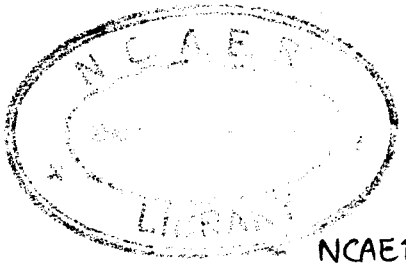
Working Paper Series No. 70

Industrial Corridors in India



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March 2000

ISBN - 81-85877-46-7

Price
Rs. 150.00
US$ 10.00

Published by

P.K. Krishnaswamy, Registrar & Secretary, NCAER, for and on behalf of
National Council of Applied Economic Research
Parisila Bhawan, 11-Indraprastha Estate
New Delhi-110002

Designed by
Rakesh Kumar Srivastava

and

Printed at
Kriti Graphics
Tel: 6405360, 6411381, 6411388

CONTENTS

ABSTRACT

This study identifies industrial corridors (two or more contiguous districts) in India with a special emphasis on their further potential. Using Principal Component Analysis, the study finds that there are five major and three minor industrial corridors in the country. The distribution pattern of these corridors reveals the domination of the western and the southern part of India. The northern region does have a large corridor around Delhi. The western coastal region is found to be the region with the highest level of industrial activity in the country. The southern part of the country has the maximum proportion of districts covered by a major or minor corridor. The eastern region however has only two corridors -- a major one around Calcutta, and a minor one in the north-east.

JEL Classification
C43, R12, R30

Keywords
Industrial Corridors, Agglomeration, India, Principal Components Analysis, Factor Analysis

I. INTRODUCTION AND SUMMARY

Appropriate location of any productive activity is one of the key factors in its success. Hence, be it agriculture, manufacturing, or services, the proper location of any activity can determine whether it succeeds or fails. This paper studies various locations in India as the destinations for manufacturing activity. Specifically, based on latest available data, it attempts to identify the 'good' locations of manufacturing activity in the country.

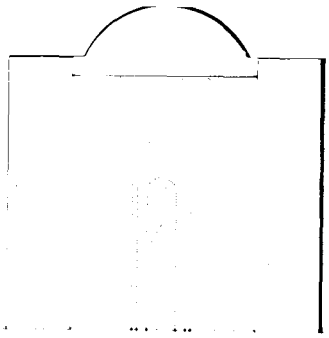
What is a good location for a manufacturing activity? Admittedly, the answer to this question depends upon the characteristics of the particular activity. For some industrial sectors closeness to major inputs is important, for others the climatic conditions might be of paramount importance. This paper attempts to identify the locations on the basis of factors that affect *all manufacturing activity*. Thus the paper attempts to differentiate various regions in the country on the basis of their manufacturing activity. The identification of these locations requires a three-step procedure.

1. Identification of the most important characteristics of a good location.
2. Collection of relevant measures of those characteristics.
3. A single rating of all the districts – based on a system that is able to integrate the position of a particular district vis-à-vis the various characteristics identified as important.

This study further develops this procedure by identifying *industrial corridors* (two or more contiguous districts) with a special emphasis on their further potential. It therefore becomes necessary to measure not only current manufacturing activity but also other factors that support this activity. These other factors, in many but not all cases, also reflect socio-economic development. This study however focuses on characteristics that are conducive to manufacturing activity.

Characteristics of a 'Good' Location

There are many location specific factors that affect the functioning of a manufacturing activity. Apart from infrastructure support, a 'good' location for any activity essentially requires the presence (of at least some) of:



- Adequate and skilled labour force.
- Easy access to inputs.
- A large market for its produce.
- Connectivity with the rest of the economy.
- Other backward and forward linkages.

Availability of natural resources, particularly mineral resources, and adequate water availability may be other important factors.

A detailed survey of the literature on Industrial location activity was conducted. (Section 2 summarizes the literature survey conducted.) The bulk of the relevant discussion in the literature is contained in two broadly defined sets of previous studies: (a) the debate on industrial dispersal policies and, (b) the promotion of infrastructure facilities in various parts of the country. In addition, some domestic and international surveys regarding the same have also been conducted. It was found that infrastructure related issues play a key role. Other factors that play an important role are mentioned below:

- Forward and backward linkages,
- Social infrastructure,
- Living conditions,
- Presence of human capital in the vicinity, and
- Level of industrial activity in the area.

Measures of the Important Characteristics

The poor state of infrastructure in India is generally regarded to be one of the key factors hindering its economic development. These infrastructure facilities, including, Power, Roads, Railways, Ports, Pollution Control facilities, Telecom, and so forth, all need to be improved and expanded considerably. India ranks amongst the lowest in infrastructure facilities, this is reflected in the Table 1.

Table 1
Infrastructure Rankings of Select Developing Countries
(Rankings among 53 Countries; Of which 18 were Developed, and 35 were Developing Countries)

	India	South Africa	Argentina	Brazil	China	Indonesia	Mexico	Malaysia
Infrastructure	**48**	26	36	47	40	22	39	8
Overall Infrastructure Quality	**53**	21	33	41	50	34	43	19
Quality of Roads	**52**	14	36	44	39	25	37	21
Quality of Railroads	**34**	12	40	47	32	36	46	31
Quality of Air Transport	**51**	21	40	29	52	33	30	22
Quality of Ports	**53**	18	31	52	42	37	45	23
Quality of Telephones and Faxes	**48**	30	31	47	43	36	38	27
Power Generation Capacity	**53**	16	26	44	52	31	39	38
Warehousing & Distr. System	**53**	18	35	36	52	43	42	28
Road Density	**43**	34	29	17	51	44	41	33
Rail Density	**4**	8	-	23	3	19	16	33

Source: *The Global Competitiveness Report, 1997.*

Table 1 presents the relative infrastructure environment of selected countries. It is evident from the given table that except for the rail density, in terms of all other indicators, India is one of the poorest in the world. It ranks forty eight. in the overall infrastructure availability index among the 53 major countries in the report. Only five countries, namely, Ukraine, Poland, Jordan, Russia and Zimbabwe are ranked below India.

Studies reveal that considerable disparities are existing among the Indian states.

It was however not possible to determine the availability of infrastructure facilities at a good enough level of dis-aggregation (the district level). This is because adequate and recent infrastructure data at the district level was not available. This problem was circumvented by placing relatively more emphasis on other factors that *reflect* the level of infrastructure in the district, and therefore are highly correlated with the presence of infrastructure facilities. These *proxy variables* include those reflecting presence of factories, level of urbanization, presence of national highways, workforce involved in manufacturing activities, etc. in the district. Many variables were identified as relevant and for which appropriate data was available. (*See* section 3 for more details.) The following

were some of the important factors that were eventually included in the study:

- Workforce involved in non-household manufacturing,
- Households using cooking gas and those having sanitation, electricity and safe drinking water facilities, and having pucca houses,
- Literacy,
- Consumption of HSD and motor spirit,
- Bank deposits,
- Number of scheduled commercial banks,
- Bank credit to industry,
- Non- agricultural establishments, and those with power,
- Degree of urbanization and number of large towns, and
- Access to national highways, etc.

Once the appropriate variables were identified with the help of the relevant literature survey, the data collected and codified, the procedure based on a *factor analytic model* was adopted. This is briefly mentioned below. (*See* section 4 for details)

Developing a Single District Level Rating for Manufacturing Activity

Since many factors affect the level and attractiveness of manufacturing activity in a district, it is essential to form a *composite index*. This composite index should incorporate many variables into one single measure. There are different means to form a composite index. The key problem in developing a composite index is that related to the process of integrating various measures into a single measure. The identification of weights assigned to different measures is one such issue in the creation of a composite index. One way to do this is to use the subjective preferences of managers/investors to identify the magnitude of the weights assigned to each factor.

Another method, which reduces subjectivity, is to use a type of Factor Analytic Model called *Principal Components Analysis* (henceforth PCA). PCA is one of the best methods of computing composite indices where the analysis involves relatively low levels of subjectivity on part of the researcher. This well used econometric tool assigns weights to variables based on the relationships among them and therefore minimizes subjectivity. Section IV further discusses this.

Identifying Industrial Corridors

Once a composite index for all the districts was created, it was possible to study the various parts of the country that possessed a high rating. When two or more contiguous districts were seen to possess a high rating they were identified to be the part of an industrial corridor. Thus it was possible to identify five major and three minor industrial corridors in the country.

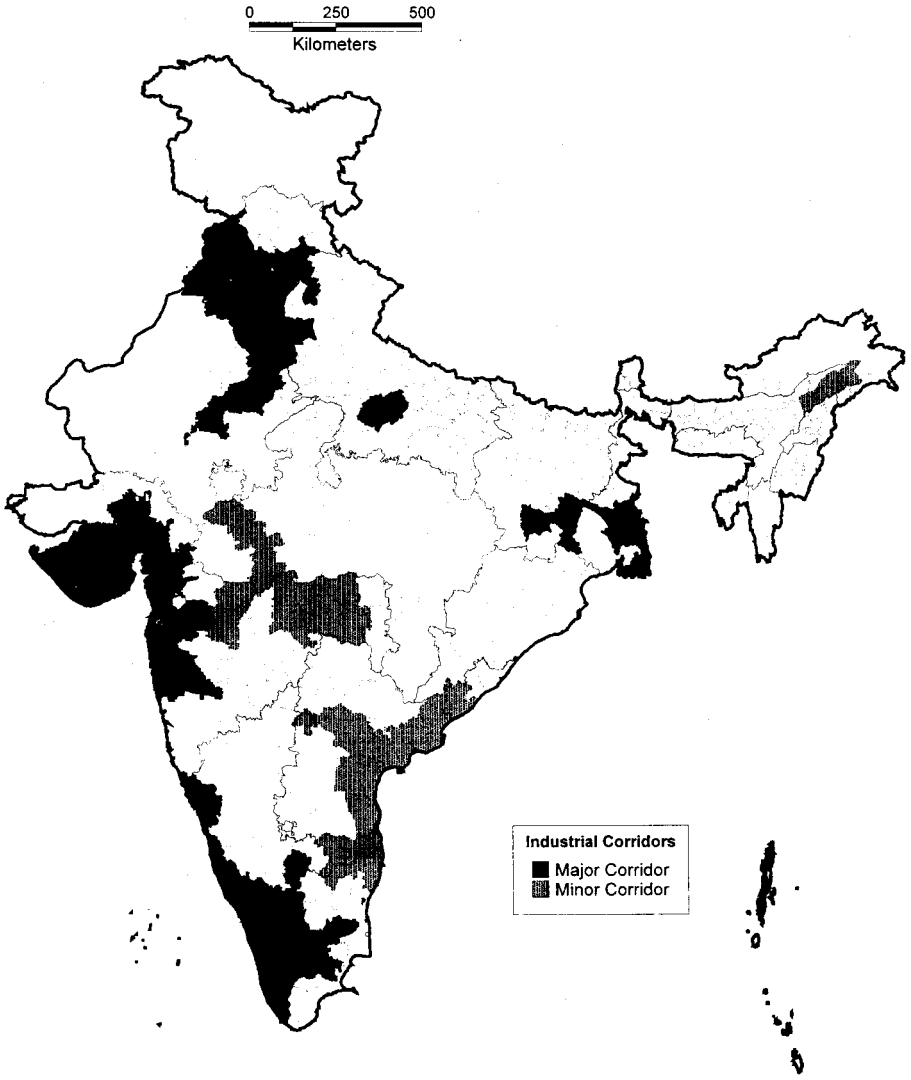
The main Industrial Corridors identified are presented in Figure 1. Along with these major corridors, minor corridors have also been identified which are presented in the same figure. To keep the discussion simple, further discussions will concentrate on all industrial corridors – irrespective of their importance. It should be noted that while demarcating the corridors a few districts are included within the corridors that did not receive a high rating. These districts play the role of connecting districts, as they are located between stretches of highly rated districts.

The distribution pattern of these corridors reveals the domination of the western and the southern part of India.[1] The western coastal region is found to be the region with the highest level of industrial activity in the country. This region is gifted with natural locational advantages. The presence of major and a large number of minor/intermediate ports has further facilitated the development of the region. Among the other corridors, the northern corridor is stretched over a region that has grown very fast in agriculture during past two/three decades. Besides these major corridors, a few minor corridors have also been identified by this study. A detailed discussion on the corridors is in the later part of this paper.

Table 2
Identified Major Industrial Corridors of India

Corridors	Districts	Geographical Region
Major Corridors		
Western Corridor	Junagadh, Jamnagar, Rajkot, Amreli, Bhavnagar, Surendranagar, Mehasana, Gandhinagar, Ahmedabad, Kheda, Vadodara, Bharuch, Surat, Valsad, Nasik, Thane, Pune, Raigad	This corridor stretches from southern Gujarat region to the Konkan coast of Central Maharashtra.
Northern Corridor	Ludhiana, Jalandhar, Patiala, Rupnagar, Kapurthala, Amritsar, Bhatinda, Faridkot, Ferozpur, Gurdaspur, Hoshiarpur, Sangrur, Ambala, Faridabad, Karnal, Kurukshetra, Panipat, Rewari, Rohtak, Sirsa, Yamunanagar, Sonipat, Bhiwani, Hissar, Jaipur, Ajmer, Ghaziabad, Meerut, Dehradun, Haridwar, Solan, Sirmaur, Simla.	It stretches out in the geographical region from northern Gangetic plain, and includes the foot hills.
South-Western Corridor	South Goa, North Goa, Uttar Kannad, Dakshin Kannad, Bangalore Urban, Bangalore Rural, Kasargod, Kannur, Kodagu, Kozhikode, Mysore, Wayanad, Malappuram, Nilgiri, Periyar, Coimbatore, Thrissure, Ernakulam, Kottayam, Thiruchirapally, Madurai, Pathanamthitta, Iduki, Alappuza, Kollam, Thiruvanantapuram, Kamrajar, Chidambaranar, Tirunelveli Kottabomman, Kanyakumari.	This long elongated corridor spreads from southern Konkan Coastal area including the entire Malabar coast. It also covers a substantial part of the southern Deccan region.
Eastern Corridor	Calcutta, North 24-Parganas, Haora, Hugli, Nadia, Barddhaman, Dhanbad, Ranchi, East Singbhum	This narrow corridor is extended from Gangetic delta to the Chhotanagpur Plateau.
North-Central Corridor	Kanpur, Lucknow	A small corridor in western UP
Minor Corridors		
Central Corridor	Ratlam, Ujjain, Indore, Dewas, East Nimar, Jalgaon, Aurangabad, Akola, Amravati, Wardha, Nagpur, Yavatmal And Chandrapur.	This corridor runs between the Malwa region and the northern Deccan areas.
South - Eastern Corridors	Rangareddy, Hyderabad, Guntur, Krishna, West Godavari, East Godavari, Vishakhapatnam, Madras, Chengai- Anna, North Arcot, Chittoor, Nellor	This region extends from the north coastal Andhra Pradesh to northern part of Tamilnadu covering Hyderabad and Rangareddy.
North - Eastern Corridor	Tinsukia, Jorhat, Dibrugarh and Sibsagar	This region extends from Jorhat to Tinsukia district of Assam.

INDIA
INDUSTRIAL CORRIDORS



The focus here, as has been stated before, is on the identification of areas that possess good locational advantages for manufacturing activities. In doing so the basic analysis is conducted at the district level. District level analysis offers the main advantage that it is at a much more disaggregated level than region or state specific analysis that is sometimes conducted. This allows the study of such issues for almost the whole country, and few areas need to be excluded from the purview of the study. Note that the 'district' being the unit of analysis, enabled the identification of Industrial Corridors that are spread across more than one state.

The rest of the paper proceeds as follows. A brief literature review is presented in Section II. Section III presents a discussion on the variables used, and their sources. Section IV discusses the methodology used as well as the identification of the industrial corridors. Section V analyses the results obtained, it also discusses other factors such as presence of ports, natural resources and rainfall in the various corridors identified. Section VI takes a closer look at the corridors identified and discusses the various bottlenecks in the districts comprising the corridors. The last section concludes.

II. INDUSTRIAL LOCATION IN INDIA: A BRIEF LITERATURE REVIEW

That the lack of appropriate infrastructure facilities is acting as a major bottleneck in the economic growth/development in India is already well known.[2] The Government of India has traditionally been the main investor in these areas. However, limited funds have seriously hampered the growth of this sector. The need to speed up the development process further underscores the urgency of building a good infrastructure network in the country. Though recent policy changes have welcomed private investments (both foreign and Indian) in this area, it is unlikely that the resource requirements would be adequate to meet the requirements for the whole country in the near future. Therefore, the key issue that relates to the improvement of infrastructure facilities is how best to utilize the limited resources available.

The literature suggests that generally policies on industrial location have aimed at a fair distribution of industries across the entire geographical areas of a country or region.[3] Experiences from many countries suggest that mostly these policies remained ineffective and failed to disperse the industries in the desirable direction.[4] The failure of these policies calls for understanding the underlying dynamics of industrial location decisions. The most important role played in industrial locations is probably the presence of a certain level of economies of scale. Concentration of resources, capital as well as labour, along with the availability of basic infrastructure for industries are of the prime importance for location decisions. This also calls for an efficient operation of backward and forward linkages in the region of location which is achieved through a complimentary manufacturing activities in the vicinity. A strong backward and forward linkage provides the firms the advantage of working in an environment with lower transport cost for acquiring the raw materials as well as for marketing of the finished products. Other facilities such as provision of banking, transport operation etc. also work at a more efficient level with a certain amount of conglomeration in the industrial activities. The other important factor to be mentioned is the easy availability of skilled labour force within the region which is possible only if there is a presence of a considerable number of industries in a region. The above discussion reveals that the concentration of industries is the culmination of a few decisive factors which are essential for the smooth operation of industrial activities.[5]

Studies suggest that there was hardly any indication of existence of industrial location policies in India before independence.[6] At the time of independence the Indian industries were mostly concentrated in a few nodes such as Calcutta, Bombay, Madras, Ahmedabad etc. It was found that most of the major ports had been developed as large industrial centres at that time.[7] This pattern was a reflection of the colonial rule in the country. With the progress of time the Indian government started taking more interventionist role in the location decisions of the industries. Most of the regional policies have come into effect since late sixties only. One of the firsts in pioneering the dispersal efforts was that of the government of the state of Maharashrta. The initial impetus for evolving an industrial dispersal policy was provided by the emerging problems of congestion

and a deteriorating conditions of the civic and other amenities and services in the fast growing region of Bombay. A wide range of policies and programmes were undertaken to arrest the growth of industries in the Bombay-Thane-Pune belt and creation of supporting infrastructures in other areas of the state.[8]

Since the beginning of the planning, the Central Government has stressed on the industrial development of the backward areas of the country. The first five year plan mentioned that "if industrial development in the country is to proceed rapidly and in a balanced manner, greater attention will have to be paid to the development of these states and regions which have so far remained backward."[9] The plan, however, only pointed out the large potential of industrial development in several backward states and observed that it would be desirable in order to secure a balanced regional development in the country. In all other five-year plans it was suggested that the dispersal should be aimed towards developing the backward areas so that the differences in the levels of development between different regions is progressively reduced.[10]

In 1968 the Central Government set up two working groups to identify the backward areas of the country and the incentives to be extended to these areas for promoting industrial growth. The responsibility of identification of the backward areas was given on the 'Pande Working Group' and the 'group' recommended a set of criteria to identify industrially backward states and union territories. Broadly, the criteria for identifying the backward areas were location of the area, poverty level of the people and population density in relation to its productive resources and employment opportunities. The list of criteria recommended for the identification of the industrially less potential states and union territories by the 'Pande group' is given below:
a) total per capita income; b) per capita income from industry and mining; c) number of workers in registered factories; d) per capita annual consumption of electricity; e) length of the surfaced roads in relation to the population and the area of the state; and f) railway mileage in relation to the population and the area of the state. On the basis of these criteria the Pande group recommended, and the government of India approved, that the following industrially less potential states and the union territo-

ries that should qualify for special treatment by way of incentives for industrial development.[11]

The Pande group also recommended the following criteria or indicators of less potentials, for identification of the less potential districts in the less potential states of the country.

1) Districts should be outside a radius of about 50 miles from larger cities and large industrial projects.
2) Poverty of the people as indicated by low per capita income starting from the lowest to 25 per cent below the State average.
3) High density of population in relation to utilization of productive resources and employment opportunities as indicated by :
   (i) low percentage of population engaged in secondary and tertiary activities (25 per cent below the State average may be as less potential);
   (ii) low percentage of factory employment (25 per cent below the state average may be considered);
   (iii) non-and/or underutilisation of economic and natural resources like minerals, forests, etc.;
   (iv) adequate availability of electric power or likelihood of its availability within the next one or two years;
   (v) availability of transport and communication facilities or likelihood of their availability within the next one or two years; and
   (vi) adequate availability of water or likelihood of its availability within the next one or two years.[12]

The Working Group on "Fiscal and Financial Incentives for Starting Industries in Backward Areas" commonly known as the Wanchoo Working Group recommended a set of incentives. In pursuance of the decisions of the committee of the National Development Council, the planning commission evolved the following criteria for identification of the industrially backward districts :

1) Per capita food grains/commercial crops production depending on whether the district is predominantly a producer of food grains or cash crops;
2) Ratio of population to agricultural workers;

3) Per capita industrial output;
4) Number of factory employees per lakh of population or alternatively, number of persons engaged in secondary and tertiary activities per lakh of population;
5) Per capita consumption of electricity; and
6) Length of surfaced roads in relation to population or railway mileage in relation of population.[13]

Studies, such as Finance Commission Report for 1995-2000 (1994), Mitra, A. and others (1998), have shown considerable disparities among the Indian states in term of availability of infrastructure facilities.[14] The state-wise *infrastructure index,* as presented in the Finance Commission Report is given in Appendix 1. The positive influence of good infrastructure on industrial performance is also well established.[15]

In India efforts to disperse industries are found in different forms, such as, rural industrialization programmes, encouraging industrial estates, metropolitan planning in different states, promoting industrial development in the backward areas etc. All the industrial policy resolutions highlighted the intensification and spread out of industrial activities in different regions to achieve a balanced regional development. An exhaustive study by *Sekhar* (1983) suggests that the promotion of 'industrial estates' in the country did not achieve its objective.[16] His study reveals that in the mid 1970s about 30 per cent of the completed sheds in the country were not operating. In rural areas the situation was even worse as half of the completed sheds were not functioning. In comparison to the rural areas the urban industrial estates were in much better situation with about 75 per cent of the completed sheds operating properly. He argues that the improper choice of location of the places for these industrial estates were the major cause for their disfunctioning. *The basic requirements for the industries, such as, transportation facilities, availability of raw materials, availability of skilled labour, presence of market for the finished products etc. were inadequate in most of the cases.*

The overall experience of the effectiveness of the industrial dispersal policies seems not to be very encouraging. International experience on reducing the concentration of industrial activities shows that such attempts are more or less ineffective.[17] This is because these policies were

aimed towards dispersal of industrial activities without considering other factors that are essential for industrial development. Equity was given priority over efficiency.[18] It is important to maintain a balance between equitable distribution and efficiency so that the operation of the firms remains viable and profitable. Though it is vital to ensure that the benefits of growth should reach every remote pocket of our country, it would be unrealistic to set up manufacturing units in locations where the economic rational does not permit it. Instead, it would be better to develop primary or service sector activities in these pockets depending on the competitive advantages that the area has.[19]

Industrial dispersal policies should be based on the understanding of the dynamics of industrial location decisions of the firms.[20] The policies should be designed in a way that firms are able to reap the benefits of natural economic advantages so that economic rationality and efficiency are not violated. This logic supports the concept of developing industrial corridors which fulfills the conditions of complimentarity as well as the competitive requirements. While complimentarity would ensure a diversified industrial base, competitiveness would likely reduce the transaction costs through better information flow and better utilization of over heads that leads towards maximization of efficiency both in terms of cost and quality. The study of *Singhi and Balaram*[21] (1997) mentions that one such corridor already exists in India (the South Gujarat- North Maharashtra) which is as efficient as the economic zones of the East Asian countries. This corridor has emerged naturally because of its location advantages but received a further boost because of the local entrepreneurial capabilities. One of the main suggestions of the study was that locations might be chosen more on account of their human resources than on account of their material resources.

Most of the other studies on industrial dispersal in India have focused on the disparities in the pattern of industrial potential.[22] Almost all of them have suggested that industrially backward areas should be given priority for the development of industries. *Rao*[23] (1985) has worked on the inter-regional disparities in industrial development of Karnataka. She suggested that a few major steps should be taken to maximize the benefit of the process of industrialization. Apart from developing the backward areas, one of her suggestions was to set up large and medium scale indus-

tries in geographically continuous areas having infrastructure linkages and industrial input-output linkages, which supports the idea of developing industrial corridor.

The international evidence and literature in this area is however does not support the high levels of diversification of regions in disparate economic activities.[24] Keeping in view the need for the development of industrial corridors, this study is an attempt to identify those potential corridors where the factor conditions are favourable for setting up of new industries.

III. DATA

Identification of industrial corridors requires incorporation of a large number of pertinent factors which determines the level of competitive advantage for firms. It includes the physical location advantages attributable to a place as well as demands for the inclusion of many others which contribute significantly to the development of industries in certain locations.

The present study excludes the North-Eastern states (but includes Assam) and Jammu & Kashmir, the reason being that the rugged terrain of the North-Eastern part of the country requires special location specific studies for the development of industrial activities and for the state of Jammu & Kashmir recent data on many of the variables are not available. The selected indicators and the rationale behind their selection are as follows:

The selection of the variables for the study is based on the premise that they are positively correlated to the industrial development level of an area. The selected variables along with the rationale for their inclusion in the study are presented in Table 3.

Table 3
Indicators and Their Main Sources

Indicator	Source
Total Population (POP)	Primary Census Abstract, General Population, India, Census of India Publication.
Population Growth Rate (PGR)	Primary Census Abstract, General Population, India, Census of India Publication.
Population Density (PDEN)	Primary Census Abstract, General Population, India, Census of India Publication.
Degree of Urbanization (PUTP)	Final Population Table, India, Census of India Publication.
Percentage of In-migration to Total Population (PIMTTP)	Computed from Census of India data on Migration
Percentage of Male Migration to Total In-migration (PMIMTIM)	Computed from Census of India data on Migration
Percentage of Main Workers to Total Population (PMWTP)	Primary Census Abstract, General Population, India, Census of India Publication.
Percentage of Non-Agricultural Workers to Total Workforce (PNAWTMW)	Primary Census Abstract, General Population, India, Census of India Publication.
Percentage of Workers in Non-houseblod Manufacturing to Total Workers (PNHWMW)	Primary Census Abstract, General Population, India, Census of India Publication.
No. of Non-Agricultural Establishments Per Lakh Population (NEPLP)	Economic Census, Central Statistical Organization, Government Of India
Percentage of Non-Agri. Establishments with power (PEWP)	Economic Census, Central Statistical Organization, Government of India
Persons Engaged in Non-Agri. Establishments Per Lakh Population (PWEPLP)	Economic Census, Central Statistical Organization, Government of India
Share of Bank Credits to Industry (SOCTI)	Banking Statistics, RBI
No. of Scheduled Commercial Banks Per Lakh Population (NSCBPLP)	Banking Statistics, RBI
Persons Working Per Non-Agri. Establishment (PWPE)	Economic Census, Central Statistical Organization, Government of India
Share of Bank Credits to Industry (SOCTI)	Banking Statistics, RBI
No. of Scheduled Commercial Banks Per Lakh Population (NSCBPLP)	Banking Statistics, RBI
No. of Large Towns in the District Per Lakh Population (NLT)	Rural Urban Distribution of Population, Census of India Publication
Access to National Highway (ANH)	Road Map of India
Percentage of Literate Population to Total Population (PLTP)	Primary Census Abstract, General Population, India, Census of India Publication.
Percentage of Female Literate to Total Population (PFLTFP)	
Percentage of Households Having Pucca Houses (PHHPH)	Housing and Amenities, Occasional Paper No. 5, Census of India Publication

(Contd.)

Table 3 (Contd.)

Indicator	Source
Percentage of Households Having Three Basic Facilities, i.e., Electricity, Sanitation and Safe Drinking Water (PHATF)	Housing and Amenities, Occasional Paper No. 5, Census of India Publication
Percentage of Households Using Cooking Gas (PHHCG)	Housing and Amenities, Occasional Paper No. 5, Census of India Publication
Consumption of HSD and Motor Spirit Per Lakh Population (CHMPLP)	Computed from the data provided by the Oil Coordination Committee, Ministry of Industry
Amount of Bank Deposits Per Lakh Population (ADPLP)	Banking statistics, RBI
Credit Deposit Ratio (CDR)	Banking statistics, RBI

Note : Variable names are given in the brackets.

The rationale for inclusion of the variables are as follows:

- **Population Related Variables: Population, Density and Growth**

Total population is an important indicator which indicates the potential market for any product. The growth rate allows us to incorporate the increase in population, inclusion of the population density brings into the model the issue of correction for the size of the district. It might be argued that is not desirable to put a high weight on population related variables. Though this issue is discussed in greater detail later. In the single PCA (discussed later) these variables together accounted for approximately 6% of the total weight for all the factors.

- **Degree of Urbanization**

This is measured as percentage of urban population to total population of the district. This variable therefore reflects better infrastructure facilities for manufacturing activity.

- **In-migration to the district: Total and Male**

In-migration to the districts is measured as the percentage of In-migration to total population of the district. To capture the recent changes in the district, in-migrants during the last decade only are considered for this study. Though in-migration takes place because of various reasons, studies suggest that a major proportion of in-migration is for economic reasons. People migrate from a less developed regions to more developed regions because of better economic opportunities.

- **Percentage of Workers to Total Population: Non Agricultural, Non-Household**

This indicator reveals the employment level of a district which is also a reflection of the existing economic activities in the district. The extent of non-agricultural activities can be captured by including the ratio of non-agricultural work-force to total work-force. It shows the work-force engaged in secondary and territory sector of the economy relative to the total working population. The ratio of workers in non-household manufacturing activities to total population is included to capture non-household manufacturing.

- **Non-Agricultural Establishments per Lakh Population: Total, with Power**

This indicator captures the extent of non agricultural activities in a district. Higher value of this indicator suggests higher level of non agricultural activities. In addition, the extent of 'powered' units was also included.

- **Non-Agricultural Establishments: Persons Engaged, Average Employment**

Two indicators were included in this class. The first, persons engaged per lakh population, and the second, average employment per establishment. These two variables capture the non-agricultural activity in the district and the average size of such establishments. The latter (average employment) indicates the size of such activities. The assumption being that larger scales (reflected by employment) are more likely to reflect the extant of industrial activity.

- **Share of Bank Credit to Industry**

This is an important indicator that reflects the comparative status of industrial activities in a district. It also shows the availability of credit facilities of the industry sector. A high value of this variable would be consistent with high investment in the industrial sector.

- **No. of Scheduled Commercial Banks Per Lakh Population**

It reveals the availability of the banking facilities in a district, as better banking facilities help industries and other sectors to perform more

efficiently. Moreover, larger branches also, to some extant, reflect the demand for their services.

- **No. of Large Towns in the District Per Lakh Population**

This indicator shows the extent of presence of large towns relative to its population. It is well known that the conducive environs for industrial development are available in the large towns at a higher level than at the smaller urban centres or at the countryside. Therefore, larger presence of the large towns is an indicator of a better climate for industrial activities.

- **Access to National Highway**

This indicator reveals better linkage of a district which helps in production as well as the distribution of the industrial products.

- **Percentage of Literate to Total Population**

This is an important indicator of overall social advancement of a particular district. A high literacy rate would also indicate a high level of awareness and skills and is hence important for industrial development in terms of production as well as marketing of the products.

- **Percentage of Female Literate to Total Female Population**

This has been included separately because females are a target group in any development effort. A higher female literacy rate would indicate the magnitude of the social development of the district.

- **Percentage of Households having Pucca Houses**

Pucca houses are an indicator of quality of housing which reflects the income level of the households of the district. Higher value of this indicator suggests that there would be higher market potential for the industrial products in the district.

- **Percentage of Households having Three basic Facilities (Electricity, Safe Drinking Water, Sanitation)**

Electricity, safe drinking water and sanitation facilities are indicative of better quality of life in the district. Higher value of this indicator suggests availability of higher human capital resources in the district which is very important for industrial development. In addition, they also reflect the income levels in the district.

- **Percentage of Households Using Cooking Gas**

The usage of cooking gas among the households reflects the modernisation and advancement and the income level of the households of the district. The higher the value of this variable the better it is in terms of potential market demand for the industrial products.

- **Consumption of HSD and Motor Spirit per Lakh Population**

This is an indicator reflects the degree of transport activities as well as energy generation, both of which are highly correlated with industrial activities in a region. Though we have not come across other studies that have used this information. For instance, the number of cars are often used as a proxy variable to measure the economic activities of a place. The select indicator for this study is a better one because it reflects a more comprehensive set of activities. It also shows the level of consumption of the residents which in turn determines the market potential of the place.

- **Amount of Bank Deposits per Lakh Population**

This indicator is a proxy one to the income variable. A high per capita bank deposit indicates a high disposable income at the hands of the people which in turn reflects a high level of income.

- **Credit-Deposit Ratio**

This gives an idea of the amount of credit given to a district out of the deposits mobilised from that region. A high credit-deposit ratio would indicate a higher degree of absorption of resources within the district itself and a high potential for future development.

The raw data has been collected from a number of secondary sources. The data sources are mainly Census of India publications, RBI Statistics, Economic Census, CMIE and Data provided by the Oil Coordination Committee, Ministry of Petroleum (refer to Table 3).

Another important source of the district level data is the Statistical Abstract published by different State Authorities which contains information on quite a few important variables like power consumption, availability of surfaced roads, medical facilities, schooling facilities, registered factories and their employment etc. The scope and scale of this study make it essential that the various variables/indicators are comparable

across districts and therefore it is essential that the data for each variable are collected for one particular time period. As the Statistical Abstracts for different states are not published in the same format as well as for some of the states the data is too old, it was not possible to include the information of the Statistical Abstracts.

The CMIE district level profile would have been another important source of data. The time period relating to the data in CMIE Statistics are not clearly mentioned and differs across the districts. This makes comparison across the districts difficult. The NIC (National Informatics Centre) data is a compilation of a number of secondary sources where the same problem of comparability arises.

This study attempted to take into consideration all those factors which directly or indirectly reflect the industrial activity of a location. For instance, variables on agricultural development like fertilizer uses, irrigated area etc. are also important because they reflect the potential demand of the place. The present study does not include them due to two reasons. The most important one is that instead of the agriculture related variables this study uses the variables such as bank credit to industry, bank deposits per lakh population, consumption of HSD and motor spirit which are more capable of capturing the potential for industrial products. The other problem is the comparability of data across different districts which has already been discussed.

The summary statistics of the data set used for the study is presented in Table 4.

Table 4

Summary Statistics of the Data

Variable Name	Mean	Standard Error	Median	Standard Deviation	Range	Minimum	Maximum	Sum	Count
POP	2020.36	64.99	1825.38	1311.18	9897.60	28.29	9925.89	822285.97	408
PGR	2.13	0.03	2.12	0.64	5.18	-0.41	4.77	865.10	408
PDEN	532.72	89.08	281.00	1797.09	23780.00	2.00	23782.00	216818.47	408
PUTP	21.65	0.89	17.37	17.91	179.18	0.00	179.18	8813.52	408
PLTP	50.40	0.76	48.01	15.37	104.05	19.01	123.06	20513.54	408
PFLTFP	37.05	0.89	34.50	17.90	94.83	4.33	99.16	15077.84	408
PMWTP	36.00	1.15	33.39	23.16	393.69	2.75	396.44	14650.00	408
PNAWTMW	29.97	0.78	25.70	15.71	96.74	2.59	99.33	12197.10	408
PNHWMW	6.01	0.29	4.03	5.81	34.85	0.46	35.31	2448.05	408
NSCBPLP	7.73	0.23	6.69	4.63	72.80	0.48	73.28	3146.38	408
ADPLP	2360.61	191.20	1337.03	3857.34	50012.03	71.22	50083.25	960767.53	408
CDR	0.64	0.08	0.51	1.59	23.22	0.05	23.27	258.60	408
SOCTI	33.70	2.18	26.53	43.98	738.03	1.84	739.87	13714.46	408
NEPLP	847.61	41.57	737.50	838.58	14754.18	53.98	14808.17	344978.06	408
PEWP	24.34	0.36	23.91	7.34	84.75	7.43	92.17	9906.17	408
PWEPLP	176.18	38.41	42.94	774.80	8761.03	2.28	8763.32	71706.66	408
PWPE	5.84	0.09	5.51	1.88	20.99	0.56	21.55	2378.15	408
PHHPH	39.96	1.10	35.56	22.22	90.65	3.34	93.99	16262.20	408
PHHATF	13.71	0.58	9.96	11.73	82.67	0.00	82.67	5581.59	408
PHHCG	6.32	0.35	3.88	7.07	42.92	0.00	42.92	2571.49	408
PIMTTP	4.43	0.15	3.72	2.95	23.18	0.42	23.60	1801.53	408
PMIMTIM	36.42	0.64	38.41	12.95	75.85	0.00	75.85	14822.25	408
CHMPLP	306088	12896	230971	260158	2222743	10795	2233539	124577671	408
NLT	0.75	0.06	1.00	1.17	16.00	0.00	16.00	306.00	408
ANH	0.62	0.02	1.00	0.49	1.00	0.00	1.00	252.00	408

**Variable names are given in Table 3.*

IV. METHODOLOGY

The process of industrialization is a complex phenomenon that is influenced by a large number of factors. Each of these factors have a certain level of contribution in determining the feasibility of a particular

location for setting up of the new industries and to support the existing ones. Study of one single important factor alone will not be able to represent the true situation prevailing in the country. Therefore, it is important to incorporate all those contributing factors while trying for identification of industrial corridors in India. This requires formation of a composite index that incorporates a large number of variables together. There are different means to form composite index where all the selected indicators are represented by one single indicator so that it becomes easier to compare across spatial locations. Principal Component Analysis is one of the best method of computing composite index where the analysis becomes free of subjectivity on part of the researcher. This well used econometric tool assigns weights to variables based on the relationships among them and therefore eliminates subjectivity.

Principal Component Analysis is a part of the Factor Analytic Model.[25] To derive the composite index Principal Component Analysis is used in two ways. One of them is the single stage Principal Component Analysis and the second one is the Multi stage Principal component Analysis. The Multi stage Principal Component Analysis is more appropriate for the problem at hand, because of its ability to capture larger amount of variation in the data set prepared for the analysis.[26] However, this study includes both procedures to provide a comparative picture as well as for a second check on the result. The methodology of Principal Component Analysis is discussed in detail in the following section.

As has been mentioned before, the development levels of the districts is a function of broad indicators like demographic characteristics, available social amenities and quality of life of the residents, available facilities, economic condition and the potential demand in these districts. All these factors contribute to the overall development of a particular district in any region or state. Thus, a methodology which essentially involves construction of a single composite index is needed to serve this purpose. This paper considers both the single and multi-stage PCA.

Delineation of Industrial Corridors

Through the Principal Component Analysis the value of the composite index of the districts of the selected states for have been

computed. The districts have been categorized on the basis of the values of this composite index. The districts have been divided into five categories on the basis of the mean and the standard deviation of the composite index values. These groups are ranked as very high, high, moderate, low and very low/least. The intervals for all the groups are one standard deviation except for the category 'moderate'. This category is formed with an interval of half standard deviation above the mean.

The delineation of industrial corridors was conducted in the following manner. First, the first two 'types' of districts ('very high' and 'high' potential) were chosen. In most cases these by themselves showed up as contiguous industrial corridors. Next, the districts bordering these two categories were studied. In most cases these were of the type 3 category ('moderate') and in very few cases type 4 category ('less'). For these two types of districts the results from *both* single and multi stage PCA were studied. In a few cases this analysis showed that the bordering districts had significant bottlenecks[27]. In such cases the bordering districts were excluded. In a few cases a district that had significant bottlenecks was included *if it was between two high/very high potential districts.* This was done to account for the fact that, by definition, an industrial corridor consists of geographically contiguous regions.

V. ANALYSIS OF THE RESULTS

The study has brought out a few important dimensions of the spatial distribution of the industrial/economic activities of the districts under study. It has already been mentioned earlier in the methodology that this study has followed the approach of the single stage and the Multi-stage Principal Component Analysis. *A high degree of similarity in the results is observed from these two approaches.* The results from the Multi-Stage Principal Component Analysis is dealt here in depth because it explains larger variation in the data set and to maintain lucidity in interpretation of the results. The exercise is performed for all the indicators that are included in one of the five broad categories/classes:

- Demographic characteristics
- Economic conditions

- Available facilities
- Social amenities and quality of life
- Potential demand.

Appendix 2 lists the set of indicators that are included in each of the above categories. It has been observed that in case of most of the districts the levels of development on the basis of these different components maintains a significant consistency. That is, if a district shows a high rating in one class, it is also likely to be rated high in other classes.

Here, the discussion stresses the over all composite index combining five broad factors which provides the basis for the identification of industrial corridors in India. The composite index of overall development reveals the structural organization of the districts in India. The factor loadings are the weights assigned to each component of the composite index and henceforth will be referred to as *weight*. These factor loadings are also reflective of the correlation of these components to the overall composite index values. The weights from the single stage Principal Component Analysis are presented in the Table 5.

The table shows that a few indicators have been given higher weight by the model. These indicators are share of non agricultural workers, non household manufacturing workers, amount of bank deposits per lakh population, households having three basic facilities (Safe Drinking Water, Sanitation and Electricity Facility), households using cooking gas, share of migrants to total population, percentage of total literate, percentage of female literate, consumption of HSD and motor spirit, households having pucca houses, average size of the non agricultural establishment, degree of urbanization etc. Most of these indicators are related to the economic condition, urban centric growth, demand potential of the district. The contribution of these indicators to the composite index of the districts are higher because of their higher weights. The eigen value for the first principal component of the model explains about 32 per cent of the total variation in the data. For computing the composite index through the Multi-Stage Principal Component Analysis the indicators have been grouped into five categories, namely, demographic characteristics, economic conditions, available facilities, social amenities and quality of life and market demand potential based on the nature of the variables. The variables with the different categories are given in Appendix 2.

Table 5
The weights of the Indicators for the Composite Index from the Single Stage Principal Component Analysis

Indicators	Weight (X_i)	Relative Weight (%) (X_i / $\sum X_i$)*100
Total Population	0.27015	2.196
Population Growth Rate	0.02162	0.176
Population Density	0.46782	3.803
Degree of Urbanization	0.76842	6.247
Percentage of Literate to Total Population	0.69919	5.684
Percentage of Female Literate to Total Female Population	0.69510	5.651
Percentage of Main Workers to Total Population	0.01813	0.147
Percentage of Non-Agricultural Workers to Total Workforce	0.92308	7.504
Percentage of Non-household manufacturing to Total Workers	0.83495	6.787
No. of Scheduled Commercial banks per Lakh Population	0.46539	3.783
Amount of Bank Deposits per Lakh Population	0.77446	6.296
Credit Deposit ratio	0.04300	0.350
Share of Bank Credits to Industry	0.18078	1.470
No of Non-agricultural establishments per Lakh Population	0.44814	3.643
Percentage of Non-agricultural establishments with Power	0.42851	3.483
Persons Engaged in Non-agricultural establishments per Lakh Population	0.15174	1.225
Persons Working per Non-agricultural establishments	0.56767	4.615
Percentage of Households having Pucca Houses	0.57533	4.677
Percentage of Households having All Three Facilities (Sanitation, Electricity and Safe Drinking Water)	0.83502	6.788
Percentage of Households Using Cooking Gas	0.86017	6.993
Percentage of In-migration to Total Population	0.62311	5.065
Percentage of Male Migration to Total In-migration	0.47552	3.866
Consumption of HSD and Motor Spirit per lakh Population	0.56007	4.553
No. of Large Towns per Lakh Population	0.35342	2.873
Access to National Highway	0.26152	2.126
TOTAL		100%

It has been mentioned earlier that the explanatory capacity of the Multi stage Principal Component Analysis is better than the single stage one and a large similarity exists between the results obtained from these two methods. Therefore, a more detail analysis is provided here for the results obtained from the Multi-Stage Principal Component Analysis for a more lucid presentation of the results.

Table 6
The weights of the Indicators for the Overall Composite Index from the Multi Stage Principal Component Analysis

Indicators	Weight (X_i)	Relative Weight (X_i / $\sum X_i$)*100
Demographic Characteristics	0.70510	17.6
Economic Conditions	0.85489	21.4
Facilities Available	0.69100	17.3
Social amenities and Quality of Life	0.88418	22.1
Potential Demand	0.86438	21.6

The weights from the above table reveal that social amenities, potential demand and economic conditions of the district are given higher weights than other two components considered. The indicators with higher weights have higher contribution to the overall composite index of the districts. This model explains about 57 per cent of the total variation in the data set.

In the methodology part it is already intimated that the higher the value of the composite index, the higher would be the development level of the district. On the basis of these values the districts have been categorized into five different groups which are of the nature of very high - type 1, high - type 2, moderate - type 3, less - type 4, and, least - type 5. A category-wise distribution of the districts belonging to different types is given in the Table 7.

A regional distribution of different categories of districts is given in Table 7. It is useful to define those regions beforehand to understand the distribution pattern of the districts. The Northern region consists of Punjab, Haryana, Uttar Pradesh and Himachal Pradesh. The western region is formed including the states of Maharashtra, Gujarat, Rajasthan and Goa. The states of Tamilnadu, Kerala, Karnataka and Andhra Pradesh form the

southern region while the districts of Bihar, Assam, West Bengal and Orissa are there in the eastern region. The districts of Madhya Pradesh are considered for the central region.

Table 7
Region-wise Distribution of Districts based on their Levels of development

Region	Number of Districts (Percentages within Parenthesis)				
	Type 1	Type 2	Type 3	Type 4	Type 5
Northern	12 (33.33)	21 (30.43)	20 (29.41)	42 (25.00)	15 (27.78)
Western	11 (30.56)	16 (23.19)	16 (23.53)	31 (18.45)	4 (7.41)
Southern	8 (22.22)	20 (28.99)	19 (27.94)	30 (17.86)	0 (0.00)
Eastern	3 (8.33)	9 (13.04)	7 (10.29)	37 (22.02)	29 (53.70)
Central	2 (5.56)	3 (4.35)	6 (8.82)	28 (16.67)	6 (11.11)
Total	36 (100)	69 (100)	59 (100)	168 (100)	54 (100)

The general distribution pattern of different categories of districts shows that type 1 category has the least proportion of the total districts in the country. The largest share is found in the type 4 category which is as high as 43 per cent. The first three types of the districts together account for about 45 per cent of the total districts in the country.

The region-wise distribution of different types of districts reveals a few important points. The northern and the western regions together share about 65 per cent of the type 1 districts identified in India. In the eastern region only 3 districts are found in this category. In type 2 category of districts larger shares are found for the northern and the southern region. The eastern and the central region are again found to have low share of this type of districts. Almost the same pattern is observed for the type 3 districts where the domination of the northern, western and the southern region continues. The change is observed for last two types of districts, i.e. type 4 and type 5 districts. In the fourth category of districts the central region which has a very low share of the total districts of India records very high proportion. The eastern region dominates the type 5 category of districts with a large share of about 54 per cent. The western region is found to have the least proportion of this category of districts. An interesting issue that emerges from this table is that a large proportion of the higher rated districts for industrial development is concentrated in northern, southern and the western regions of India.

To understand the intra-region distribution pattern of different types of districts and its comparison across the regions the data is given in the Table 8.

Table 8
Intra-region Distribution of Districts of Different Categories

Region	Type 1	Type 2	Type 3	Type 4	Type 5	Total
Northern	10.91	19.09	18.18	38.18	13.64	100.00
Western	14.10	20.51	20.51	39.74	5.13	100.00
Southern	10.39	25.97	24.68	38.96	0	100.00
Eastern	3.52	10.59	8.24	43.53	34.12	100.00
Central	4.44	6.67	13.33	62.22	13.33	100.00

The above table suggests that the most skewed distribution of district is found in the eastern and the central regions. In the eastern region the type 1 districts are as low as 3.52 per cent where as the last two types, i.e., type 4 and 5 account for about 80 per cent of the total districts in the region. The situation is almost similar for the central region too. In case of all other three regions, the first three types of the districts which possess the conducive environs for future industrial development account for more than fifty per cent of the total districts of the region.

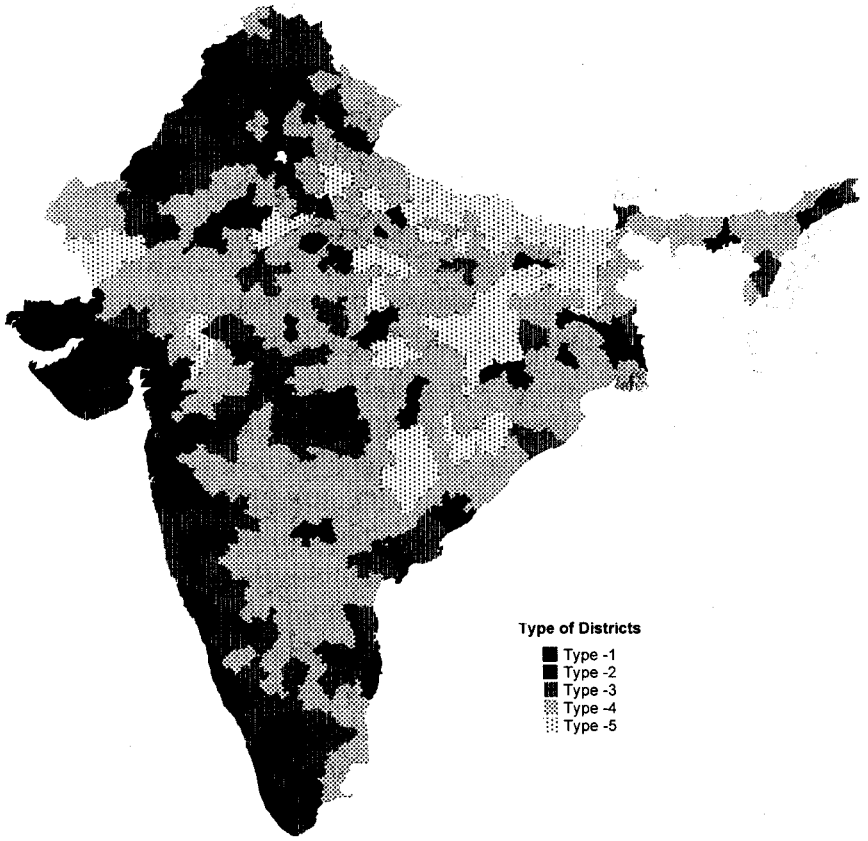
The spatial distribution of the districts according to their relative rating is given in figure 2. The figure makes it clear that most of the very high rated districts are located in and around the coastal region. A few exceptions to this trend are the districts like Ludhiana, Jalandhar, Ambala, Lucknow, Bhopal, Indore, Bangalore etc. This trend is also true for the high and moderate rated districts. The map suggests that only a few districts of the eastern coast like Ramanathapuram, Pudukottai, Thanjavur, South Arkot of Tamilnadu, Vizianagaram and Srikakulam of Andhra Pradesh, Ganjam, Cuttak, Balasore of Orissa and Medinipur and South Twenty Four Parganas of the state of West Bengal are rated lower. Not a single district of the western coastal region is found to be in the 'least' category. A large number of the very low rated districts are located in the Bihar-Nepal border. Because of the uneven terrain and adverse climate these districts are devoid of substantial economic activities.

INDIA
LEVELS OF DEVELOPMENMT

(Based on Multistage Composite Index)

0 250 500

Kilometers



The pattern clearly reveals that the most highly rated districts are largely concentrated in or around the coastal region of the country. This phenomenon is common all over the world and not unique to India. In most of the countries it is observed that the coastal regions are ahead of other regions particularly in terms of economic activities. In fact, apart from economic factors geographical factors too play an important role in determining the level of economic development of a place.[28] It is found that the longer the coast line of a country the higher is its level of economic development. The present study indicates that India is no exception to the general trend that is prevailing in other parts of the world. Some districts with higher ratings are also concentrated in parts of northern India.[29] The present study identifies a significant difference between the western and the eastern coastal region.

Port related hindrances may be one reasons behind the differences. There are 11 major ports among which six are located in the western coast and five are located in the eastern coast. Besides these major ports there are about 148 minor or intermediate ports distributed through out the coastal belt of the country. The location pattern of these major and minor/intermediate ports are stated in Table 9.

Table 9
Corridor-Wise Distribution of Major and Minor/Intermediate Ports

Corridor	Major Ports	Minor/ Intermediate Ports	Total Ports
Western	3	93	96
South-Western	3	31	34
South-Eastern	3	22	25
Eastern	2	2	4

***Source**: Indian Ports, Vol.28, No. 3, Indian Ports Association, New Delhi, 1997.*

The above table reveals that the number of ports in the western region is much higher than in other regions of the country. Among 159 ports in India 96 are located in the western region which accounts for more than 60 per cent of the total ports in the country. Though the difference in number of the major ports is not significant, minor or the intermediate ports causes the large differential between the western and other regions

of the country. The south-western region follows the western region with the second largest number of ports. Therefore it may be perceived that as a large number of minor or intermediate ports are located in the western and the south western regions of the country, the port related economic activities would also be at a higher level in these region. Only four ports are located in the eastern region which accounts for less than 3 per cent of the total ports in India.

However, a better way of understanding the impact of port activities would be to study the quantum of cargo handled in the various minor and major ports in the different regions. The following table represents region wise cargo handling by the ports in India. It helps in explaining the distribution pattern of potential districts in India, particularly their distribution in the coastal regions.

Table 10
Cargo Handled by the Major and Minor or Intermediate Ports
(In '000 tonnes)

Corridor	Major Ports			Minor Ports		
	Loaded	Unloaded	Total	Loaded	Unloaded	Total
Western	197270	461200	658470	6769	19389	26158
South-Western	246600	129300	375900	390	766	1156
South-Eastern	238100	422700	660800	549	1511	1315
Eastern	134600	193100	327700	161	200	361

Source: *Indian Ports, Vol.28, No. 3, Indian Ports Association, New Delhi, 1997.*

The above table shows the region wise cargo handling pattern in India both for the major and the minor ports. The major ports of the western and the south-eastern region of the country handle almost double the amount of cargo compared to the other two regions. In terms of the western (including south western) and eastern (including south eastern), there is no significant difference in the quantity of cargo handled. The data on cargo handling by the minor or the intermediate ports reveal that the ports of the western region of the country handle about 90 per cent of the total cargo handled by the minor or the intermediate ports of the country.

VI. BOTTLENECKS WITHIN THE INDUSTRIAL CORRIDORS

This study has attempted at identifying the important corridors for future industrial development considering a large number of variables which belong to a few broad categories. The districts have been categorized on the basis of composite index which are derived through the Principal Component Analysis. This composite index is the reflection of the overall development related to those factors which are essential for industrial development. For most of the districts it is found that the index values maintain a consistency over different broad categories of indicators. (That is, a district that shows a high rating in one category is also likely to show a rating in other categories) However, in a few cases it was seen that a high rating was not present in all the categories. For instance, a district may have a high level of economic activity but be poor in terms of social amenities. If the social amenities would also have been of the high order, the district would have performed even better. This is the *bottleneck* a district is facing which might be affecting the overall performance of the corridor, and such districts are henceforth referred to as *bottlenecked districts.*

The identification of the bottlenecks was done in the following manner. First the standard deviation of the index values (of the 5 categories calculated in the intermediate stage of the multi-stage PCA), were calculated. The districts for which the standard deviation was found above the average of the standard deviations for all districts were considered as the bottlenecked districts. Second, those districts were also considered to be 'bottleneck-ed' where one or more factor/factors show a substantially lower level of development compared to other factors. A list of these 'bottleneck-ed' districts is given in the Table 11.

The above table reveals that a total of 30 districts have been identified as the bottlenecked districts in the identified industrial corridors. The south-western corridor possesses maximum number of these bottleneck districts followed by the northern corridor. The central corridor is without even a single bottlenecked district, while the south-eastern corridor has only one bottlenecked district.

Table 11
Distribution of the 'Bottleneck-ed' Districts

Corridor	No. of 'Bottleneck-ed' Districts	'Bottleneck-ed' Districts
Northern	9	Sangrur, Agra, Tehri Garhwal, Meerut, Varanasi, Kurukshetra, Simla, Sirmaur, Gurdaspur.
Western	3	Amreli, Bhavnagar, Raigad.
South-Western	13	Bangalore Rural, Idukki, Wayanad, Kodagu, Alapuzha, Kottayam, Kollam, Kozhikode, Kassaargod, Cannur, Nilgiri, Kamrajar, Kanyakumari.
South-Eastern	1	Anna-Chengai MGR
East	4	Jorhat, Dhanbad, Sundargarh, North 24 Parganas.
Central	0	-

Identification of the districts having bottlenecks for future industrial development calls for specification of those bottlenecks present there. In the following table the bottleneck creating factors for the bottlenecked districts are shown.

The above discussion shows that the presence of the bottleneck districts within industrial corridor are higher in the northern and the southern region of the country. As these identified bottleneck districts are otherwise conducive for the industrial development in terms of most of the other broad indicators small amount of investment should be able to remove these bottlenecks. If special attention are given to these short comings within the corridors with specificity, the concept of these future industrial corridors would be more effective and fruitful for the coveted industrial development of the country.

Table 12
Factors Creating Bottlenecks in the Major Identified Corridors

Corridors/districts	Factors creating bottlenecks
Western	
Amreli	Facilities
Bhavnagar	Facilities, Social Amenities
Raigad	Facilities
South Western	
Bangalore Rural	Facilities
Idukki	Facilities
Wayanad	Facilities
Kodagu	Economic
Alpuzha	Demographic
Kottayam	Facilities
Kollam	Demographic
Kozhikode	Potential Demend
Kassargod	Potential Demand
Cannur	Potential Demand
Nilgiri	Facilities
Kamrajar	Facilities
Kanyakumari	Demegraphic, Potential Demand
South Eastern	
Chengai Anna	Demographic
Northern	
Sangrur	Facilities
Agra	Demographic
Tehri Garhwal	Economic
Meerut	Demegraphic
Varanasi	Demographic
Kurukshetra	Facilities
Simla	Economic
Sirmaur	Facilities
Gurdaspur	Demographic
Eastern	
Jorhat	Economic, potential demand
Dhanbad	Facilities
Sundargarh	Potential Demand
North 24 Parganas	Demographic, Potential Demand

VII. CONCLUSION

The delineation of industrial corridors is based on the premise that the first three categories, namely, type 1, type 2, and type 3, are most suitable to be the part of industrial corridors because of the presence of

conducive environs for industrial activities. The districts chosen for this purpose should be contiguous so that the economies of scale, scope, and the agglomeration effect can easily be achieved. The areas which have been identified as industrial corridors of the country are given in Figure 1. This study has identified six major corridors. These corridors are named as Western corridor, South-Western corridor, Southern corridor, Eastern corridor, South-Eastern corridor, Northern corridor and the Central corridor. The South-Western corridor stretches between Gujarat and Maharashtra. It extends from the south of Gujarat to Raigad of Konkan coast in Maharashtra. Almost contiguous with this is the South Western corridor. It extendes from Goa to Kanyakumari covering the entire Malabar coast. This corridor also covers a large part of the interior Deccan including Bangalore, Madurai etc. A narrow but important corridor is identified in the eastern part of the country which covers part of Bihar and West Bengal. This corridor stretches from the district of North 24 Parganas of the Ganga delta to Ranchi of the Chhotanagpur plateau. This corridor is endowed with rich mineral resources as well as other natural resources.

The south eastern corridor extends from the north coastal Andhra Pradesh to the northern part of Tamilnadu covering Hyderabad and Rangareddy. The Northern corridor covers the part of Indus valley, Upper Ganga plain and a part of the foot hills of the Himalayan region. It includes the districts which are the areas of high agricultural productivity along with commensurate industrial activities that covers important industrial clusters of India. It also covers the areas which act as the gateway to the Himalayan region thus providing the linkage with the plain land. The Central corridor consists of the districts of the Malwa plateau and the part of the Deccan plateau. Besides these major corridors there exist a few other corridors which do not have much either not very potential for industrial development or are not substantially large or continuous to reap the benefit of agglomeration economies or the complimentarity within a corridor. These minor corridors have also been identified and are shown in the figure mentioned earlier.

Principal Component Analysis is adopted for the identification of these industrial corridors. Six large corridors have been identified by this study. These are named as the western corridor, south western corridor, eastern corridor, northern corridor, central corridor and the south eastern

corridor. The factors used to determine these corridors (numbering 25) can be classified under the following headings: Demographic, Industrial and Economic, Facilities, Social Amenities, and Potential Demand.

The present study has also brought out the bottlenecks existing within the identified corridors. Certain factors did not show a rating as high as other important factors considered. These would need to be developed further in order to ensure that the district possesses a good combination of various criteria required for a high level of industrial activity. However a study focusing only on the bottlenecks aspects would be required to generate more in-depth recommendations on these bottlenecked areas.

Study of the available infrastructure facilities, such as, power availability, water availability, road and railway facilities and other modern communication facilities etc. are of great importance to frame this sort of 'location' development policies. These were *not taken into consideration* in this study. The other factors considered such as economic and industrial activity, facilities etc. already reflect the quality and quantity of these facilities.

Once the areas have been identified on the basis of current and potential activity, then the presence of these infrastructure facilities should be taken into consideration in designing an overall infrastructure investment policy. This paper contributes in the first stage of this process. Further study on the availability of these infrastructure facilities would prove to be complementary to the findings of this study and would help in formulating a comprehensive policy for future industrial development of the country. The second stage would require a much more in-depth information on infrastructure facilities, water availability and such issues. Because of the restrictive data availability, this study could not highlight these basic infrastructure facilities of the districts under consideration.

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Appendix 1

Index of Economic and Social Infrastructure

State	Infrastructure index
Andhra Pradesh	99.19
Arunachal Pradesh	48.94
Assam	81.94
Bihar	92.04
Goa	192.29
Gujarat	123.01
Haryana	158.89
Himachal Pradesh	80.94
Jammu & Kashmir	76.07
Karnataka	101.20
Kerala	205.41
Madhya Pradesh	65.92
Maharashtra	121.70
Manipur	70.38
Meghalaya	73.75
Mizoram	61.85
Nagaland	70.92
Orissa	74.46
Punjab	219.19
Rajasthan	70.46
Sikkim	104.62
Tamil Nadu	149.86
Tripura	83.55
Uttar Pradesh	111.80
West Bengal	131.67
All India	100.00

***Source** : Finance Commission Report for 1995-2000, New Delhi, 1994.*

Appendix 2

Broad Categorisation of Indicators

- **Demographic Characteristics**
  Total Population (POP)
  Population Growth Rate (PGR)
  Population Density (PDEN)
  Degree of Urbanisation (PUTP)
  Percentage of Inmigration to Total Population (PIMTTP)
  Percentage of Male Migration to Total Inmigration (PMIMTIM)

- **Economic Conditions**
  Percentage of Main Workers to Total Population (PMWTP)
  Percentage of Non-Agricultural Workers to Total Workforce (PNAWTMW)
  Percentage of Workers in Nonhousehlod Manufacturing to Total Workers (PNHWMW)
  No. of Non-Agricultural Establishments Per Lakh Population (NEPLP)
  Percentage of Non-Agricultural Establishments with power (PEWP)
  Persons Engaged in Non-Agri. Establishments Per Lakh Population (PWEPLP)
  Persons Working Per Non-Agri. Establishment (PWPE)
  Share of Bank Credits to Industry (SOCTI)

- **Available Facilities**
  No. of Scheduled Commercial Banks Per Lakh Population (NSCBPLP)
  No. of Large Towns in the District Per Lakh Population (NLT)
  Access to National Highway (ANH)

- **Social Amenities and Quality of Life**
  Percentage of Literate Population to Total Population (PLTP)
  Percentage of Female Literate to Total Population (PFLTFP)
  Percentage of Households Having Pucca Houses (PHHPH)
  Percentage of Households Having Three Basic Facilities, i.e., Electricity, Sanitation and Safe Drinking Water (PHHATF).

- **Potential Demand**

  Percentage of Households Using Cooking Gas (PHHCG)

  Consumption of HSD and Motor Spirit Per Lakh Population (CHMPLP)

  Amount of Bank Deposits Per Lakh Population (ADPLP)

  Credit Deposit Ratio (CDR).

Appendix 3

It is generally difficult to say whether a particular region A is more developed or less developed than another region B, when the development level is defined in terms of a large number of indicators. Thus, a methodology, which essentially involves construction of *a single composite index* that would ideally represent the chosen set of variables, is required to serve this purpose.

Assumptions

1. The condition of weak a Pareto rule demands that when a state registers values of indicators uniformly higher than those of the other states - the former should have a higher ranking than the latter;
2. The condition of non-dictatorship implies that no single indicator should be considered so significant as to determine the final ordering all by itself;
3. The condition of unrestricted domain implies that the method should be capable of giving the final ranking for all possible data matrices; and
4. The final condition is that of independence from irrelevant alternatives, which demands that while ranking two regions/districts, the decision must be guided by the values of the indicators for these units under study alone and not by any other irrelevant phenomenon.

With these general assumptions, the composite index is defined as,

$$C_1 = W_1x_{11} + W_2x_{12} + W_3x_{13} + \ldots\ldots\ldots\ldots + W_nx_{1n}$$

or, $$C_i = \sum W_i x_{ij}$$

where C_i is the composite index for the i^{th} observation, W_j is the weightage assigned to j^{th} indicator and x_{ij} is the observation value after elimination of the scale bias.

From the formula stated above of the composite index, it is evident that to compute the composite index two major components are to be known, that is, the weightages assigned to the indicators and the observation values after eliminating the scale bias for the available indicators. These two have been discussed below in detail.

Elimination of Scale Bias

To ensure comparability (and prevent scale bias), the variables were normalized in the following manner:

$$x_{ij} = (X_{ij} / X_m)$$

where x_{ij} is the scale free observation, X_{ij} is the original observation and, X_m is the mean of the series. The transformed series now would be scale free and, would have a mean of zero and a standard deviation of unity.

Assigning Weightages Objectively Using the Factor Analytic Model

Once the bias of measurement is removed from the observations, the crucial problem that remains is that of *assigning appropriate weightages to the selected indicators*. In this analysis the weightages for individual indicators have been assigned on the basis of the factor analytic model.

Factor analysis is used to construct a composite index in such a way that the weights given maximize the sum of the squares of correlation (of the indicators with the composite index). This method enables one to determine a vector known as the first Principal Component or Factor, which is linearly dependent on the variables, having the maximum sum of squared correlation with the variable.

The weights to the indicators are chosen in such a way so that the Principal Components satisfy two conditions:

a) The number of principal Components are equal to the number of indicators and are un-correlated or orthogonal in nature.

b) The first Principal Component or P_1 absorbs or accounts for the maximum possible proportion of variation in the set of the indicators. This is the reason why it serves as the ideal measure of composite index.

Method Outlined

- **Step 1**

  We start by taking the simple correlation coefficients of the k numbers of indicators. These correlation coefficients may be arranged in a table that is called the correlation table. The elements

of the diagonal would be unity as they are the self-correlation, i.e., the correlation of each X_i with itself ($r_{xi\ xi} = 1$ for all the i's). The correlation matrix is symmetrical, i.e., the elements of each row are identical to the elements of the corresponding columns, since $r_{xi\ xj} = r_{xj\ xi}$.

Correlation Table of the Set of K Variables

	X_1	X_2	X_3	X_k	$\Sigma^k_i\ r_{xi\ xj}$
X_1	$r_{x1\ x1}$	$r_{x1\ x2}$	..	$r_{x1\ xk}$	$\Sigma^k_i\ r_{x1\ xi}$
X_2	$r_{x2\ x1}$	$r_{x2\ x2}$	..	$r_{x2\ xk}$	
"	..	..	..	..	
"	..	..	..	..	
X_k	..	..	..	..	
"	$r_{xk\ x1}$	..	..	$r_{xk\ xk}$	
$\Sigma^k_i\ r_{x1\ xj}$	$\Sigma^k_i\ r_{xi\ x1}$	$\Sigma^k_i\ r_{xi\ x2}$	$\Sigma^k_i\ r_{xi\ x3}$	$\Sigma^k_i\ r_{xi\ xk}$	$\Sigma^k_i\ \Sigma^k_i\ r_{xi\ xj}$

- **Step 2**

  Sum of each column (or row) of the correlation table is computed, obtaining k number of sums of simple correlation coefficient.

  $$\Sigma^k_i\ r_{xi\ xj} = \Sigma^k_i\ r_{xi\ xj}$$

- **Step 3**

  We compute the sum total of the column (or row) sums-

  $$\Sigma^k_i\ \Sigma^k_j\ r_{xi\ xj}$$

  and we take its square roots.

- **Step 4**

  Finally, we obtain the loadings for the first Principal Component P_1 by dividing each column (or row) sum by the square root of the grand total.

  $$a_{ij} = (\Sigma^k_i\ r_{xi\ xj}) / \sqrt{\Sigma^k_i\ \Sigma^k_i\ r_{xi\ xj}}$$

  It should be clear that the loadings thus obtained are the correlation coefficients of the respective indicator with the composite index.

- **Step 5**

  The P_1 or the first Principal Component is constructed in the following way

$$P_1 = a_{11} x_1 + a_{12} x_2 + \ldots\ldots\ldots\ldots + a_{1k} x_k$$

- **Step 6**

  The sum of the squares of the loading of the Principal Component is called the latent root (or eigen value) of this component and are denoted by λ with the subscript of the Principal Component to which it refers. For example, the latent root of the first Principal Component P_1 is

$$\lambda_1 = [\text{latent root of } P_1]$$
$$= \Sigma^k_i \lambda^2_I$$
$$= \lambda^2_1 + \lambda^2_2 + \ldots + \lambda^2_k$$

The sum of the latent root of all the Principal Components would be equal to the number of indicators - $\Sigma^k_i \lambda_i = k$

The importance of the latent root or the eigen value lies in the fact that it expresses the percentage of variation in the set of indicators that the Principal Component explains. If for example, $\lambda_1 = 2.797$ and the number of variables are 8, then the P_1 expresses -

$\lambda_1 / k = (2.797/8)*100 = 35$ % of the variations of the set of 8 variables.

Tests of significance of the loadings: the loadings in our study have been tested based on the levels of significance of the Pearson Correlation coefficients.

Endnotes

[1] Though a large number of districts in southern part of India, particularly, from Kerala are included in the industrial corridors, many of these districts are *bottlenecked* districts. Bottlenecks within industrial corridors are discussed separately in section VI.

[2] See Government of India, *India Infrastructure report : Policy Imperatives for Growth and Welfare,* Expert Group on the Commercialisation of Infrastructure Projects, Ministry of Finance, New Delhi, 1996.

[3] Mohan Rakesh, Industrial Location Policies and Their Implication for India, Ministry of Industry, Government of India, 1993.

[4] Mohan Rakesh, 1993.

[5] *See* Shukla, V. 1996, Rakesh Mohan, 1993.

[6] *See* Raza and Habeeb, 1988 and Mohan Rakesh, 1993.

[7] *See* Raza, M. and Habeeb, A., 1988, Dasgupta, B., 1988.

[8] Godbole, *Industrial Dispersal Policies*, Himalaya Publishing House, Bombay, 1978.

[9] Government of India, Planninmg Commission, *The First Five Year Plan*, New Delhi.

[10] Godbole, 1978.

[11] These are: States: Andhra Pradesh, Assam, Bihar, Jammu and Kashmir, Madhya Pradesh, Nagaland, Orissa, Rajasthan and Uttar Pradesh.Union Territories: All Union Territories except Chandigarh, Delhi and Pondicherry. Subsequently, Meghalaya, Himachal Pradesh and sikkim were added to the above list.

[12] Industrial Development Bank of India, *Industrial Development of Backward Regions*, 1974.

[13] See Godbole, 1978.

[14] Please refer to the *Finance Commission Report for 1995-2000*, New Delhi, 1994 and Mitra,, Varoudakis and Veganzones, *State Infrastructure and Productive Performance in Indian Manufacturing*, Technical Paper, OECD Development Centre, 1998.

[15] See Mitra, Varoudakis and Veganzones, 1998.

[16] Sekhar, U., *Industrial Location Policies : The Indian Experience*, World Bank, Working Paper No. 620, 1993.

[17] Rakesh Mohan, 1993.

[18] For a detailed discussion on this debate refer to Richardson, H. W., 1975 and Egner, E., 1962

[19] Singhi and Balaram, *Location of Industries in Backward Areas- A Study of Effectiveness of Past Policies and Future Policy Options*, Ministry of Industry, Government of India, 1997.

[20] As cited in Singhi and Balaram, 1997.

[21] Singhi and Balaram, 1997.

[22] *See* Godbole, 1978 and Sreekantaradhya, 1985.

[23] Hemlata Rao, *Inter-Region Disparities In Industrial Potential*, in Sreekantaradhya ed. Regional Dispersal of Industries and Industrial Development, New Delhi, 1985.

[24] For a detail discussion please refer to Porter, M. *The Competitive Advantage of Nations*, The Macmillan Press Ltd, London, 1990, Barnes, T. J. and Gertler, M. S., *The New Industrial Geography: Regions, Regulations and Institutions*, Routledge, London, 1999.

[25] For discussion on Principal Component Analysis see Kundu, A. *Measurement of Urban Process*, Rawat Publication, New Delhi, 1978, and Mahmood Aslam, *Statistics for Geographers*, Rawat Publication, 1978.

[26] R. Venkatesan and others, Estimated Revenue and Demand Forecasting for Mobile Telecom Services, National Council of Applied Economic Research, 1996.

[27] *See* the last section for a discussion on the 'bottlenecked' districts.

[28] *See Leong and Morgan, Human and Economic Geography, Oxford University Press, Kualalampur, 1982 and Hartshrone and Alexander, Economic Geography, 1988 for detailed discussion.*

[29] *Kundu and Raja, Indian Economy : The regional Dimension, Spectrum, New Delhi, 1982.*