactured exports	**72.7**	**12.3**
Textile	9.5	17.3
Ready–made garments	9.6	10.5
Leather manufacture	6.7	6.4
Gems–jewellery	12.5	12.7
Chemical products	7.6	22.9
Petroleum products	6.1	9.5
Engineering goods	15.1	18.3
Other manufactures	6.8	19.6
Total exports	**100**	**10.4**

Source: Authors' calculation from World Bank (1996).

V. THE ROLE OF INFRASTRUCTURE IN TOTAL FACTOR PRODUCTIVITY GROWTH

Conditional Convergence of Total Factor Productivity across States

There is by now strong evidence that the rather low contribution of TFP to measured labour productivity growth can be partly due to the industrial policy implemented up to the mid 1980s (Section II.a.). As far as we are concerned, we focus on the role of infrastructure in explaining the relative poor performances of Indian manufacturing productivity.

Most empirical studies on the subject of infrastructures, carried out to date, have focused on the United States and have produced mixed results. Munnell (1990) and Garcia–Milà and McGuire (1992) — respectively using both aggregate and disaggregate measures of public capital (highways, education spending) — identified a positive impact on private–sector productivity. Evans and Karras (1994) confirmed this result only for capital invested in education. From a slightly different angle, Mullen, Williams and Moomaw (1996) demonstrated that public capital can explain differences in productive efficiency in manufacturing industry across the States of the United–States.

However, Hulten and Schwab (1991) found no significant elasticity in manufacturing output in relation to public capital at the regional level. Kopp (1995) also observed an absence of significant effects of public capital for German Länders. Similarly, Holtz–Eakin (1994) showed that taking account of fixed effects when estimating regional production functions in the United States cancels out the productive impact of public capital. More recently, Garcia–Milà, McGuire and Porter (1996), using disaggregated indicators for physical infrastructure (highways, water supply and sewage systems) showed that the effect of public capital is positive in estimations of regional production functions in “levels" form, but disappears when the functions are estimated with first order differences. However, as Munnell noted (1992), there is no reason *a priori* to prefer either of these specifications. Estimation using first order differences also raises conceptual problems, as it erases the possible long–term relationship between public capital and productivity.

Our purpose is to build on existing empirical work at the regional level, by assessing the impact of infrastructure on Total Factor Productivity (Section V) and Technical Efficiency (Section VI) of India’s manufacturing. The differences of TFP growth across States are explained for each industry. Our estimates are based on a conditional convergence equation in which the long–run equilibrium productivity level of each State is supposed to depend on the level of infrastructure that this State possesses. Our conditional convergence equations have been estimated on an annual frequency panel data set and are expressed as follows:

$$\ln(TFP_{i,t}) - \ln(TFP_{i,t-1}) = \alpha_i - \beta \ln(TFP_{i,t_{-1}}) + \gamma \ Infra1_{i,t-1} + \eta_t + u_{i,t} \qquad (3)$$

$TFP_{i,t}$ is the level of Total Factor Productivity for State i, and $TFP_{i,t-1}$ its previous period level. $Infra1_{i,t-1}$ is the aggregated indicator for infrastructure already presented (Section II), and β and γ are parameters common to all States.

As we have mentioned, by using an aggregate infrastructure indicator we hope to overcome the difficulties of estimating the impact of a large number of indicators that may have collinear relationships. Our method allows for subsequent calculation of the contribution of initial indicators to productivity growth performance for the various industries. The calculation is based on the estimated elasticity of the aggregate indicator, as well as on the weights of each principal component in the aggregate indicator and on the loadings of the initial variables in each principal component.

Table 6 gives the results of the estimations. The industry samples are unbalanced due to missing observations. The estimation period is the same: 1976–1992. The heteroscedastic bias of standard deviations is corrected with the White estimator. The equations are estimated using the fixed effect method, the hypothesis of a common intercept for all States being rejected by the Fisher test. Hausman specification tests show that the estimation of a fixed effect model is preferable to that of a random effect model, with the exception of industry 24 and 28. Furthermore, the estimations for industry 26, 27, 28, 33 and 34 required the use of time fixed effects for some years.

Our estimates reveal, for all industries, conditional convergence of TFP (negative coefficient for delayed value of TFP — first row of Table 6). Nevertheless, individual industries show very different patterns with respect to the implicit speed of convergence. Convergence is fast for industry 20–21, 25, 26 and 34, and slow for industry 24 and 28.

The findings also validate the positive impact of infrastructure on the long–run level of TFP of Indian manufacturing industries. The impact of infrastructure appears, at first sight, quite different from one industry to another. TFP growth in industries 27, 34, 38, as well as in industries 20–21, 26 and to a lesser extent, 30, seems to be more sensitive to the availability of infrastructure. Knowing that industries 26, 27 and 34 have shown negative rates of TFP growth (Section IV), this result indicates that these industries might have been particularly hindered by a lack of infrastructure. These results complement the findings by Nagaraj, Varoudakis and Véganzonès (1998) which show, at a more aggregated level, that infrastructure is an important factor explaining long–run growth of Indian States.

Table 6. **Estimation of TFP Growth of Indian Manufacturing Industries**

Dependent variable: $\ln(TFP_t) - \ln(TFP_{t-1})$

	Manufacturing Industries[1]															
Independent variables	**20-21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**30**	**31**	**32**	**33**	**34**	**35-36**	**37**	**38**
$\ln(TFP_{t-1})$	-1.0	-0.87	-0.76	-0.37	-0.95	-0.84	-0.66	-0.42	-0.58	-0.74	-0.78	-0.65	-0.88	-0.72	-0.74	-0.50
	(24.8)	(12.3)	(12.2)	(6.8)	(12.1)	(9.8)	(8.8)	(7.5)	(8.0)	(9.9)	(11.2)	(10.2)	(11.6)	(8.1)	(8.7)	(9.0)
Infra1	0.45	0.03	0.15	0.22	0.32	0.41	0.56	0.13	0.39	0.24	0.17	0.13	0.57	0.06	0.17	0.56
	(3.0)	(0.34)	(2.9)	(3.0)	(3.4)	(2.8)	(3.5)	(2.0)	(3.7)	(1.9)	(3.1)	(0.8)	(3.6)	(1.8)	(2.4)	(4.8)
Fisher specification test	2.3 **	8.5 **	1.9 *	3.0 **	4.3 **	6.6 **	2.1 **	3.3 **	3.6 **	4.3 **	6.8 **	4.8 **	7.8 **	7.4 **	7 **	5.4 **
Hausman specification test	12.5 **	21.4 **	2.6	6.3	17.5 **	9.5 **	22 **	10.5	7.2 *	18.2 **	26.7 **	15.1 **	11.5 *	13 **	21.5 **	8.7 **
Number of observations	207	232	238	194	120	199	188	235	230	227	237	207	233	234	223	191
R^2 adjusted	0.76	0.41	0.34	0.16	0.56	0.44	0.52	0.27	0.28	0.31	0.34	0.38	0.48	0.33	0.36	0.36

Note: Equations have been estimated using the fixed effects method, except in the case of industry 24 and 28 for which the random effect model has been selected. * (**) indicates that the specification tests were significant at 5% (1%) level. Time dummy variables have been necessary to estimate equations 26, 27, 28 33, and 34. 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 1976-92.

TFP = Total Factor Productivity, *Infra1* = Aggregate indicator of infrastructures (see definition of variables in *Appendix 1*).

The Impact of Infrastructure on Long–Run Productivity by Manufacturing Industry

The impact of each type of infrastructure can be computed as follows: Let P be the vector (1xn) of n principal components selected and δ the vector (nx1) of their weights in the aggregate infrastructure indicator. Furthermore, the n principal components are expressed as a linear combination of initial variables such that *P = AX*, *X* being the vector (kx1) of k infrastructure variables, and A represents the matrix (kxn) of loadings assigned to them. In our case, n = 7 and k = 12. The composite infrastructure indicator is expressed as: *Infra1* = δ *P* = δ *A X*. Denoting by γ the estimated coefficient for this indicator, the convergence equation can be written:

$$\ln(PGF_{i,t}) - \ln(PGF_{i,t-1}) = \alpha_i - \beta \ln(PGF_{i,t_{-1}}) + \gamma\ \delta\ A\ X_{i},_{t} + \eta_t + u_{i,t} \qquad (4)$$

The vector (kx1) (*E*), expressing the impact on productivity growth of the original infrastructure variables, can be calculated such that *E* = $\gamma\ \delta\ A$. These coefficients are estimated for each industry from equations in Table 6 and from the loadings summarised in *Appendix* 2A. However, given the standardisation procedure for variables associated with the principal components method, the contribution of variations in level of each infrastructure variable to productivity growth is expressed by the previously calculated coefficient (e_i), divided by the standard deviation for each variable (e_i/σ_i). The elasticities of the long–run TFP level with respect to different types of infrastructure is then obtained by dividing the impact coefficients by the convergence coefficient (β). Table 7 gives these long–run elasticities for each manufacturing industry.

A number of conclusions can be drawn from this table. Firstly, the social infrastructure approximated by the education and health variables shows the greatest impact on industrial TFP growth (this being true especially for education). Another interesting result of this effect is the greater impact of primary education compared to secondary education. This result, which can be related to the low level of development of Indian States, involves that improving access to primary education could be a source of big productivity improvements in manufacturing industries. Moreover, improving health conditions turns out to have a significant impact on productivity which is approximately the same as that for secondary education.

The second item of importance, after primary education and literacy, is financial development, as represented by three indicators. The number of branch offices of banks per 1 000 population shows the greatest impact on productivity growth, the ratio of deposits and loans to State Domestic Product shows an elasticity of the same order of magnitude, but lower than that for the number of branch offices. This result is all the more significant in the Indian context, as the country was long subject to a controlled financial policy regime with hindered the development of financial intermediaries and the mobilisation of savings.

Finally, our regressions also establish a significant impact of core infrastructure on TFP. The impact of power generation infrastructure, proxied by industrial power consumption, is highest, and is of the same order of magnitude as that for financial development. That for road transport, captured by per capita

Table 7. Impact of Infrastructure Variables[1] on Growth and Steady-state Level of TFP

Long-run elasticities

	Manufacturing Industries[1]													
	20-21	**23**	**24**	**25**	**26**	**27**	**28**	**30**	**31**	**32**	**34**	**35-36**	**37**	**38**
Eli	0.42	0.14	0.56	0.33	0.48	0.83	0.30	0.60	0.31	0.21	0.63	0.08	0.22	1.09
Rte	0.13	0.05	0.18	0.11	0.15	0.27	0.09	0.19	0.10	0.07	0.20	0.03	0.07	0.35
Veh	0.28	0.09	0.37	0.22	0.32	0.56	0.20	0.40	0.21	0.14	0.42	0.06	0.15	0.73
Rail	0.09	0.03	0.12	0.07	0.10	0.18	0.06	0.13	0.07	0.04	0.13	0.02	0.05	0.23
Post	-0.17	-0.06	-0.23	-0.14	-0.20	-0.34	-0.12	-0.24	-0.13	-0.08	-0.26	-0.03	-0.09	-0.45
Lit	0.76	0.26	1.02	0.60	0.87	1.52	0.54	1.09	0.56	0.38	1.15	0.15	0.41	1.98
Prim	0.96	0.33	1.29	0.77	1.11	1.93	0.68	1.38	0.72	0.48	1.47	0.20	0.51	2.52
Sec	0.33	0.11	0.44	0.26	0.38	0.66	0.23	0.47	0.25	0.16	0.50	0.07	0.18	0.87
Mor	-0.38	-0.13	-0.51	-0.30	-0.43	-0.75	-0.27	-0.54	-0.28	-0.19	-0.57	-0.08	-0.20	-0.99
Bk	0.55	0.19	0.74	0.44	0.64	1.11	0.39	0.79	0.41	0.27	0.84	0.11	0.30	1.45
Dep	0.45	0.15	0.61	0.36	0.52	0.91	0.32	0.65	0.34	0.22	0.69	0.09	0.24	1.19
Cred	0.41	0.14	0.55	0.33	0.47	0.82	0.29	0.59	0.31	0.20	0.63	0.08	0.22	1.08

1. Definition of variables and industries is given in *Appendix 1.*

Source : Authors' calculation.

number of vehicles (which are mainly utility vehicles in India) and the density of the road network, comes in second place. The rail and postal networks seem, nevertheless, to have a lower impact on TFP.

However, it is interesting to notice that, due to budgetary constraints, infrastructure bottlenecks are not in the way of being reduced. Table 8 shows trends in infrastructures components of public spending, as a share of GDP, during 1988–96 period. It can be seen that, since the acceleration of reforms in 1991–92, productive public expenditures have been proportionally more reduced than average spending. This is particularly the case of economic expenditures (current as well as capital), among which energy and transport–telecommunication. Public investment in these fields of activity have been strongly hurt, hindering industrial growth capacity. But, social expenditures have also been stagnant. Current spending in education and health — which is already rather low at respectively around 3 and 1 per cent of GDP — have been slowly falling during the same period. It can be noticed that the States' governments are strongly involved in productive public spending. Their contribution in financing social expenditures reach almost 90 per cent and their share of economic spending 50 to 90 per cent (Table 8, last column). In the context of budgetary constraints, reallocation of public spending toward the most productive uses would be highly supportive to industrial productivity and sustained growth. At the same time, other ways of developing core infrastructures should be investigated, by involving the private sector and foreign capital to the financing of priority projects.

Table 8. **Public Expenditures** (% GDP)

(% GDP)		1988–90	1991–92	1993	1994	1995	1996	1993–96 States' expenditures (% of total)
Current expenditures		**27.2**	**27.2**	**26.8**	**26.9**	**26.5**	**26.4**	*50.9*
of which	*social*	*5.8*	*5.6*	*5.4*	*5.3*	*5.3*	*5.4*	*89.8*
	education	3.1	3.1	2.9	2.9	2.9	2.9	*91.6*
	health	1.0	0.9	0.9	0.9	0.9	0.8	*90.7*
	economic	*7.1*	*7.1*	*6.6*	*6.4*	*6.3*	*5.9*	*59.0*
	energy	0.4	0.6	0.4	0.5	0.4	0.3	*87.0*
	transport–telecom	0.7	0.6	0.6	0.6	0.6	0.5	*70.9*
Capital expenditures		**7.9**	**6.4**	**5.3**	**5.5**	**5.0**	**5.0**	*42.1*
of which	*social*	*0.4*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	*83.1*
	education–health	0.1	0.1	0.1	0.1	0.1	0.1	*91.9*
	economic	*3.0*	*2.5*	*2.2*	*1.9*	*2.1*	*1.5*	*66.2*
	energy	0.5	0.4	0.2	0.2	0.2	0.1	
	transport–telecom	0.8	0.7	0.7	0.5	0.5	0.4	*48.1*

Source: World Bank (1996).

To get some more insight into the effort that remains to be done in spending on broad infrastructure, it is useful to compare India with China. During 1990–95, China spent on average 2.3 per cent of its GDP on education. The corresponding figure for India over the same period was 2.9 per cent. It should be noticed however that, although China's population is 30 per cent higher than India's, its GDP (measured in PPP constant dollars) is 1.5 time bigger than India's. Consequently, over the first half of the 1990s, China spent on average 50 per cent more than India on education in per capita terms. The extent to which India is lagging behind in this area is all the more impressive if one recalls that the illiteracy rate in adult population is almost one–half lower in China than in India (27 per cent against 52 per cent in early 1990s). On the basis of the above figures, India should spend on education around 4.5 per cent of its GDP if it were to equate China's per capita education spending. This figure should of course be increased further for the existing gap in educational attainment between the two countries to be bridged in the medium term.

The elasticity calculations point, in addition, to some industries which seem to be comparatively most constrained by infrastructure bottlenecks. The intermediate and capital goods industries seem to be the most sensitive to the availability of infrastructure (basic chemicals, 30, metal products, 33–34, equipment, 35–36, and other manufacturing industries, 38). These industries have been previously identified as the comparatively most productive and better export performing ones. Some consumption goods industries show, however, a big sensitivity to infrastructure (wool, 24, and wood industries, 27, in particular). Improving infrastructure availability seems therefore important to support further productivity improvements in most dynamic industries, as well as an increased integration of the country into the world economy.

VI. DIFFERENCES IN TECHNICAL EFFICIENCY ACROSS STATES AND THE ROLE OF INFRASTRUCTURE

The estimations of the production functions presented in Section III (Table 2) reveal significant differences among the fixed effects associated with the different States for almost all manufacturing industries. Put simply, for the same level of production inputs, the output for each industry varies greatly with location. In each industry, a State can be identified for which a given level of inputs produces a maximum level of output, whereas other States produce below this technical boundary. Furthermore, these differences are systematic, as indicated by Hausman tests of the fixed–effects versus the random effect model.

Following the study by Mullen, Williams and Moomaw (1996), we interpret these differences in productivity among States as differences in technical efficiency (TE) that do not vary over time[13]. In each industry, the State for which the production function shows the highest fixed effect is considered to be the State which is at the technological frontier, hence 100 per cent efficient. The other States can then be ranked in descending order of TE, depending on the levels of fixed effects associated with them. This implies reformulating the production function (1) as follows:

$$\ln(Y_{i,t}) = \delta_i + \alpha \ln(K_{i,t}) + \beta \ln(L_{i,t}) + \gamma_i\, T + \eta_t + u_{i,t} \quad \text{with} \quad \delta_i = \delta - \varepsilon_i \quad \text{and} \quad \varepsilon_i \geq 0 \qquad (5a)$$

The non–negative term ε_i represents the technical inefficiency of each State *i*. This is measured from estimation of the fixed effects of (5a) as:

$$\varepsilon_i = \delta - \delta_i = \max(\delta_i) - \delta_i \qquad (5b)$$

A Technical Efficiency indicator (E_i) for each State in each industrial branch is then developed, using $E_i = \exp(-\varepsilon_i)$. Our estimates for TE by State are given in Table 9.

Maharashtra exhibits maximum efficiency in five out of the fourteen industries considered. It is ranked second in four other industries. This high level of efficiency shows up in the heavy intermediate and capital–goods industries, with the exception of basic metals (33). Tamil Nadu and West Bengal have the same sectoral TE pattern as Maharashtra, albeit with relatively lower levels.

Our working hypothesis is that the observed differences in TE among States can be partly attributed to differences in physical, economic and social infrastructure. To check this hypothesis, we have attempted to test to what extent our composite indicator for infrastructure availability has a significant influence on efficiency differences. Given that, in our calculation, TE of the States is assumed not to vary over time, we used the composite indicator *Infra2* developed from the average values for 12 disaggregated infrastructure indicators for the 1976–1992 period (see *Appendix* 2B and Figure 2). Given the limited number of observations by industry, and to take into account the possible correlation between the pattern of efficiency differences for each industry, we carried out a *simultaneous* estimation of the TE

Table 9. **Technical Efficiency of Indian Manufacturing Industries**

States	Manufacturing Industries[1]													
	22	**24**	**25**	**26**	**27**	**28**	**30**	**31**	**32**	**33**	**34**	**35**	**37**	**38**
AP	0.23	0.17	0.37	0.09	0.04	0.65	0.28	0.49	0.73	0.71	0.44	0.58	0.38	0.48
ASS	0.39	0.21	0.17	0.11	0.14	0.15	0.14	0.92	0.29	0.73	0.59	0.18	0.17	0.00
BIH	**1**	0.39	0.26	0.02	0.09	0.33	0.05	0.72	0.56	0.10	0.39	0.40	**1**	0.02
GUJ	0.26	**1**	0.68	0.08	0.14	0.56	0.56	0.88	0.59	0.21	0.62	0.51	0.26	0.36
HAR	0.40	0.65	0.16	0.14	**1**	0.73	0.14	0.57	0.62	0.69	0.86	0.59	0.38	0.31
KAR	0.55	0.19	0.81	0.09	0.12	0.65	0.26	0.30	0.68	0.26	**1**	0.51	0.57	0.63
KER	0.24	0.67	**1**	0.20	0.12	0.59	0.31	0.81	0.48	**1**	0.64	0.30	0.31	0.55
MAH	0.39	0.81	0.34	0.15	0.15	**1**	**1**	**1**	**1**	0.19	0.99	**1**	0.94	0.93
MP	0.61	0.44	0.20	0.08	0.12	0.78	0.23	0.25	0.89	0.22	0.56	0.57	0.19	0.19
ORI	0.32	0.67	0.28	0.04	0.12	0.72	0.21	0.18	0.77	0.35	0.34	0.24	0.12	0.22
PUN	0.53	0.67	0.33	**1**	0.07	0.16	0.12	0.32	0.23	0.40	0.72	0.34	0.60	0.52
RAJ	0.36	0.49	0.31	0.16	0.50	0.19	0.23	0.46	0.66	0.61	0.62	0.37	0.15	0.40
TMD	0.57	0.37	na	0.12	0.16	0.90	0.60	0.83	0.95	0.21	0.91	0.73	0.85	0.38
UP	0.38	0.66	na	0.24	0.10	0.51	0.33	0.56	0.42	0.27	0.50	0.43	0.29	0.24
WB	0.53	na	na	0.14	0.17	0.73	0.28	0.62	0.63	0.09	0.67	0.79	0.70	**1**

1. Manufacturing Industries are defined in *Appendix 1*.

equations using the seemingly unrelated regressions (SUR) method. As the SUR estimation requires an equal number of observations per estimated equation, we had to eliminate industries 24 and 25, for which data were missing for one and three States respectively. The estimation used 180 observations (15 States and 12 industries).

The second explanatory variable for differences in technical efficiency was the share of the agricultural sector (*Agri*) in State Domestic Product. The expected effect of this variable on TE is negative. This is so, firstly, because agricultural States generally have scattered rural populations, meaning that enterprises cannot benefit from agglomeration economies that would increase their efficiency. Secondly, the relatively small size of the industrial sector in agricultural States can reduce the scale of external economies enjoyed by enterprises in more industrialised States, which are also source of improved efficiency.

The variables were transformed into logarithms so that the coefficients could be compared and the results interpreted in terms of elasticities. Furthermore, the structural coefficients and intercept are assumed to be common to all industries, so that the estimated effects should be interpreted as average effects on the aggregate manufacturing industry. The results of the estimation are presented in Table 10 (A). As can be seen, the relative size of the agricultural sector exhibits a negative effect on technical efficiency of States. The positive sign of *Infra2* also confirms that differences in infrastructure constitute an additional predictor for differences in efficiency among States.

Table 10**. Estimation of Technical Efficiency (A) and Impact of Desaggregated Infrastructure Variables (B)**

(A)		(B)	
Dependent variable	Independent variable ln(*Eff*$_i$)	Eli	0.18
		Rte	0.04
Infra2	0.18	Veh	0.16
	(2.6)	Rail	0.03
Agri	-0.52	Post	-0.11
	(3.4)	Lit	0.30
constant	0.85	Prim	0.46
	(1.5)	Sec	0.13
		Mort	-0.15
Number of observations	180	Bk	0.30
Estimation method: SUR		Dep	0.22
		Cred	0.19

Eff = Technical Efficiency, *Infra2 =* Aggregate indicator of infrastructures, *Agri* = Agriculture Value Added in total SDP (definition of variables is given in *Appendix 1).*

Source: Authors' calculation.

The contributions of disaggregated infrastructure indicators to the productive efficiency of States are presented in Table 10 (B). The relative order of magnitude of elasticities shows a similar pattern as the estimations of impact on TFP presented in the previous section (Table 7). In this case it is, however, interesting to note that road and rail network density does not have a significant impact on technical efficiency differences across States. Among elements of core infrastructure, electricity consumption by industry, the number of vehicles, and postal system density apparently play an important role in efficiency. This appears to be a fairly reasonable result, as power generation shortages carry a risk of disorganisation of industrial production and insofar as availability of transport (vehicles) and communication (postal services) allow for improved production efficiency by reducing inherent delays at various stages of production.

In addition, the level of educational development of States plays a significant role in explaining differences in productive efficiency. In a manner consistent with the previous results, development of primary education explains a far more substantial part of efficiency than secondary education. This is also true for variables capturing the level of development of State financial sectors, which also account for differences in TE.

VII. CONCLUSION

In this study we reviewed the low performances in Total Factor Productivity of Indian manufacturing industries. To explain there industrial performances, we focused on the role of broadly measured infrastructure. We showed that differences in infrastructures endowments across Indian States explain in a significant way their differences in industrial performances. This is true for Total Factor Productivity, as well as for Technical Efficiency. Our results are stronger than that usually found in the case of the regions of developed countries (the United States in particular). This provides support to the idea that lack of infrastructure can bring to a halt growth in developing economies (World Bank, 1994). A high risk of bringing the growth momentum to a halt seems to exist in India, since the major part of the States faces strong infrastructure bottlenecks. Our results show, therefore, that enhancing equipment in infrastructures can constitute a powerful engine of industrial take off.

Our study allows, moreover, identification of the industries where Total Factor Productivity and Technical Efficiency and, therefore, competitiveness and export capacity, depend particularly on infrastructure. An increase of public investment will show a comparatively stronger impact on those industries which could become the leading sectors of the manufacturing. This result constitutes an even more important means of appreciating the positive impact of public investment policies, since India will be increasingly integrating into the world economy. In fact, with the implementation in 1991 of economic reform based on an outward looking policy, India export capacity strengthening could be seen as a priority.

Improving manufacturing productivity can also be seen as a powerful factor of convergence of labour productivity at the State level. In the case of India, the regional disparities are still significant and have been increasing over time. These growing inequalities entail a risk of compromising the reforms and adjustment of the economy. Targeting public investment on infrastructures that favour the convergence of industrial productivity most can constitute an important element of a strategy of balanced regional growth. In this context, investment in primary education shows a comparatively high return in terms of Total Factor Productivity growth and Technical Efficiency gains. Moreover, reforming the financial system in order to improve its efficiency in the mobilisation of deposits and the distribution of credit could be an efficient and low opportunity cost mean to promote industrial growth. Finally, as far as core infrastructure is concerned, our findings confirm that enhancing the potential of power production appears to be, in the case of India, a key factor in increasing industrial Total Factor Productivity and Technical Efficiency.

NOTES

1. In comparison, according to IMF (1997) estimates, the average annual growth rate of per capita GDP in Asian countries, during the first three years following the implementation of a SAF programme, was slightly above 2 per cent.

2. See Nishimizu and Page (1986) for an examination of the link between Domestic Resource Cost (DRC) indices of international competitiveness and changes in TFP.

3. For a detailed report on Indian industrial policy and performance, see Ahluwalia (1991) and (1995).

4. Andhra Pradesh (AP), Assam (ASS), Bihar (BIH), Gujarat (GUJ), Haryana (HAR), Karnataka (KAR), Kerala (KER), Madhya Pradesh (MP), Maharashtra (MAH), Orissa (ORI), Punjab (PUN), Rajasthan (RAJ), Tamil Nadu (TMD), Uttar Pradesh (UP), West Bengal (WB).

5. Food products (20–21), beverages and tobacco (22), cotton textiles (23), wool, silk and man–made fibre textiles (24), jute and other vegetable fibre textiles (25), textile products (including wearing apparel) (26), wood and furniture (27), paper and printing industries (28), leather (29), basic chemicals and chemical products (30), rubber, plastics, petroleum and coal products, processing of nuclear fuels (31), non–metallic mineral products (32), basic metal industries (33), metal products (34), machinery and equipment (35–36), transport equipment (37), other manufacturing industries (38).

6. In spite of the weak industrial orientation of the State (less than 20 per cent of total SDP), Uttar Pradesh being a very populated State, participates to a non negligible percentage of the industrial production of the country (7 per cent, just before West Bengal, Table 1).

7. In the case of *Infra1* for example, the first component is weighted by 53/95, the second by (70–53)/95, etc (see *Appendix* 2B).

8. In the latter case, however, the especially high labour elasticity (1.36) and the weakly significant capital elasticity could suggest estimation or data problems. Conclusions will therefore be viewed cautiously in the case of this sector.

9. It is not significant for industry 29 (leather), which may be due to data or estimation problems. This sector will be eliminated from the analysis.

10. Some special cases should, however, be mentioned. Industries 33, 34 and 37 (metal products and transport equipment) have an exceptionally low capital elasticity in relation to labour — the case of basic metals (sector 33) being peculiar as we have already pointed out. Conversely, two sectors have a very high capital elasticity: food products (20–21) and basic chemicals (30). Although this makes sense for basic chemicals, it might be questionable for food products.

11. In the rest of this document, industry 29 has been excluded due to the unsatisfactory estimate of the production function (see Section III).

12. However, it should be remembered that sector 33's results should be considered cautiously, given the problems with estimating the production function (Section III).

13. Wu (1995) acknowledges that his estimates of sectoral technical efficiency for China's provinces can vary with time. These variations are, however, modelled in a relatively arbitrary manner by non–linear time trends.

APPENDIX 1. SOURCES OF DATA AND DEFINITION OF VARIABLES

1. Manufacturing Industry Data

The data for production, intermediate consumption, energy, capital and labour are taken from the annual industrial survey. They are available per State for 1976–77 and 1992–93 for 17 manufacturing industries:

- Industry 20–21: Food products,
- Industry 22: Beverages and tobacco,
- Industry 23: Cotton textiles,
- Industry 24: Wool, silk and man–made fibre textiles,
- Industry 25: Jute and other vegetable fibre textiles (except cotton),
- Industry 26: Textile products (including wearing apparel),
- Industry 27: Wood and wood products, furniture and various fixtures,
- Industry 28: Paper and paper products, and printing, publishing & allied industries,
- Industry 29: Leather and products of leather, fur & substitutes of leather,
- Industry 30: Basic chemicals and chemical products (except products of petroleum and coal)
- Industry 31: Rubber, plastics, petroleum and coal products, processing of nuclear fuels,
- Industry 32: Non–metallic mineral products
- Industry 33: Basic metal and alloys industries,
- Industry 34: Metal products and parts, except machinery and equipment,
- Industry 35–36: Machinery and equipment other than transport equipment (manufacture of scientific equipment, photographic/cinematographic equipment and watches & clocks is classified in industry 38),
- Industry 37: Transport equipment and parts,
- Industry 38: Other manufacturing industries,

Industry 20–21 and 35–36 have been aggregated due to a change in survey method from 1989–90. Similarly, industry 39 (equipment repairs), which did not exist before that date, has not been taken into account.

Although the survey methodology is consistent from State to State and over time (apart from the 1989–90 change), some States show missing values for some years. Similarly, for some States, some manufacturing industries have sometimes been aggregated due to problems in data collection. The years concerned have had to be eliminated. As a result, the number observations varies depending on the industry and differs most of the time from the 255 observations expected (17×15 States). Due to lack of information, some States have been eliminated from the sample for some manufacturing industries: Kerala, for industry 24; Haryana, Punjab and Rajasthan for industry 25; and Assam and Kerala for industry 29 and 38. The number of observations for manufacturing industries is given in Table 2.

The survey data for production, intermediate consumption, energy and capital are expressed in current prices. Accordingly, they have been deflated by the corresponding wholesale prices. This has led us, in the case of intermediate consumption, to construct a special price indicator for each manufacturing industry as a function of the composition of intermediate consumption taken from the Inputs/Outputs national accounting table. Labour is expressed in numbers of employees.

2. Infrastructure Data

Various indicators of physical, social and economic infrastructure are available per State for 1970 to 1993. The indicators used are as follows:

1 – Electricity

Eli: per capita industrial electricity consumption (in kWh).

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

2 – Roads

Rte: length of road network (number of km per 1,000 sq.km).
Veh: number of motor vehicles per 1,000 inhabitants.

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

3 – Railways

Rail: length of rail network (number of km per 1,000 sq.km).

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

4 – Post

Post: thousand inhabitants per post office.

Source: Director General of Posts and Telegraphs, Department of Communication, published in SAI.

5 – Education

Lit: literacy level (as % of age group).
Prim: primary school attendance (6–11 years of age, as % of age group).
Sec: secondary school attendance (11–17 years of age, as % of age group).

Source: HRD Ministry's Educational Statistics, CMIE.

6 – Health

Mort: infant mortality (as %)

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

7 – Banks

Bk: number of branch offices per 1 000 inhabitants.
Dep: bank deposits as percentage of SDP.
Cred: bank loans as percentage of SDP.

Source: Reserve Bank of India: annual statistical tables on Indian banks.

3. Other Data

The State domestic product (SDP) data used in this study come from the Central Statistical Organization (CSO) where inter–state comparable estimates have been elaborated from the series published by the States Statistical Bureaus (SSBs).

Based on these data, we have built time series at 1980 prices for per capita SDP and SDP per sector of activity. The SDP breaks down as follows: *Agriculture* (agriculture, forestry, fishing); *Industry* (mines, manufacturing enterprises (registered or not); construction, electricity, gas and water); and *Services* (transport, storage and communications; trade, hotels and restaurants; banking and insurance; property; public administration; other services). The demographic data are taken from the Registrar General, *Census of India*.

APPENDIX 2A

Principal Components Analysis
(15 States, annual data 1976–92)

Component	Eigenvalue	Cumulative R^2
P1	6.35	0.53
P2	2.00	0.69
P3	1.07	0.78
P4	0.58	0.83
P5	0.54	0.88
P6	0.46	0.92
P7	0.36	0.95

Infrastructure variables *	Loadings **						
	P1	P2	P3	P4	P5	P6	P7
Eli	0.67	0.52	0.20	0.03	0.26	0.22	0.20
Rte	0.57	-0.39	-0.64	0.15	0.20	0.00	0.06
Veh	0.81	0.24	0.36	0.19	-0.11	0.19	-0.005
Rail	0.27	-0.71	0.37	0.31	0.37	-0.19	-0.03
Post	0.05	-0.83	0.22	-0.27	-0.08	0.38	0.11
Lit	0.91	-0.06	-0.26	-0.004	0.05	0.19	-0.02
Prim	0.79	0.19	-0.07	-0.28	0.30	0.09	-0.33
Sec	0.77	-0.28	0.20	0.005	-0.27	-0.09	-0.33
Mort	-0.79	0.24	0.36	-0.11	0.29	-0.01	-0.09
Bk	0.83	0.29	0.07	0.32	-0.12	-0.001	0.01
Dep	0.85	-0.16	0.24	-0.21	-0.03	-0.23	0.24
Cred	0.85	0.16	-0.02	-0.33	-0.003	-0.30	0.10

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

APPENDIX 2B

Principal Components Analysis
(15 States, average levels 1976–92)

Component	Eigenvalue	Cumulative R^2
P1	6.21	0.52
P2	2.30	0.71
P3	1.29	0.82
P4	0.73	0.88
P5	0.56	0.92
P6	0.37	0.95
P7	0.28	0.98

Infrastructure variables *	Loadings **						
	P1	P2	P3	P4	P5	P6	P7
Eli	0.68	0.60	0.19	0.09	0.23	0.25	0.03
Rte	0.56	-0.46	-0.57	-0.23	0.24	0.004	0.001
Veh	0.74	0.41	0.47	-0.15	-0.001	0.04	-0.10
Rail	0.26	-0.65	0.49	-0.14	0.44	-0.20	0.06
Post	0.08	-0.85	0.27	0.21	-0.08	0.37	-0.04
Lit	0.89	-0.14	-0.27	-0.02	0.08	0.21	-0.14
Prim	0.77	0.12	-0.23	0.47	0.24	-0.12	-0.17
Sec	0.77	-0.3	0.28	-0.01	-0.31	-0.20	-0.28
Mort	-0.80	0.31	0.30	0.21	0.24	-0.02	-0.08
Bk	0.82	0.33	0.08	-0.42	-0.03	0.05	0.05
Dep	0.85	-0.23	0.25	0.19	-0.10	0.002	0.29
Cred	0.88	0.11	-0.12	0.30	-0.14	-0.13	0.18

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

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