Industrial Clusters in India: Evidence from Automobile Clusters in Chennai and the National Capital Region

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Aya OKADA* and
N.S. SIDDHARTHAN **
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* Professor, Nagoya University (aokada@gsid.nagoya-u.ac.jp)
** Hon. Professor, Madras School of Economics (Siddharthan@vsnl.com)

Abstract

This study analyzes the patterns of agglomeration of some modern manufacturing sectors in India, and in particular the Indian automobile sector. It also examines and contrasts the factors that have led to different patterns of cluster development in two leading auto clusters in India—Chennai and the National Capital Region (NCR). Moreover, the study analyzes whether firms in clusters perform better than those that are excluded and whether the relative importance of variables that determine the behavior of firms differs among clusters. Our analyses, which employ a combination of quantitative and qualitative methods, show that Indian industrial clusters are largely concentrated in the three clustered regions: NCR, Mumbai-Pune, and Chennai-Bangalore, across different manufacturing sectors. Our study of the auto clusters in Chennai and the NCR find considerable differences in the patterns of cluster formation, due partly to the historical and policy conditions under which firms, particularly, the lead firms must operate. Moreover, our econometric analyses confirmed that being part of a cluster positively influences the performance of the auto component firms and those belonging to a cluster perform better.

INSTITUTE OF DEVELOPING ECONOMIES (IDE), JETRO
3-2-2, WAKABA, MIHAMA-KU, CHIBA-SHI
CHIBA 261-8545, JAPAN

Industrial Clusters in India: Evidence from Automobile Clusters in Chennai and the National Capital Region[1]

Aya Okada, and N. S. Siddharthan

1. Introduction

Empirical studies on agglomeration economies have primarily focused on the nature and sources of agglomeration, its impact on the performance of firms and industries, and mechanisms that connect agglomeration to innovation and regional growth (Saxenian 1994; Breschi and Lissoni 2001; Rosenthal and Strange 2004). With regard to the sources of agglomeration economies, the classical literature, in particular Marshall's (1920) seminal work, discussed highly localized industries and their contribution to continued growth of the town and the industry (1920:271), identifying three key factors – increasing returns to scale, labor market pooling and knowledge spillovers. More recent works, particularly recent theoretical advancements in economic geography, have expanded and built on Marshall's classic arguments (Fujita, Krugman and Venables, 1999; Rosenthal and Strange 2004). Some scholars have identified other relatively immobile resources, such as knowledge, skills, local institutions, industrial and corporate structures and networks, as important determinants of growth enhancing

[1] This study was undertaken when Siddharthan was a Professor at the Institute of Economic Growth, Delhi. We are grateful to the Institute of Economic Growth for their academic and administrative support and to the Institute of Developing Economies, Japan, for their generous financial support. We thank Mr. G. Lakshmana Rao for his able research assistance.

effects of agglomeration (Saxenian 1994; Breschi and Malerba 2001; Karlsson, Johansson and Stough 2005).

Some recent works, that support localization economies rather than urbanization economies, however, suggest a variation across industries in agglomeration effects (Henderson 1986, 2003; Nakamura 1985; Rosenthal and Strange 2003). Others stressed the important role of foreign direct investment (FDI) as a determinant of the patterns of agglomeration particularly in the context of developing countries (He Canfei 2002). However, empirical literature on agglomeration and clusters in developing countries is still limited, despite the growing recognition of the importance of these for their regional and national economic development. Especially, the literature on the causes of variations of the patterns of cluster formation and development across and within industries is very few. As for India, apart from a few case studies, virtually no systematic studies exist on the spatial dimension of its industrial development, despite recent growing interest in India's growth prospect among scholars and policymakers inside and outside the country.

Therefore, the objectives of this chapter are threefold. First, we analyze the patterns of agglomeration of some modern manufacturing sectors in India, and in particular the Indian automobile (including the automotive components) sector. Second, we examine and contrast the factors that have led to different patterns of cluster development in two leading auto clusters in India—Chennai in the state of Tamil Nadu, and the National Capital Region (NCR).[2] Finally, we analyze whether firms in clusters

[2] The National Capital Region (NCR) refers to a region in and surrounding the national capital, Delhi. This includes some districts in the state of Haryana (such as Gurgaon and Faridabad), and some districts in Uttar Pradesh (such as

perform better than those that are excluded and whether the relative importance of variables that determine the behavior of firms differs among clusters.

This study focuses on these two auto clusters in India for several reasons. First, the automobile industry, because of its large backward linkages, greatly influences the pattern of economic development in almost every country and every region that produces cars. Second, the automobile sector has grown remarkably since the 1980s, to become one of India's leading manufacturing industries (Okada 2000). Third, these two auto clusters, while operating in the same industry in the same country, exhibit very different patterns of agglomeration, and thus allow us to examine and contrast the factors that have led these clusters to grow differently.

This study employs a combination of quantitative and qualitative analyses. For the former, we present aggregate analyses to identify the patterns of spatial distribution of selected modern manufacturing industries, and econometric analyses to examine the differential patterns of behavior between clustered and non-clustered firms, using the data set available from the *Capital Line* database.[3] Our sample consists of all the automobile component manufacturing firms listed in the *Capital Line* data set, covering the period from 1998 – 2005.

In addition, we present qualitative analyses drawing on extensive interviews we conducted with both assemblers and component suppliers in the Indian automobile industry as well as with representatives from the government agencies, industrial

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Noida and Ghaziabad) adjacent to Delhi.

[3] This is one of the most widely-used databases in India, available "on line" as well as in CD on subscription, which. provides data for about 8000 firms registered in India, including multinationals registered in the Indian Stock Exchanges.

associations such as the Confederation of Indian Industries (CII), the Society of Indian Automobile Manufacutrers (SIAM), and the Automotive Component Manufacturers Associations (ACMA).

This paper is organized as follows. Section 2 surveys the literature on clusters, knowledge spillovers, and FDI to position this study in the light of the literature. Section 3 examines the patterns of industrial agglomerations of selected modern manufacturing industries in India, measured by value added and employment. It also briefly identifies leading firms in major clusters of different industries and considers their roles. Section 4 presents the geographical distribution of FDI in India, and compares this with the patterns of industrial agglomeration identified in Section 3. Section 5 analyzes the factors that have influenced the formation and growth of automobile clusters in Chennai and the NCR. Section 6 presents an econometric analysis of the differences in the conduct and performance of firms in the three main auto clusters in India, namely, in Chennai, the NCR, and the Mumbai-Pune belt (in the state of Maharashtra), and firms that are outside the three clusters. Section 8 summarizes the findings and brings out the main lessons from the study.

2. Factors Contributing to the Growth of Clusters

Various scholars, particularly endogenous growth theorists, have focused on the role of knowledge spillovers and their role in generating increasing returns (Romer 1986; Krugman 1991; Grossman and Helpman 1991). Furthermore, there is evidence that R&D spillovers are influenced by physical distance from the knowledge source (Acs et al. 1994; Feldman 1994). In this context, the study by Audretsch and Feldman (1996)

shows that even after controlling for the degree of geographic concentration in production, there is a clustering of innovative activities in industries where knowledge spillovers play a decisive role. Other recent studies have emphasized the role of universities and education institutions and public laboratories in encouraging cluster formation (Zucker et al. 1998; Cooke 2001; Breschi and Malerba 2001; Audretsch and Lehmann 2005). Similarly, other studies emphasize the role of region specific characteristics in explaining regional innovative activity and in particular the role of networking within the region in enhancing innovation (Ronde and Hussler 2005). Their empirical results suggest that a high level of qualified and skilled labor force and the presence of good universities is a necessary condition for regional innovation. Likewise, the study by Asheim and Coenen (2005) on Nordic clusters also emphasizes the key role played by the supply of a highly skilled labor force and access to scientific excellence. They make a distinction between clusters and regional information systems, which though strongly interrelated are yet different concepts.

The literature on FDI inflows favoring industrial clusters is rich. Statistical results from several studies focusing on developing economies strongly buttress the argument that foreign investors are inclined to favor such locations that could minimize information costs and offer a variety of agglomeration economies (He Canfei 2002). Belderbos and Carree (2002) analyze the location choices by Japanese electronics manufacturers in China's regions and provinces during 1990-1995 and confirm the major impact of regions in promoting industry, and Japanese *keiretsu*-specific agglomeration benefits. Export-oriented plants are more responsive than

local-market-oriented plants to Japanese-type (*keiretsu*) agglomeration and the presence of seaports, but appear less responsive to regional demand and region-specific incentives. Tuan and Linda (2003) find that with given distance from the core, firms prefer sites with higher firm agglomeration. It may also influence the sectoral pattern of FDI across countries or inter-country distribution of a particular sector's FDI flows (Eaton, Lipsey and Safarian 1994).

Wei (1999) analyzes the determinants of the regional distribution of FDI within China and finds that there exists a long-term relationship between the spatial distribution of FDI and a number of regional characteristics. Provinces with a higher level of international trade, lower wage rates, more R&D manpower, higher GDP growth rates, quicker improvement in infrastructure, more rapid advances in agglomeration, more preferential policies and closer ethnic links with overseas Chinese attract relatively more FDI. Similarly, Jianping (1999) examines the agglomeration effects of the location of U.S. and Japanese manufacturing firms within China's 30 administrative regions during the period 1981-1996. The empirical results indicate that agglomeration effects exist in both countries' site choices, though they are varied in degree by sectors owing to firms' nature and country's preference.

Likewise for Indonesia, Syamwil et al. (2000) analyze regional changes in the spatial pattern of Japanese manufacturing industries and the effect of deregulation of foreign investment during 1984-94. They use the data of 560 Japanese manufacturing industries in Indonesia. The result of this study indicates continuous regional concentration in the core region of Java and that markets, agglomeration and

infrastructure continue to be the main reasons for the location of Japanese manufacturing industries in the region.

Evidence from developed economies also display the favoring of strong linkages between FDI and agglomeration (Ford and Strange 1999). Agglomeration economies, local industry output, educational attainment and English language ability have significantly positive effects on the location decision of firms investing abroad, whereas wage levels, unionization, and local industry productivity all had significantly negative effects.

Head et al. (1995) argue that firms in the same industry may be drawn to the same locations because proximity generates positive externalities or 'agglomeration effects,' and that chance events and government inducements can have a lasting influence on the geographical pattern of manufacturing. Their study examines the location choices of 751 Japanese manufacturing plants built in the United States since 1980 and its findings indicate that industry-level agglomeration benefits play an important role in location decisions. In yet another study Head and Ries (1996) find that `attractive' cities, i.e., those with good infrastructure and an established industrial base, gained most and that agglomeration effects greatly magnified the direct impact of policy. Kuchiki (2004) in what he calls “a flowchart model” identifies the role of policy interventions (such as the creation of industrial zones and export processing zones); local capacity building (infrastructure, institutions, and human resource development); and lead firms, as important factors for developing industrial clusters.

Some recent studies have stressed the importance of intra-industry linkages.

For example, Braunerhjelm and Swenson (1996) find the overseas operation of Swedish firms to be positively affected by the host countries' large production in the industry of the investing firm. The effect of agglomeration was strongest in the technologically more advanced industries. Other studies have emphasized the role of the existing Japanese firms in attracting other Japanese firms to the same location (Head et al. 1995).

The studies surveyed in this section suggest that an interaction of various factors—including idiosyncratic local characteristics and historical events, contribute to the formation and development of industrial clusters.

3. Regional Agglomeration of Selected Modern Industries: Consumer Electronics, Electronics Components and Computer Hardware, and Drugs and Pharmaceuticals

This section briefly maps out the pattern of spatial distribution and concentration of selected modern manufacturing industries in India which include the following: consumer electronics; electronics and computer hardware; and drugs and pharmaceuticals. Due to some technical difficulties in mapping out the city-level plant location of the firms in these industries, we present a state-wise pattern of geographical concentration of these industries. As many firms have plants in and nearby the state capital, these patterns can be however, interpreted as an approximate proxy for industrial clusters emerging in and around the state capital.

3.1 Consumer Electronics

Consumer electronics comprise of audio products, television sets, video recording and an assortment of products like electronic watches, and video games.

This is a newly emerging industry in India and the lead firms include some of the well-known multinationals.

Table 1 presents the share of different States in the value addition and employment of the three manufacturing sectors – consumer electronics, electronics and computer hardware, and drugs and pharmaceuticals. The table presents data for 33 Indian states and Union territories, classified into four regions – north, east, west and south.[4]

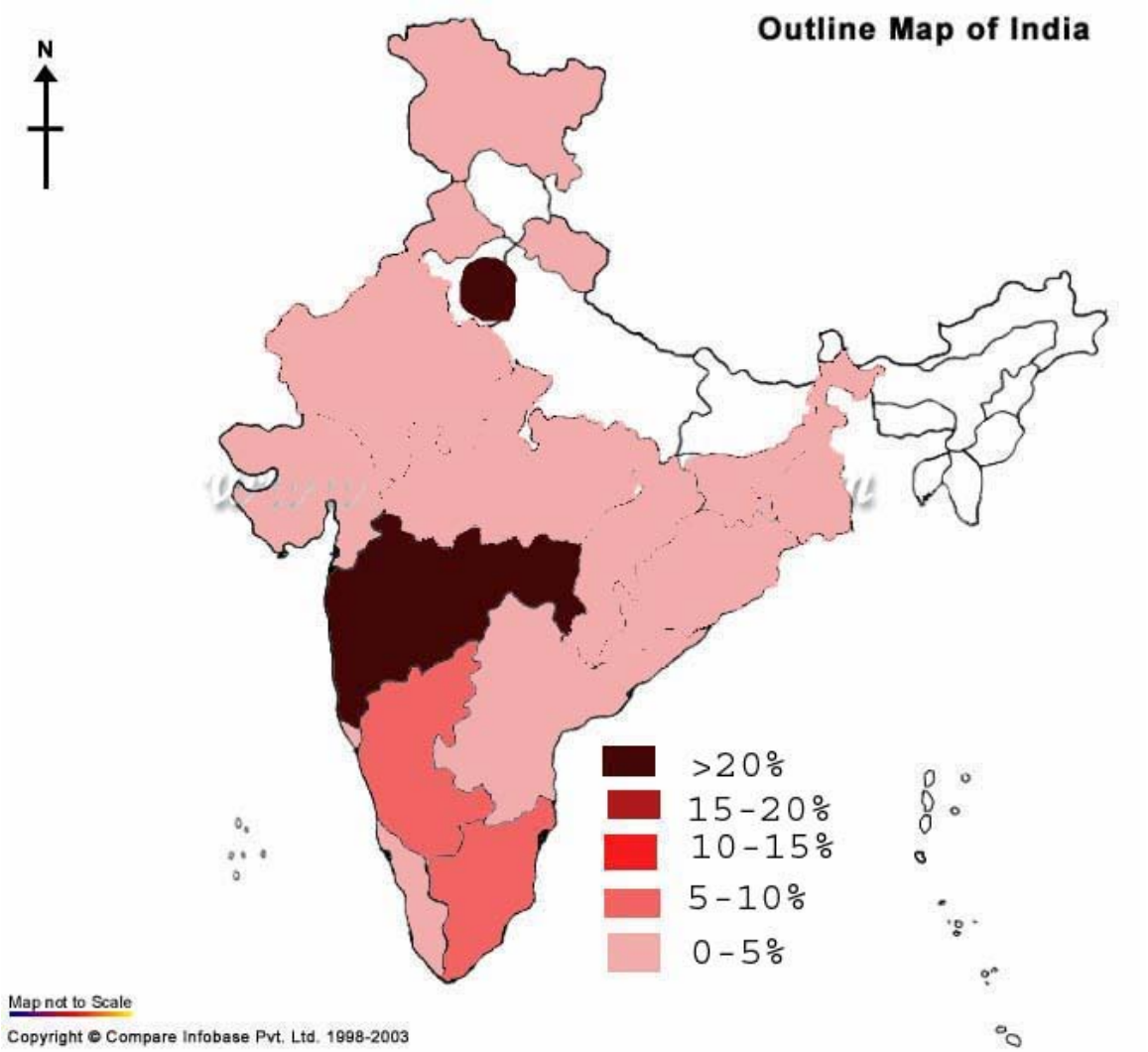
[4] The northern States includes Jammu and Kashmir, Himachal Pradesh, Punjab, Chandigarh (Union Territory), Uttranchal, NCR, Rajastan, Bihar and Madhya Pradesh. Of these, Jammu and Kashmir, Himachal Pradesh and Uttranchal are hill states where large factories cannot be located. The eastern States include Nagaland, Manipur, Meghalaya, Assam, Tripura, Arunachal, Mizoram, Sikkim, West Bengal, Jharkhand, Orissa and Chattisgharh. Of these, Nagaland, Manipur, Meghalaya, Tripura, Arunachal, Mizoram and Sikkim are dominated by hill regions where it is difficult to establish large factories. Jarkhand was earlier part of Bihar and Chattisgharg was part of Madhya Pradesh. The western States include Gujarat, Daman and Diu, Dardra and Maharastra. Of these only Gujarat and Maharastra are large states. The southern States include Andhra Pradesh, Karnataka, Goa, Kerala, Tamil Nadu and Pondichery (Union Territory). The list does not include the Andaiman and Nicobar islands as they have no industrial unit.

Table 1: Spatial Distribution of Selected Modern Manufacutring Industries : Value Added and Employment

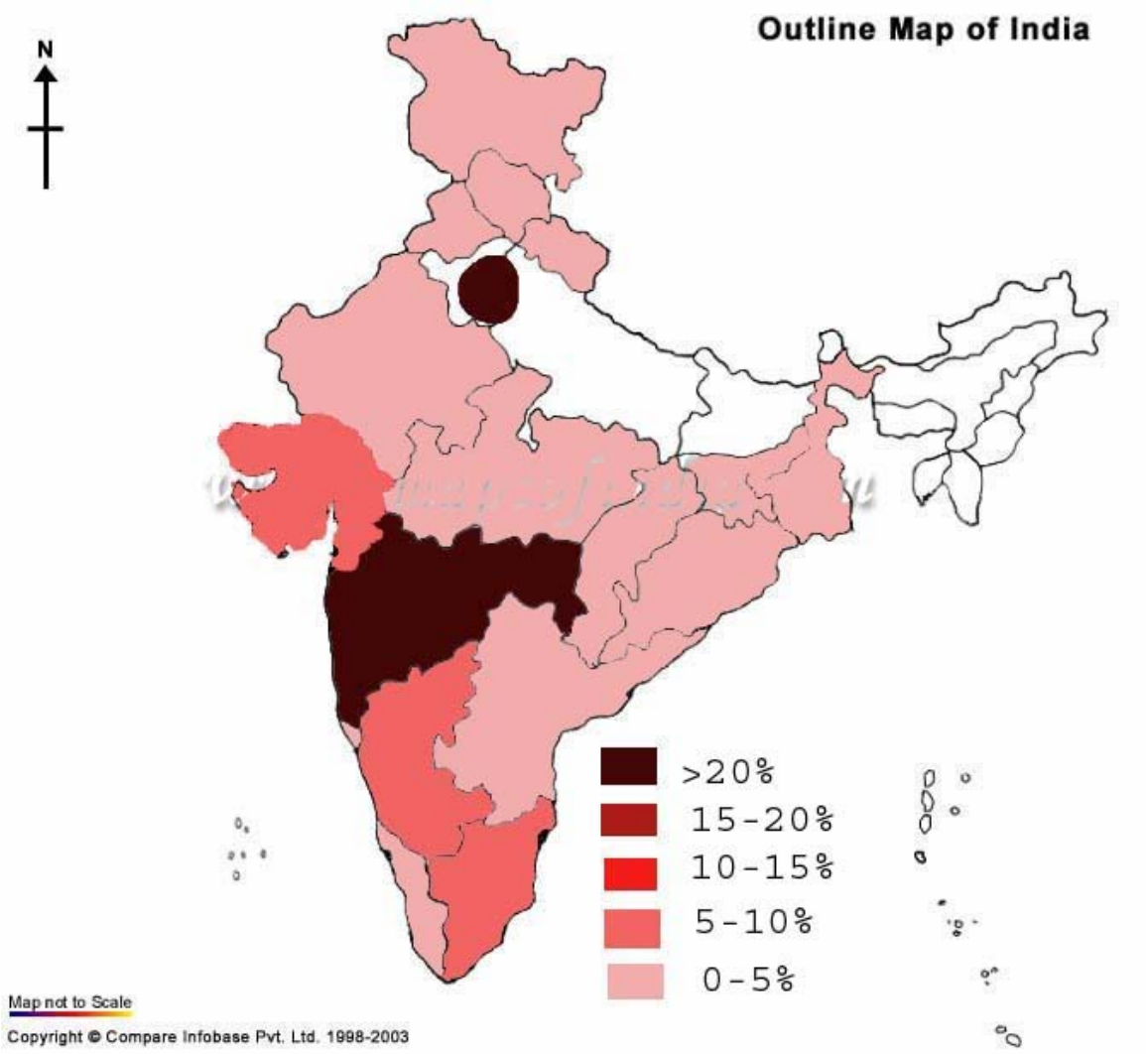
State	Drugs (%)	Electronics (%)	Consumer Electronics (%)	Drugs (%)	Electronics (%)	Consumer Electronics (%)
	VA	VA	VA	Emp	Emp	Emp
North						
J&K	0.06	0.07	0.07	0.05	0.30	0.30
HP	2.28	0.21	0	0.49	1.91	0.58
Punjab	2.63	0.54	0.67	1.68	4.95	1.08
Chandigarh	0.04	0.15	0.12	0.04	0.37	0.16
Uttranchal	0.39	1.01	0.55	0.32	0.94	1.11
NCR	3.04	**21.76**	**31.64**	4.0	17.31	26.24
Rajastan	0.89	4.27	2.23	1.31	1.31	2.71
UP-Rest	3.79	-	-	4.52	-	-
Bihar	0.07	0	0	0.24	0	0
MP	4.14	0.96	3.35	3.11	0.81	2.48
East						
Nagaland	0	0	0	0	0	0
Manipur	0	0	0	0	0	0
Meghalaya	0	0	0	0	0	0
Assam	0.25	0	0	0.28	0	0
Tripura	0.002	0	0	0.01	0	0
Arunachal	0	0	0	0	0	0
Mizoram	0	0	0	0	0	0
Sikkim	0	0	0	0	0	0
W.Bengal	3.69	1.44	3.55	4.60	2.80	4.54
Jharkhand	0.42	0	0.83	0.53	0	0.71
Orissa	0.09	0	0.12	0.44	0	0.33
Chattisgarh	0.05	0	2.17	0.26	0	1.71
West						
Gujarat	**15.13**	**12.17**	4.84	15.43	6.49	8.88
Daman&Diu	3.04	0.07	3.01	1.32	0.14	3.50
Dardra	4.06	1.97	0	1.34	0.48	0
Maharashtra	**25.92**	**9.30**	**26.98**	16.47	15.38	27.14
South						
AP	**9.86**	**8.88**	1.70	9.04	10.10	2.57
Karnataka	4.25	**15.46**	**9.67**	4.89	20.04	6.44
Goa	4.29	2.24	0.15	1.36	1.42	0.30
Kerala	1.61	**5.30**	1.08	1.78	4.83	1.97
Tamil Nadu	**6.25**	2.47	**5.87**	25.49	6.07	6.20
Pondichery	3.74	**6.63**	0	1.10	0.63	0

Source: Calculated from Annual Survey of Industries, Government of India.

Map 1: Consumer Electronics Industry: Spatial Distribution of Value Added by State



Map 2:Consumer Electronics: Spatial Distribution of Employment by State



As Table 1 and Maps 1 and 2 show, this industry is concentrated in three major states: NCR with 32 percent of the output share; Maharashtra with 27 percent of the output share; Karnataka with about 10 percent, and Tamil Nadu with six percent, as measured in valued added. The rest of India had an insignificant presence.

The key players in this industry include:

- ***Philips Electronics, established in 1930 with units mainly in Maharashtra, Gujarat and West Bengal with a current sales turnover of Rs. 230 billion;***

  Philips is one of the oldest establishments in India and produces consumer electronics and electronics hardware, manufacturing consumer electronic products at its plants in Pimpri (in the city of Pune, Maharashtra) and Kolkatta (West Bengal). Nevertheless, it has not acted as a lead firm in developing a cluster in consumer electronics in these regions.

- ***BPL, established in 1963 with factories mainly in Bangalore. It also has units in Kerala and the NCR, yielding a current sales turnover of Rs. 102 billion.***

  BPL manufactures such products as televisions, test and measuring equipments, medical electronic equipments and office automation products. The technical tie-up with Sanyo, Japan, has helped the company widen its product range making it a formidable player in the Indian electronic industry. It has played a notable role in developing the Bangalore cluster.

- ***Videocon International (VIL), established in 1985 with factories mainly in Maharashtra, Gujarat, the NCR and Karnataka, with a current sales turnover of Rs. 400 billion.***

  VIL manufactures televisions, washing machines, refrigerators, air conditioners, air coolers, VCRs, VCPs and audio systems. It also has launched a complete range of kitchen appliances. The firm has technical collaboration with the Japanese giants - Mitsubishi, Toshiba, and Matsushita, and has overseas production centers in Dubai, Thailand and South Africa.

- ***Samsung India Electronics, established in 1995 with plants in the NCR and with a sales turnover of Rs. 317 billion.***

3.2 Electronics and Computer Hardware

India entered this sector in the late 1940s by establishing a production base for radio receivers with foreign collaboration. During the 1940s and the 1950s distinctions were not made between consumer electronics and other electronic hardware. In the mid-1960s, electronic production was initiated mainly in the defense sector as an import substitution measure. Under electronics and computer hardware, we cover industrial electronics, computers and office automation.

As seen from Table 1 and Maps 3 and 4, in the electronics and computer hardware sector, three states dominate: the NCR with an output share of about 22 percent, Karnataka with about 15 percent and Gujarat with about 12 percent. In this industry also the share of the South Indian States is very high, at about 40 percent. In this sector, many of the earlier firms started with a different product mix producing mainly electrical goods and have switched over to electronics and computer hardware in recent years.

The lead firms in this industry include:

- ***Philips Electronics, established in 1930, with plants mainly in Maharashtra, Gujarat and West Bengal with a current sales turnover of Rs. 230 billion;***

  Philips Electronics is a multi-product and multi-plant firm, producing consumer electronics and electronics hardware. It is a leading firm in both the segments. Philips India was incorporated in 1930 as a private limited company under the name Philips Electrical Company (India), as a subsidiary of Philips, the Netherlands. It acquired its present name in 1956, after privatization and was

converted into a public limited company in 1957. Initially, the company commenced by trading in radios and subsequently, set up plants to manufacture consumer electronics, electronic components, industrial electronics and lighting. The firm is also into office automation products. It produces electronic components, passive devices and printed circuit boards in its plant in Pune (Maharashtra). It has also established a large R&D center in Bangalore that serves the global interests of Philips.

- ***ITI Limited, established in 1950 with plants mainly in Karnataka and the NCR, with a current sales turnover of Rs. 105 billion.***

  ITI Ltd (formerly Indian Telephone Industries) was a state-owned enterprise. However, the government diluted its share through disinvestments in favor of financial institutions, banks and mutual funds. It played a crucial role in developing the IT industry in Bangalore by developing ancillaries and training skilled workforce. It produces telecom products like electronic switching equipment, digital radio, telephone instruments, optical fibre equipment, open wire bags, and digital exchanges. It has technical tie-ups with Alcatel, France, and NKT, Denmark, for switching equipment and optical link technical equipment, with NEC, Japan for digital microwave equipment. Its lead role in developing the Bangalore IT cluster has been well recognized.

- ***Moser Baer Ltd, established in 1983 with plants mainly in the NCR with a current sales turnover of Rs. 135 billion.***

Moser Baer Ltd. manufactures storage media for data applications and audio/video applications. It is a leading exporter of 5.25 floppy diskettes and CD-Rs. It has also entered into an agreement with German firms Mag Media, IMTC and RES, all of Germany, on a world-wide basis for the supply of its entire production of 3.5" MFD of 1-MB and 2-MB capacity. The firms R&D focuses on developing newer, faster and more reliable CD-R products, improving the existing CD-R process to reduce manufacturing cost and developing new high density storage formats for both digital versatile CD(DVD-R) and higher density DVD formats. It has all its plants (seven) in Noida (NCR). It has played a leading role in developing the NCR cluster – the most important cluster for this industry.

- ***HCL Infosystems Limited, established in 1986, with plants mainly in Tamil Nadu and Pondichery with a sales turnover of Rs. 142 billion.***

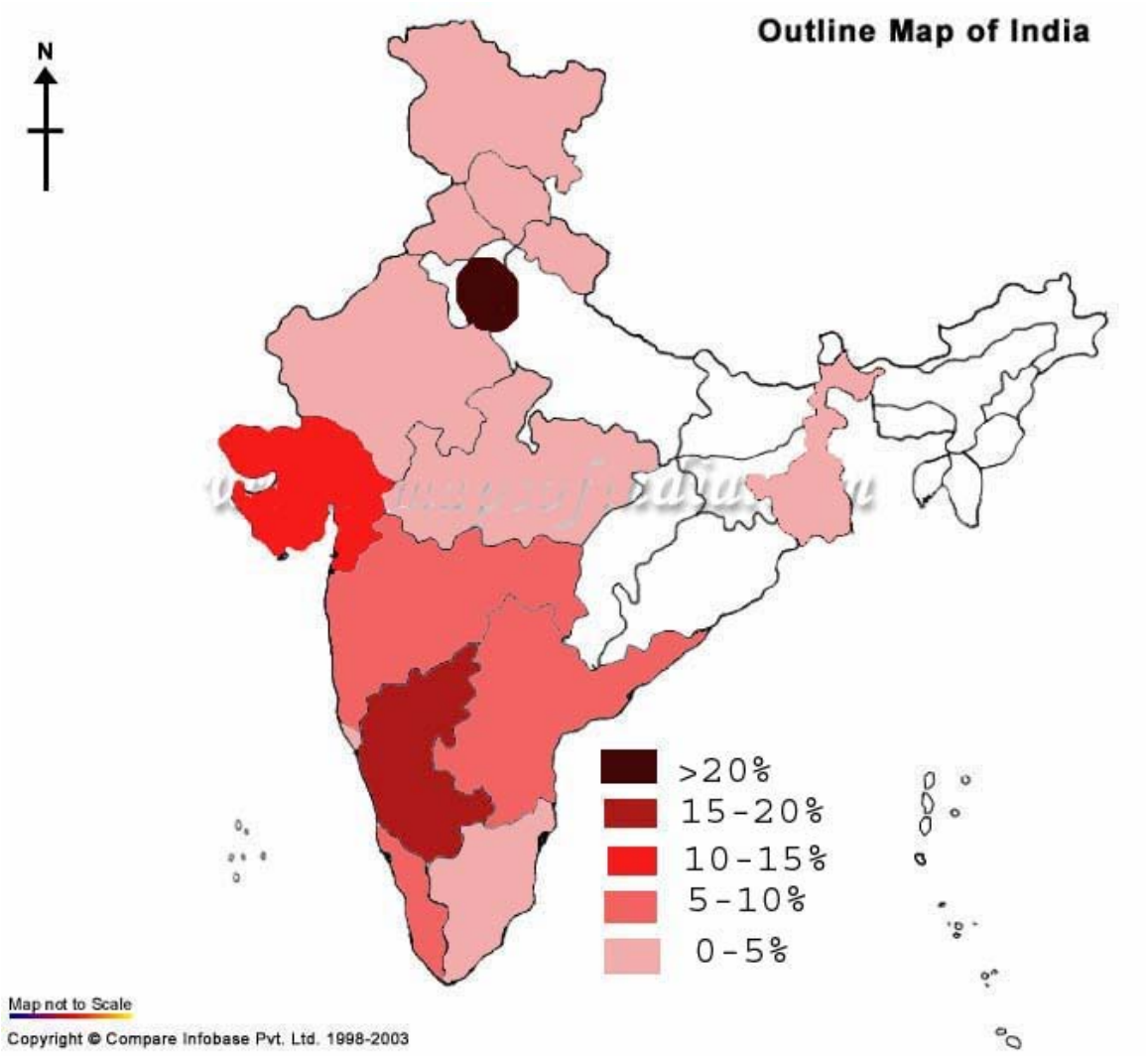
  HCL Infosystems Ltd. (formerly HCL Hewlett-Packard) was promoted by a group of technocrats. In May 1986, the company took over Hindustan Computers, Hindustan Reprographics, Hindustan Instruments and Indian Computer Software Co. In 1991, the firm entered into a joint venture with Hewlett-Packard Co, US, for combining the computer manufacturing, marketing and servicing activities of the company and Hewlett Packard India Pvt. Ltd. The company manufactures computer systems at Noida (in NCR) and computer peripherals at Chennai. It also manufactures multi-user super-minis and

engineering workstations, using the technology provided by Hewlett-Packard. The firm has also played a notable role in developing the NCR cluster.

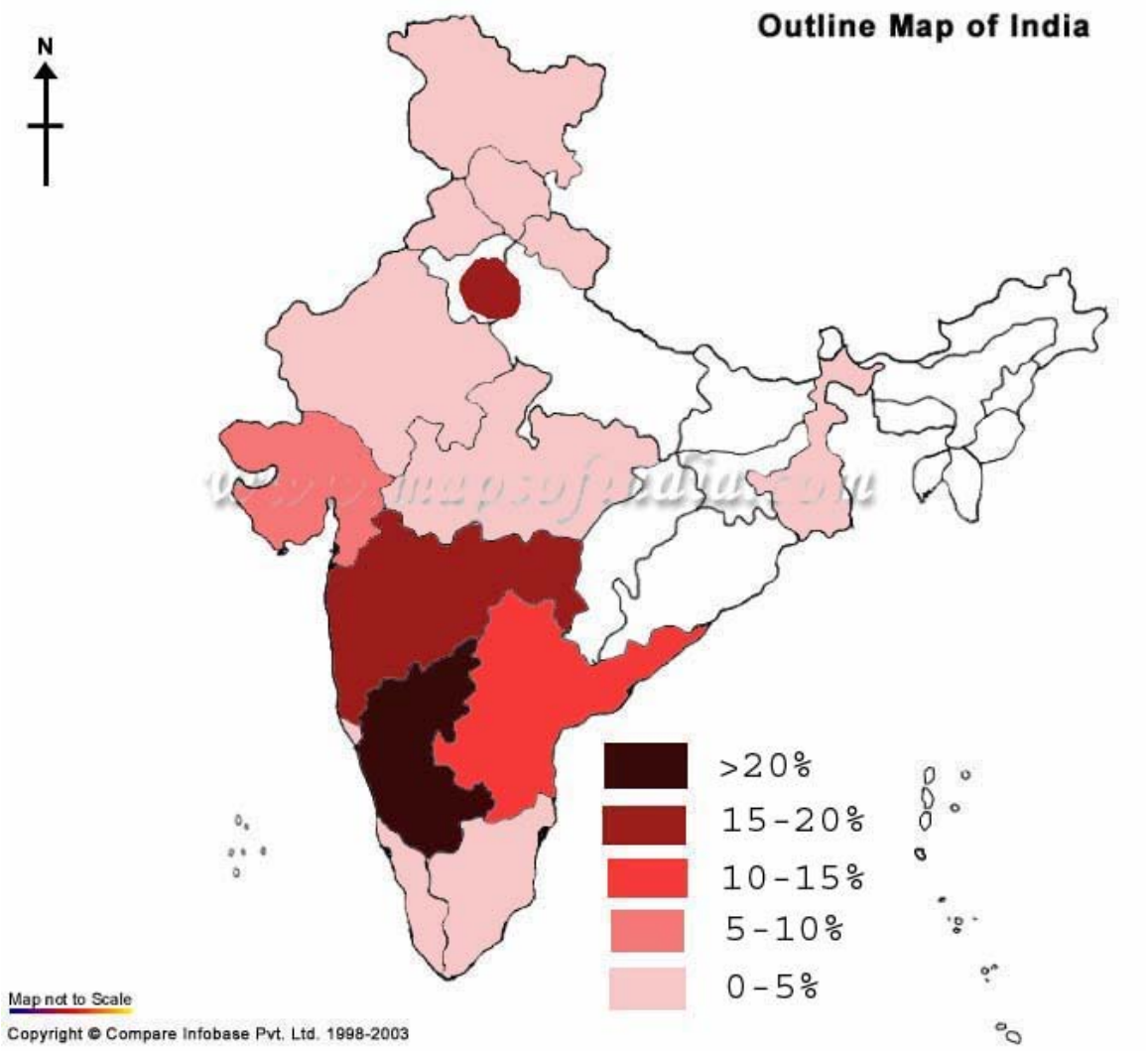
- ***Himachal Futuristic Communications, established in 1987 with plants mainly in Himachal Pradesh and NCR with a turnover of Rs. 100 billion.***

  Himachal Futuristic Communications, established as a public sector company and promoted by the Himachal Pradesh State Electronics Development Corporation. It was privatized in 1988. Commercial production commenced in 1989. It first manufactured subscriber line multiplexers (subscriber carrier systems) at Solan, Himachal Pradesh. It has also set up an optical fibre cable plant at Goa. Himachal Futuristic Communications has three ISO 9002 approved manufacturing plants located at Solan and Goa. It has currently nine product lines namely, analogue subscriber carrier system; 30 and 120 channel PCM multiplexers; 2 GHz digital microwave radios; optical line transmission equipment (PDH); coils and transformers; 10 channel digital UHF radios; high order multiplexers; line concentrators; and optical fibre cable.

Map 3: Electronics and Computer Hardware Industry: Spatial Distribution of Value Added by State



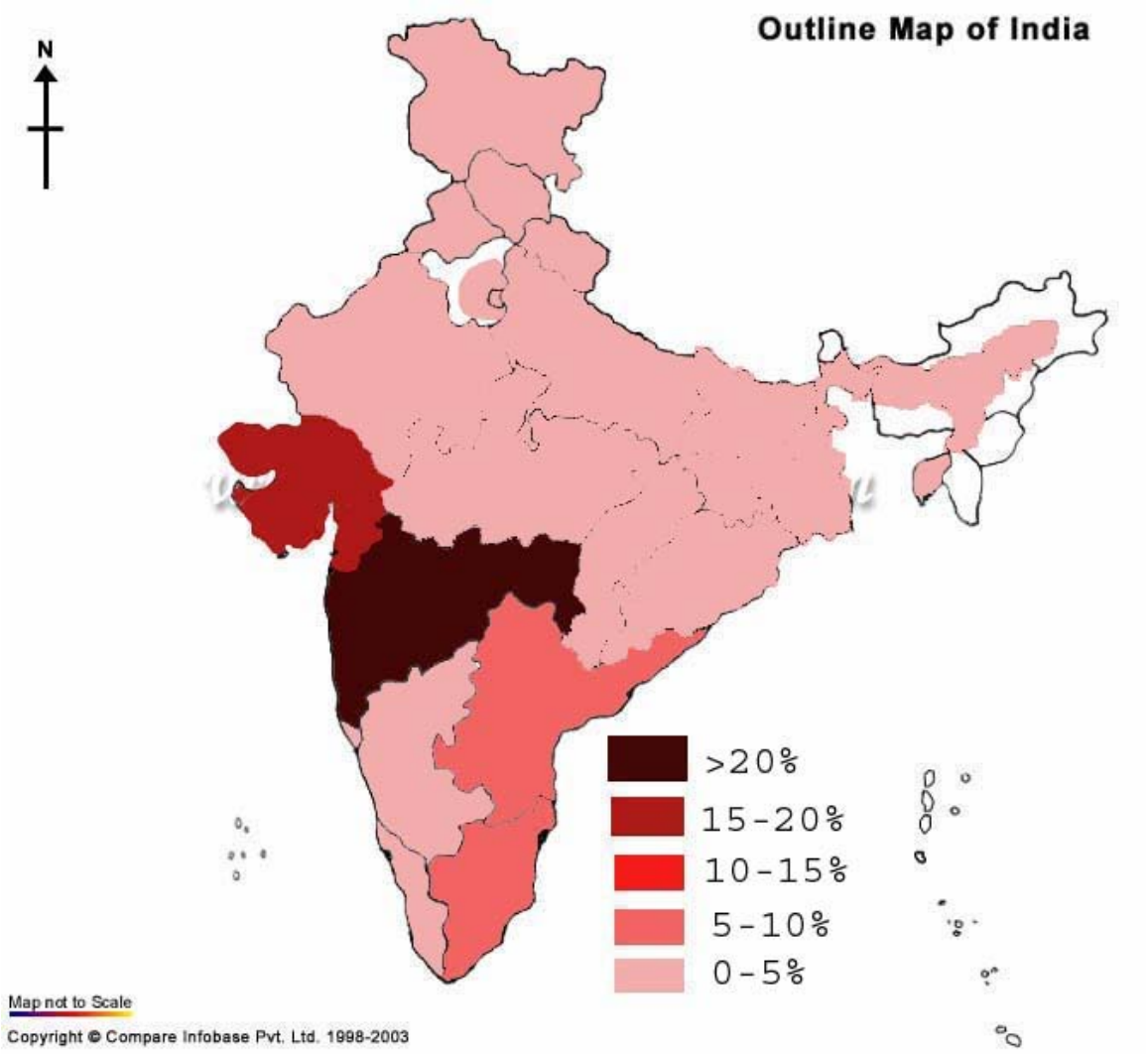
Map 4: Electronics and Computer Hardware: Spatial Distribution of Employment by State



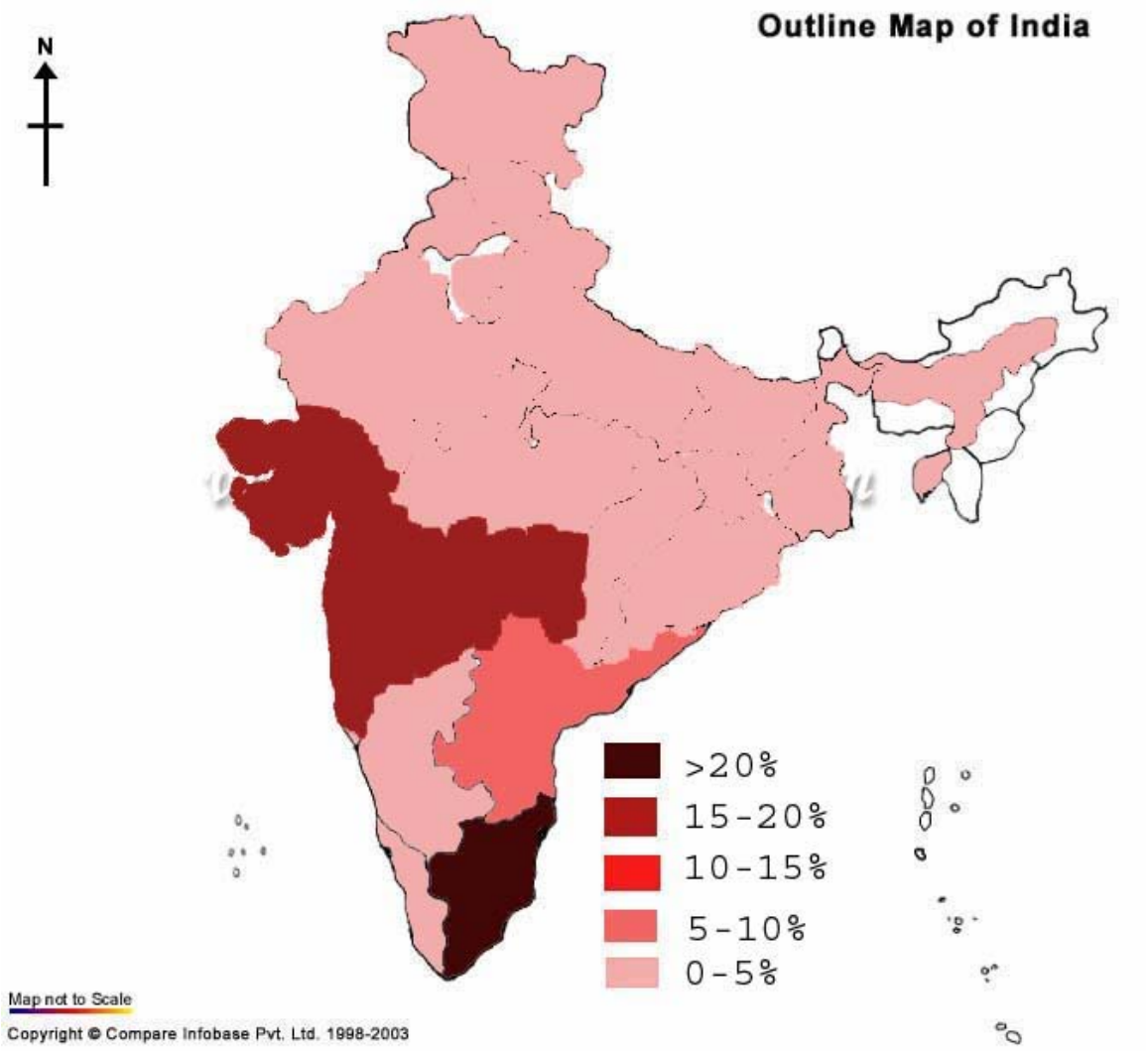
3.3 Drugs and Pharmaceuticals

Among the developing countries, India has been recognized by UNIDO as one of the top ranking countries in terms of production and distribution of pharmaceuticals. Till recently, India allowed only process patenting and did not permit product patenting. By now, however, the Indian intellectual property protection laws are compatible with the World Trade Organization (WTO) regime, making the Indian pharmaceutical industry stand for global competition. The industry is very competitive, and some Indian firms have become global players in terms of exports and acquisition of European and U.S. pharmaceutical companies.

Map 5: Pharmaceutical Industry: Spatial Distribution of Value Added by State



Map 6: Pharmaceutical Industry: Spatial Distribution of Employment by State



As Table 1 shows, a few Indian States account for the major bulk of pharmaceutical output in India. The pharmaceutical firms are mainly located in the West and Southern States such as Maharashtra, Gujarat, Tamil Nadu, and Andhra Pradesh. Map 5 presents the share in value added, and shows Maharashtra and Gujarat dominating with more than a 20 and 15 per cent share while Tamil Nadu and Andhra Pradesh come next. However, in terms of employment, Tamil Nadu dominates, while Maharashtra and Gujarat follow thereafter (see Map 6). This implies that the plants located in Maharashtra and Gujarat are generally more capital intensive, while firms in Tamil Nadu are more labor intensive.

The two adjacent states of Maharashtra and Gujarat were part of a single State (the Bombay Province) until the 1950s before the States were reorganized. Major pharmaceutical firms came to Bombay even before India's independence in 1946.

Among others the current leading pharmaceutical firms include the following:

- ***Glaxo, established in 1924 with a current sales turnover of Rs.148 billion. Most of its plants continue to be in Maharashtra though it has recently started some plants in Karnataka.***

  Glaxo is one of the earliest pharmaceutical firms in India. Glaxo India started as an agency house to distribute the well-known Glaxo baby food, to become a wholly-owned subsidiary of Joseph Nathan and Co, UK. In 1947, the firm was renamed as Glaxo Laboratories (India). Glaxo India is now an affiliate of Glaxo Smith Kline plc, which holds 51% of the equity. Glaxo has a strong product

line with quite a few brands in the country's top 250 brands. Among its principal products are Betamethasone- based topical steroids, Betnovate-C, Betnovate-M, and Betnovate- GM. Glaxo has also been encouraging the development of several small and medium enterprises to supply it with chemicals and other materials.

- ***Cipla Limited, established in 1935, has a current sales turnover of about Rs.233 billion, and its plants are mainly in Maharashtra.***

  In recent years Cipla Limited has attracted international attention as it sells drugs for AIDs, anti-bacterials, anti-asthmatics, anti-inflammatory anthelminites, anti-cancer and cardiovasculars at a fraction of an international price. Furthermore, it was in the international news during the anthrax scare as it was in a position to supply anti-anthrax drugs in sufficient quantities at a fraction of the price charged by the US firms. To position itself in the global market it made sure that all its bulk drug facilities in India (mainly the Maharashtra) have been approved by the US FDA and the formulation facilities have been approved by the Medicine Control Agency, UK; the Medicine Control Council, South Africa; the Therapeutic Goods Administration, Australia and other international agencies. This is a special case of an Indian firm emerging into a global player with plants located mainly in India and in particular, in the state of Maharastra.

- ***Nicholas Piramal Limited, established in 1947, and its plants mainly in***

Maharashtra and Gujarat were largely responsible for the development of the Maharashtra-Gujarat cluster. In recent years it established plants in Tamil Nadu and Andhra Pradesh also. Its current sales turnover is Rs.138 billion.

The firm was incorporated in 1947 as Indian Schering as a subsidiary of the British Schering, UK. However, the management of the company was acquired by Piramal Enterprises in 1988. It is a major player in formulations, diagnostics and vitamins in the Indian pharmaceutical industry, besides having good export presence. The firm has a portfolio of around 160 brands, with accreditations and approvals from USFDA, MCA of UK,TGA of Australia, European Drug Authorities and Canadian Drug Authorities.

- ***Ranbaxy Laboratories, established in 1961, with factories mainly in Punjab and the NCR. Its sales turnover is Rs.368 billion.***

  Ranbaxy is a Delhi-based firm that has plants mainly in Punjab and the NCR. However, in developing a large cluster in and around Delhi its role is limited when, compared to Dr. Reddy's in Andhra Pradesh. As a private limited company, the firm is the largest exporter of bulk drugs and pharmaceutical dosage forms in India, and has three successful overseas joint ventures in Nigeria, Malaysia and Thailand, and the US. A joint venture incorporated in India with Eli Lilly - a leading original research company in pharmaceuticals has began its operations. Its bulk antibiotics plant at Toansa, Punjab, has been approved by the US FDA and the dosage forms pharmaceuticals plant at Dewas,

MP, is accredited by the World Health Organization (WHO). It has three plants in Punjab and one each in Himachal Pradesh, Delhi, Goa, Madhya Pradesh, and Maharashtra. Despite the presence of a large firm like Ranbaxy, the share of North India and the NCR in the output of the industry has not increased significantly.

- ***Dr. Reddys Laboratories, established in 1984 in Andhra Pradesh. Most of its plants are in Andhra Pradesh, but it also has plants in London, Yorkshire, Goa and Pondichery. Its current sales turnover is Rs.163 billion.***

  Dr. Reddy's Laboratories has emerged as a leading Indian pharmaceutical company with vertically integrated operations. The firm develops, manufactures and markets a wide range of pharmaceutical products in India and in export markets such as the UK, Switzerland, Germany, Spain, Italy and the Netherlands, with over 190 finished dosage brands and 60 active pharmaceutical ingredients currently in production. Unlike other Maharashtra-based leading firms, Dr. Reddy's is a R&D intensive firm and actively pursues a basic research program under the aegis of Dr. Reddy's Research Foundation (DRF). DRL has signed a joint venture agreement with the Khetan group, Nepal, for setting up a joint venture for the manufacture and marketing of finished formulations in Nepal and other neighboring countries. It also signed a marketing and distribution agreement with Organics, Israel, for a wide range of sophisticated diagnostic kits. The products are recognized by WHO and other leading

organizations in the healthcare industry. Since 2001, its equities are traded in the New York Stock Exchange. The firm has about 23 plants and except for four plants (two of them are in the UK), the rest are located in Andhra Pradesh. It is certainly the lead firm responsible for the Andhra Pradesh cluster.

The pharmaceutical industry came into existence in the pre-independence era (1920s and 1930s) and was mainly located in the Bombay province of the British India which has now been divided into two main States, the States of Maharashtra and Gujarat. Some of the lead firms that dominated in that era continue to dominate even now and the current share of Maharashtra and Gujarat in the industry output is as high as 41 percent. However since the 1980s, several new firms have emerged in other regions such as the NCR, Andhra Pradesh and other South Indian states. Unlike the traditional lead firms, these new firms have no MNE participation or FDI inflows; instead, they are emerging as Indian MNEs while investing in Europe and the U.S. They are knowledge-intensive and R&D driven, have introduced new products and processes, and have penetrated the European and the U.S. markets. Currently, the share of South India in the pharmaceutical value added is about 30 percent, and Andhra Pradesh alone accounts for about 10 percent. These new firms are mainly responsible for the clusters in the NCR and Andhra Pradesh.

An analysis of the patterns of spatial distribution of the three modern manufacturing industries as reviewed in this section reveals several notable trends: First, Indian manufacturing activities across sectors are geographically concentrated in

several states in terms of both value added and employment. The locations of these are the NCR (i.e., Delhi and Haryana), Maharashtra, Gujarat, Tamil Nadu and Karnataka. In the case of pharmaceuticals, Andhra Pradesh is also important. Second, the sectoral differences in the patterns of regional concentration are very small among the three modern industries. Third, differences between output and employment in terms of the patterns of spatial distribution are also small. Fourth, in all the three industries, most lead firms have continued to be dominant since the pre-Independence era, except the newly-emerging pharmaceutical firms are dominant by being more knowledge intensive and R&D driven. Finally, most lead firms in these industries have had significant FDI involvement even in the pre-licensing era, again except the newly emerging pharmaceutical firms that do not depend on FDI; to the contrary, they are themselves MNCs.

3.4 Geographical Distribution of Investment in Industries and Socioeconomic Infrastructure

The States where these three industries are agglomerated also receive most investments for all the industries. As the exact State-wise data on private sector aggregate investment for the decade 1991-1999 is not available, we present the data on the letter of intent granted by the Central government as a proxy for the level of investment in each state, as summarized in Table 2.

Table 2: Industrial Investment Proposals (State-wise)
(Letters of intent issued)
August 1991 to October 1999.

State	Investment (Rs.10mill)	Percentage
Gujarat	20090	19.23
Maharashtra	12176	11.65
Tamil Nadu	10479	10.03
Andhra	10076	9.74
Uttar Pradesh	9894	9.47
Karnataka	9261	8.86
Orissa	5443	5.21
Punjab	4995	4.30
Haryana	4093	3.92
West Bengal	3956	3.79
Madhya Pradesh	3628	3.47
Kerala	2513	2.41
Assam	2530	2.33
Bihar	1806	1.73
Rajastan	1608	1.54

Source: Ministry of Industrial Development.

Note: The States that receive less than 1% are omitted from the table.

In Table 2, investments in Uttar Pradesh and Haryana mainly refer to the NCR. Uttar Pradesh receives very little investment outside the NCR. Thus, the States that dominated domestic private investments are Gujarat (mostly in petrochemicals and pharmaceuticals), Maharashtra, Tamil Nadu, NCR, Andhra Pradesh and Karnataka. Interestingly, the very same states that dominated in the value addition in the three industries discussed earlier, receive the most domestic investment. Within these States, industrial investment and production activities are concentrated in specific clusters, as in the Mumbai – Pune belt in Maharashtra, and the Chennai – Bangalore (including Hosur)

belt in Tamil Nadu and Karnataka.[5] Thus, Indian industrial clusters are largely concentrated in the three clustered regions: NCR, Mumbai-Pune, and Chennai-Bangalore (see Map 7).

As Table 3 shows, the six main States with high industrial agglomeration have also been ranked high in terms of the state-wise human development index (HDI) and the index of social and economic infrastructure, both prepared by the Indian Government. For example, States like Tamil Nadu, Maharashtra, Gujarat, Haryana and Karnataka enjoy high ranks in both the HDI and the socio economic index. In the literature on FDI, these indicators are considered to be very important in attracting investment as they reflect the presence of a high quality and healthy workforce. Thus, these socio-economic variables seem to influence the formation of industrial clusters and inter-state differences in the degree of industrial development. Indeed, Delhi, Chennai, Bangalore and Mumbai are also well-known educational centers. Delhi, Mumbai and Chennai have each an Indian Institute of Technology (IIT). Bangalore houses the Indian Institute of Science (IISc), and Ahmedabad and Bangalore have Indian Institutes of Management (IIM). In addition, these six industrial clusters house a large number of engineering and technical institutions, which provide a good skill base for all industries.

Likewise, the enrolment rates of students aged 11-14 years, as a proxy indicator for the level of supply of an educated workforce, are higher among the states

[5] Therefore, some industrial associations suggest that we should regard the Chennai – Bangalore belt as a single cluster.

with high levels of corporate investment and industrial concentration, than the national average of 67 percent. Tamil Nadu enjoys the highest enrolment rate of 99 percent, followed by Maharashtra at 87 percent, Gujarat 76 percent, Karnataka 74 percent, Haryana 67 percent, and Andhra Pradesh 63 percent. States with very little investment inflows are ranked poorly in terms of these indexes. The high levels of educational performance among these six States clearly support the agglomeration literature that links the education and social infrastructure to the location of industrial concentration.

Map: 7 The Prominent Three Clusters

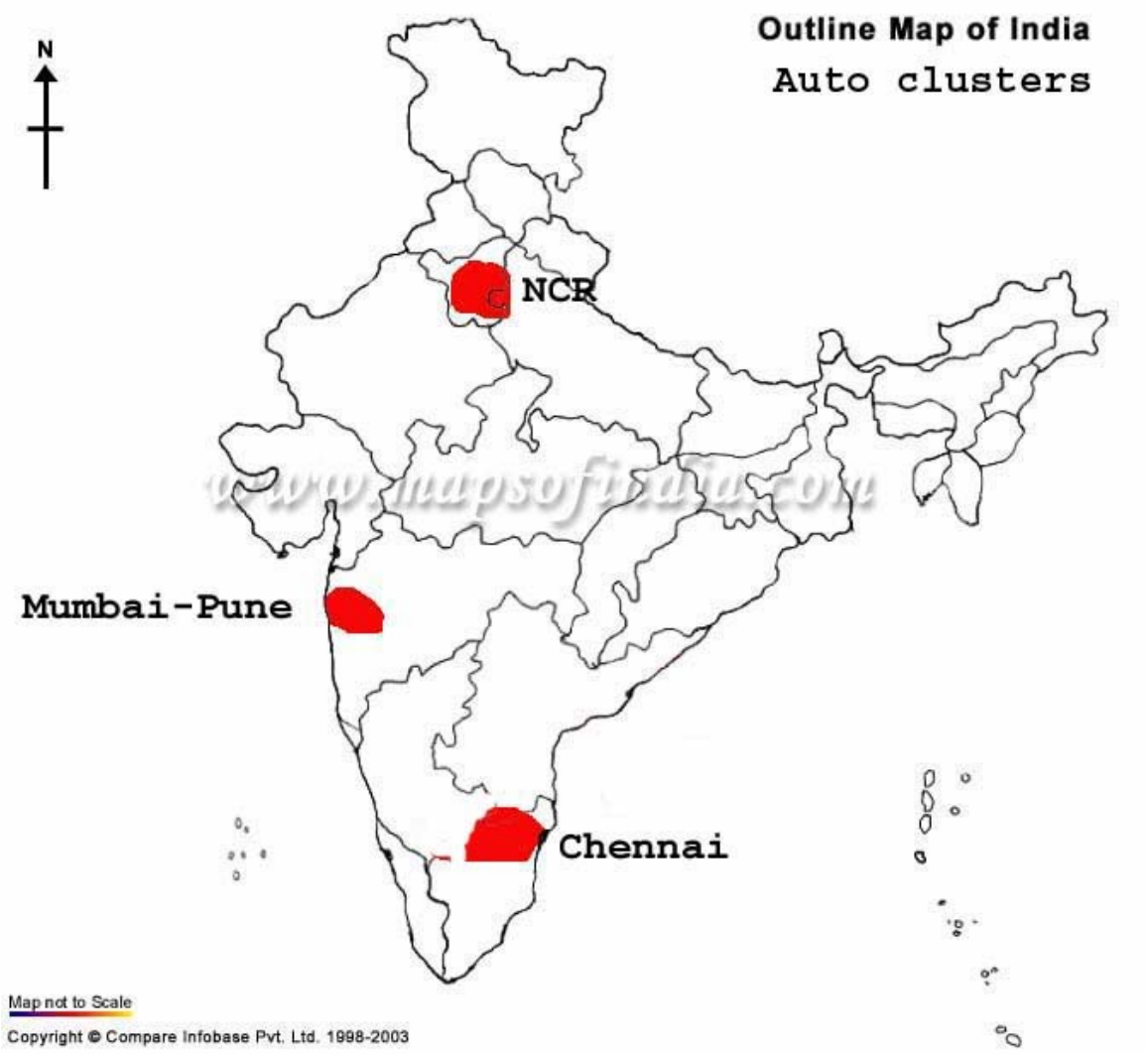


Table 3: **Indexes of Social & Economic Infrastructure & Human Development**

State	Social Eco. Index	Social Eco. Index Rank	HDI Value	HDI Rank	Enrolment Ratio – 11-14 years
Year	2000	2000	2001	2001	2002-03
North					
Punjab	187.57	1	0.537	2	59.09
Haryana	137.54	4	0.509	5	67.33
Rajastan	75.86	15	0.424	9	55.67
UP	101.23	10	0.388	13	46.84
Bihar	81.33	11	0.367	15	24.98
MP	76.79	14	0.394	12	63.50
East					
Assam	77.72	13	0.386	14	56.22
W.Bengal	111.25	7	0.472	8	58.00
Orissa	81	12	404	11	56.43
West					
Gujarat	124.31	5	0.479	6	75.94
Maharashtra	112.8	6	0.523	4	86.97
South					
AP	103.3	9	0.416	10	63.12
Karnataka	104.88	8	0.478	7	74.28
Kerala	178.68	2	0.638	1	97.07
Tamil Nadu	149.1	3	0.531	3	99.08
All India	100	-	0.472	-	60.99

Source: Col.2&3, 11th Finance Commission, Government of India; Rest, Economic Survey, Government of India.

4. State-wise Geographical Distribution of FDI Flows

There are very few analytical studies on the inter-state or inter-province differences in FDI inflows. However, several studies analyze inter-country differences in FDI emphasizing location advantages (Wei 2000; Habib and Zurawicki 2002; Globerman 2002; and Globerman and Shapiro 2003). Scholars have traditionally identified various locational advantages such as size of the market, income, and the growth rate; membership of the regional union; labor and skills; infrastructure (e.g., transport, telecommunications, electricity, and port facilities); and institutional framework (customs, legal dispute settlement, and the Rule of Law). More recent studies have focused on such factors as technological status, brand name, openness of the economy, and macro trade policies of the government, and intellectual property protection. Other recent studies indicate the importance of the tax rate, corruption, good governance, and skill content of the work force in influencing FDI (Wei 2000; Habib and Zurawicki 2002; Globerman and Shapiro 2003). For example, Wei's (2000) study analyzes the determinants of the bilateral stocks of FDI from 12 source countries to 45 host countries. The source countries include the U.S., Japan, Germany, U.K., France, and Italy. In analyzing FDI, the following explanatory variables are used: tax rate, corruption, tax credit, political stability, GDP, population, distance between the two countries, linguistic ties between countries and the wage rates. The study shows the overwhelming importance of the tax rate, corruption, political stability and skill content of the workforce in influencing FDI.

Habib and Zurawicki (2002) analyze the impact of corruption on FDI for 89

countries for the period 1996-98. They use the corruption perception index produced by the Transparency International. In explaining FDI inflows, in addition to corruption they also introduce the following variables: population, GDP growth, per capita GDP, unemployment rate, openness of the economy as measured by the ratio of trade to GDP, science and technology indicators, cultural distance and political stability. Their findings suggest that corruption is a serious obstacle for investment. Apart from corruption, geographical distance and economic ties also emerge as important determinants of FDI.

Globerman and Shapiro (2003) examine the statistical importance of government infrastructure as a determinant of FDI. They conducted the analysis in two stages. In the first stage the probability that a country was a recipient of US FDI was estimated. In the second stage their analysis was restricted to those countries that did receive FDI flows and estimated equations that were focused on the determinants of the amount of FDI received. These measures include the following: (a) rule of law index, which measures contract enforcement, property rights, theft and crime; (b) political instability and violence index, which measures armed conflict, social unrest, ethnic tension and terrorists threats; (c) regulatory burden index, which measures government intervention, trade policy and capital restrictions; (d) government effectiveness index, measuring red tape and bureaucracy, wastes in government and public infrastructure; (e) graft and corruption index, measuring corruption among public and private officials and the extent of bribery; and (f) voice and accountability index, which measures civil liberties, political rights, free press, and fairness of the legal system. Their results

consistently show that governance infrastructure is an important determinant of whether a country will receive any US FDI, and, if so, how much. All the governance variables considered in the study are relevant for inter-state analysis in India as these indicators differ significantly between the Indian States. The determinants of FDI locations that emerge from econometric studies are summarized in Chart 1.

Figure 1: FDI and Locational Advantage: Factors determining FDI Inflows

Table 4: FDI Approvals August 1991 – June 2002

State	Amount Rs. billion	Percentage to Total
Maharashtra	487.2	17.32
Delhi	338.1	12.02
Tamil Nadu	234.7	8.34
Karnataka	219.4	7.80
Gujarat	184.5	6.56
Andhra Pradesh	130.9	4.65
Madhya Pradesh	92.3	3.28
West Bengal	88.1	3.13
Orissa	82.3	2.92
Rest of the states	955.8	33.98
Total	2813.3	100

Source: Economic Survey, Government of India.

As Table 4 indicates, the top six States that received high levels of FDI inflows are also at the top in terms of high domestic corporate investment inflows (see Table 2). By and large, most investments went to the coastal areas and the NCR (Delhi and the surrounding areas). As Map 8 shows, the rest of the States received very little investment, both domestic and foreign. Moreover, the States that received higher inflow of FDI enjoyed higher levels of per capita income than the Indian average.[6] For example, in 2000, the per capita income of the States with large FDI inflows were: Maharashtra, Rs.23,398, Delhi, Rs.35,705, and Tamil Nadu, Rs.19,141. States with small FDI such as Bihar and Uttar Pradesh had lower per capita income levels of Rs.6,328 and Rs.9,765, respectively.

Thus, in India, by and large, these six States stand out in terms of both industrial agglomeration and FDI inflows, suggesting the important role of FDI in forming industrial clusters: Tamil Nadu enjoys an 8 percent share in Indian FDI

[6] The per capita income of India in the year 2000 (at current prices) was Rp. 15,562.

inflows; a 10 percent share in total corporate investments; ranks third in HDI and the socio economic index with more than 99 percent of the children in the age group of 11-14 attending schools; and produces 6 percent each of pharmaceuticals and consumer electronics. In the case of automobiles (to be discussed in the next section) it produces about 35 percent of auto components and houses three major auto manufacturing firms, namely, Hyundai, Ford and Ashok Leyland.

Karnataka accounts for 7.8 percent of FDI inflows; an 8.86 percent of corporate investment; ranks eight in socio economic index and seven in HDI with more than 74 percent of children in the age group of 11-14 attending school; produces 15 percent of electronic hardware; and 10 percent of consumer electronics.

Andhra Pradesh accounts for about 5 percent of FDI inflows; a 9.7 percent of total corporate investment, occupies ninth rank in socio economic index and is tenth in the HDI with more than 63 percent of children in the age group of 11-14 attending schools; produces about 10 percent of pharmaceuticals and 9 percent of consumer electronics. Among the Southern States Andhra has done relatively poorly in the socio economic and human development index. Correspondingly, it has also not done very well in terms of investment inflows.

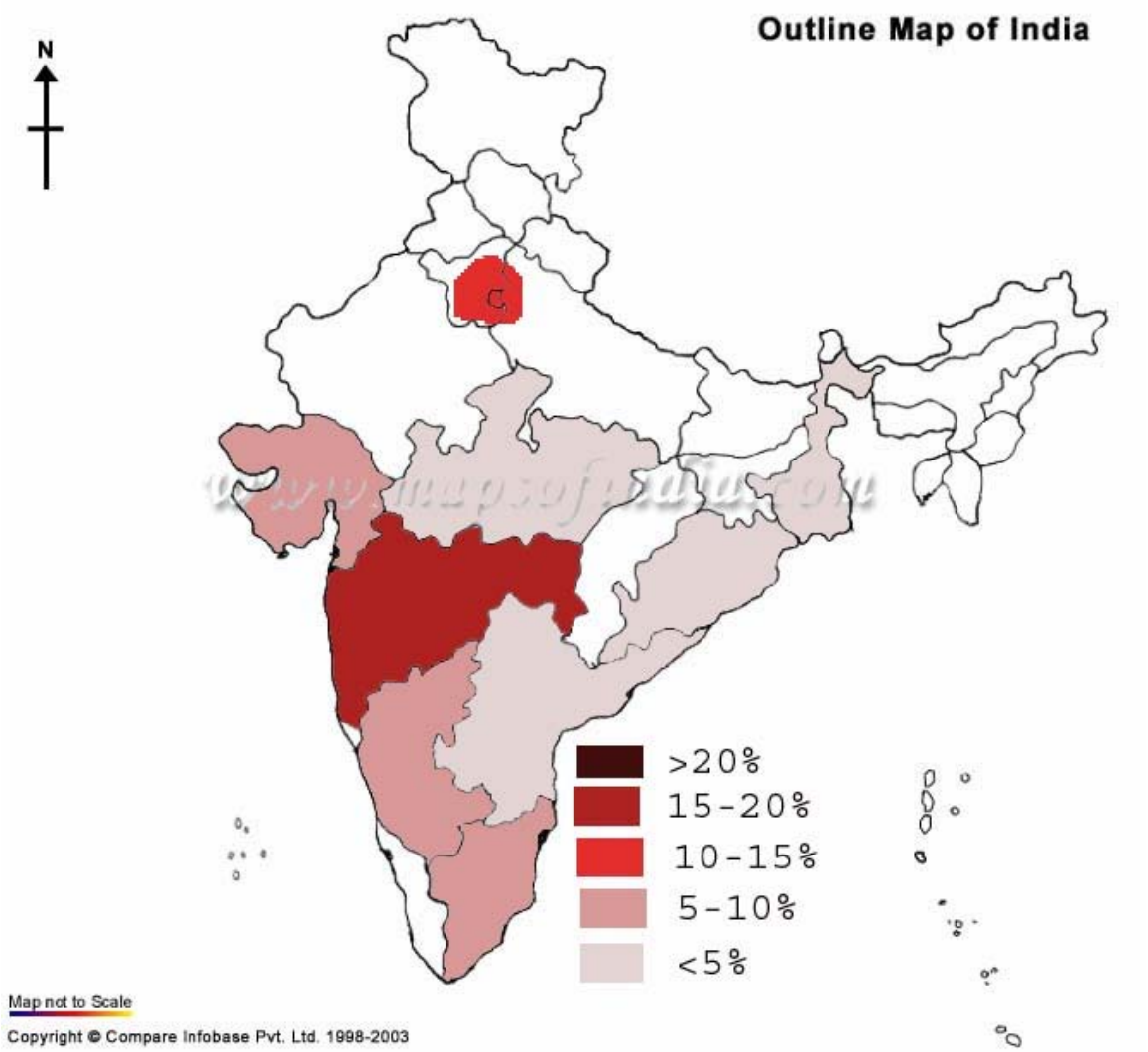
Maharashtra attracts 17 percent of FDI; a 12 percent of corporate investment; occupies the rank sixth in the socio economic indicators and fourth in HDI with more than 86 percent of children in the age groups of 11-14 attending schools; produces about 26 percent of pharmaceuticals; 9 percent of electronics hardware; and 27 percent of consumer electronics. It also houses two of India's leading auto companies, namely,

Bajaj Auto and Tata Motors.

Gujarat gets 6.56 percent of FDI inflows; a 19 percent of corporate investments; occupies the fifth rank in socio economic indicators and the sixth position in HDI with more than 74 percent of children in the age group of 11-14 years attending schools; produces 15 percent of pharmaceuticals and 12 percent of electronics hardware.

The NCR, which includes Delhi and parts of Haryana and Uttar Pradesh that are adjacent to Delhi, accounts for 12 percent of FDI flows; 13 percent of corporate investment; 22 percent of electronic hardware production; and 32 percent of consumer electronics production. While Haryana has a reasonably good school enrolment ratio of 67 percent, Uttar Pradesh has a miserable 46 percent.

Map 8: Distribution of FDI by State



5. A Study of Two Auto Clusters: Chennai and the National Capital Region

In this section we focus on two of India's leading clusters of another key manufacturing industry, the automobile industry located in, namely, Chennai (the state capital of Tamil Nadu) and the NCR, and consider the factors that contributed to the development of these clusters.

5.1 The Evolution of the Indian Automobile Industry

Before considering the two clusters, we briefly outline the historical evolution of auto clusters in India. During the mid-1950s, the automotive industry started in India. Before then, India imported cars and most spare parts. Large family-owned conglomerates, locally known as business houses, took the lead in the import of cars and spare parts. The main importers of spare parts were the TVS group and the Amalgamations group in Madras (now renamed as Chennai), Anand and Nandas (Escorts) in Delhi, and Doshi in Bombay (now Mumbai). In 1957, the Indian Tariff Commission decided to discourage imports and encourage the manufacturing of automobiles and spare parts in India as part of India's inward-looking import substitution industrialization strategy. Consequently, the main importers entered into manufacturing: The Birla group (Hindustan Motors, setting up a plant in Calcatta to produce Ambassador); Doshi (Premier Auto in Bombay). Standard Motors (Standard Herald in Madras). the Tata Engineering and Locomotive Co. Ltd. (TELCO; recently renamed as Tata Motors, one of over 120 affiliated firms of the Tata group) (in

Jamshedpur in the state of Bihar to produce Tata trucks),[7] and Ashok Leyland (in Madras, to assemble Leyland trucks and chassis). Thus, auto clusters have started to emerge in Mumbai and Chennai.

Out of these initial ventures, except for TELCO and Ashok Leyland, the rest have ceased to be important players or have gone out of business. This is partly because the government, through the implementation of its 1963 Monopolies and Restrictive Trade Practices (MRTP) policy, which introduced an extensive licensing regime, restricted the activities of large private business houses in order to control monopolies and the growth of private firms and to promote public-sector enterprises (Encarnation 1989; Okada 2000). Moreover, the government had also restricted the inflow of FDI since the early 1970s, both in terms of the sectors to enter and the equity share, to promote the localization of the domestic industries and limit FDI only to the sectors that accorded with the government priority (Lall 1987; Encarnation 1989; Okada 2000).[8] These policies have resulted in a stagnation of the automobile industry in terms of both output growth and technological development for more than two decades until the mid-1980s, when the government started gradually lifting these inward-looking and restrictive policies, and entered into a joint venture with Suzuki Motors to establish MUL, as discussed in more details in the subsequent subsections.

With the Indian government's introduction of the new economic policy and new industrial policy in 1991, the Indian automobile industry has experienced rapid

[7] Initially, TELCO entered into a joint venture with Mercedez-Benz, as a half of the 120 Tata affliated firms did, in the late 1950s, but the partnership expired in 1962 (Encarnation, 1989).

[8] The government restricted the inflow of foreign capital, and the Foreign Exchange Regulation Act (FERA) of 1974 forced foreign investors to keep their share to 40% or less (Lall 1987). For the detailed discussions of this policy and its effects, see Lall 1987.

transformations, with many new entrants forming joint ventures with foreign car manufacturers, drastically changing the structure of the automobile industry. By the mid-1990s, the Indian automobile industry consisted of about two dozen assemblers of different vehicle types and the component manufacturing industry, which in turn consisted of about 350 large- and medium-scale firms in the organized sector, and approximately 6,000 small firms, which are mostly in the unorganized sector (ACMA 1995).

5.2 Chennai Auto Cluster

Currently, as a leading auto cluster in India, Chennai (or Tamil Nadu) accounts for 21 percent of passenger cars, 33 percent of commercial vehicles and 35 percent of of the auto components produced in India. At present, over 100 medium and large auto companies are located in and around the Chennai cluster. In the auto component industry, Tamil Nadu has a more than 50 percent share in the production of inlet and exhaust valves, valve guides, valve tappets, fuel pumps, oil pump assembly, thermostat, timings chair, water pump assembly, starter motors, alternators, camshafts, oil seals, brake linings, wiper motors, air brake assembly and engines. It enjoys between a 30 and 50 percent share in the voltage regulations, flywheel magnetos, steering gears, wheel rims, electric horns, and dashboard instruments. Further, it has between a 10 and 30 percent share in delivery valves, crankshafts, bi-metal bearings, radiators, clutch plates, clutch assembly, shock absorbers, tyres and automotive seats. Most of them have ISO certification and about a quarter of them have QS certification. Chennai's

emergence as one of India's leading auto clusters is due to historical, political and economic factors, as discussed below:

5.2.1 The Emergence of Chennai Auto Cluster

First, when the Tariff Commission decided to discourage imports and favor the domestic production of automobiles and spare parts, several Tamil Nadu-based firms like TVS and Standard Motors were already at the forefront. For example, the TVS group set-up plants in Madras (Chennai) and developed an important industrial enclave in a locality called Padi at the outskirts of the city. The emergence of Madras, Bombay, and Calcutta as important auto clusters until the early 1960s is partly because these cities had important seaports. Clearly, proximity to a seaport was an important consideration for the formation of the auto clusters in the earlier years, as until the early 1960s the industry (including the component sector) heavily depended on imports.

Second, during the late 1950s and the early 1960s, these local firms were actively supported and promoted by the Government of Tamil Nadu, (which was earlier called Madras State) and in particular, its Chief Minister, K. Kamaraj, the Industry Minister, R. Venkataraman (who later-on became a Member of the Indian Planning Commission and the President of India) and T. T. Krishnamachari.[9] These political leaders were instrumental in giving industrial licenses to firms to set up heavy vehicles factories and truck manufacturing plants in and around Chennai.

Third, several Tamil Nadu-based industrialists, such as those of the TVS group,

[9] T.T. Krishnamachari was from Tamil Nadu and occupied some key cabinet ministerial positions in the Government of India including that of Finance, Commerce and Industry, playing a key role in the development of the auto industry in Tamil Nadu.

MRF, Ashok Leyland, Standard Motors, and the Rane group, played a notable role in forming the auto cluster in Chennai.[10] For example, Mammen Mappillai, who started off with a toy balloon plant in a small shed in Tiruvottiyur (a Madras suburb) in 1946, became one of the largest tyre manufacturers in India. In 1952, he started manufacturing tread rubber, which gradually blossomed into MRF with the technical collaboration with Mansfield Tire and Rubber Company, US, in 1961. By 1967, MRF had started exporting tyres to the U.S.[11]

5.2.2 Capacity Building: Infrastructure, Human Resources and Institutions

Several additional factors explain the subsequent development of the Chennai cluster after its initial formation in the 1950s. One important factor that attracts FDI and domestic firms in auto and information technology (IT) industries in Chennai is the adequate infrastructure – both physical (particularly reliable telecom network), and of human resources (a steady supply of skilled workforce), and government interventions in terms of investments in technology parks including IT and auto parks. With regard to human resources, Tamil Nadu produces the largest number of engineering graduates in the country (Ramachandran and Goebel 2002). In Chennai, several engineering colleges are located, including the Indian Institute of Technology (IIT), the Guindy Engineering College, and the A. C. College of Technology. In addition, some regional engineering colleges and several private engineering colleges were also established in

[10] They include T. V. Sundaram Iyengar (TVS group); Mammen Mapillai (MRF); Raghubir Saran (Ashok Leyland); Gopalakrishnan of Union Motors (Standard 10, Standard Companion, and Standard Herald and Gazel); N. Mahalingam, (Anamalai Body Building Works for trucks and buses and Anamalai Tyre Retreading); L. G. Brothers (body building and auto equipment); L. L. Narayanan (Rane Group, producing steering wheels and brake linings); and Anantharama Krishnan (India Pistons, Tractors and Farm Equipment and SRVS).

[11] Even today tyres for Rolls-Royce cars roll out from MRF.

Tamil Nadu. As industrial estates were set up, several technical institutes to train technicians and mechanics were simultaneously set up. Moreover, the State government introduced a mid-day meal program in primary and secondary schools to improve attendance in the schools and reduce dropout rates. Thus, from primary schools to highly sophisticated engineering institutes, Tamil Nadu already had the education institutions in place in the late 1950s. Furthermore, during the 1980s, several new engineering colleges were set up both by the government and the private sector. Lower-level technical institutions such as the government-run Industrial Training Institutes (ITI) to train technicians proliferated, and consequently Tamil Nadu emerged as the state that produced the largest number of technical graduates. The state government has also involved the private sector in training workers and professionals. At the same time, the mid-day meal program in primary and secondary schools was strengthened and its scope widened. As a result, as discussed earlier, 99 percent of children in the age group of 11 – 14 attend schools – the highest percentage in India.

With regard to infrastructure, Chennai has an international airport and two sea ports, the second one was recently constructed at distance of 25 kilometres from the city. In addition to the two Chennai ports, Tamil Nadu has an all-weather port at Tuticorin, as well as two intermediate and six minor ports.

Moreover, the State government gives a number of financial incentives like capital subsidies, power tariff concessions, sales tax waiver and other schemes to firms located at the industrial estates created by the State government. Moreover, four major state agencies are actively involved in soliciting and facilitating FDI in the State:

Electronic Corporation of Tamil Nadu Ltd; the State Industrial Promotion Council of Tamil Nadu Ltd.; Tamil Nadu Industrial Guidance and Export Promotion Bureau; and Electronics Test and Development Center.

The human and physical infrastructure provided by the government and the presence of large component manufacturing firms attracted global firms like the Ford, Hyundai and Mitsubishi to set-up plants in Chennai. The arrival of these firms had a major impact on the Chennai auto cluster resulting in a radical restructuring of the industry. Till the early 1990s, Tamil Nadu was mainly producing components to the Indian market. The main auto component suppliers of Chennai like the TVS and Amalgamations groups made strategic use of the government's earlier policies like subsidized access to overseas technology, support for participation in international trade fairs, and have emerged globally competitive to face the current WTO regime (Tewari 2003).

5.2.3 Lead firms in Chennai Cluster

Several Chennai-based firms, which are mostly Indian conglomerates, have played a critical role as lead firms in the development of the Chennai auto cluster, including the TVS Group, the Rane Group, and Ashok Leyland Ltd. The TVS Group originally started as a transport company in 1911 and now has over 29 companies as India's leading suppliers of automotive components, many with FDI involvement.[12] For example, a group firm, Wheels India Ltd., was set-up as a joint venture between

[12] TVS & Sons Ltd., the parent and holding company of the TVS group, was established in 1911 and now has become the largest automobile distribution company in India with a turnover of more than US $450 million.

TVS and Dunlop, UK., in 1960, and was located in Padi at the outskirts of Chennai. Engaged in producing wheels for commercial vehicles, cars, jeeps, tractors, construction equipment, earth moving equipment, and defence vehicles, it supplies components to all the vehicle manufacturers in India. Another group firm, Lucas-TVS, a joint venture with the Lucas Variety group, UK and the TVS group, was established in 1961 and is a leading manufacturer of auto electrical products and diesel fuel injection equipment in India. It covers all segments of the auto industry – passenger cars, jeeps, light and heavy commercial vehicles, industrial engines, tractors and two wheelers. Its products include starter motors, alternators, dynamos, regulators, wiping systems, blower motors, fan motors, power window systems, ignition systems and horns.

Other group firms such as Brakes India, Sundaram Clayton Ltd., Sundaram Fastners Ltd., and Turbo Energy Ltd., were all established in the 1960s, as a joint ventures with British firms, and are all located in Padi at the outskirts of Chennai. Brakes India, incorporated in 1962 as a joint venture between TVS & Sons and Lucas Industries Plc., U.K., to manufacture brake equipment, caters to over 60 percent of the domestic OEM market and exports to over 35 countries. Sundaram Clayton Ltd. is the first firm to manufacture brake systems in India and has been the market leader since its inception. It exports to U.S., U.K., Egypt, Australia, Sri Lanka, Middle East and East Asian countries. Sundaram Fasteners Ltd. has emerged as the largest manufacturer of high tensile fasteners in India and is the key supplier of radiator caps to General Motors (GM)'s U.S. plants. It manufactures standard fasteners like hex head bolts, screws and

nuts; special fasteners like connecting rods bolts and nuts, cylinder head bolts and nuts, main bearing cap bolts, and wheel.

Similarly, other Chennai-based group firms established in the 1980s and the early 1990s such as Turbo Energy Ltd.,[13] India Nippon Electricals Ltd., Sundaram Dynacast Ltd, also have technical and financial collaboration with component manufacturers abroad such as Germany, Japan, and the U.S., producing key components such as turbo changers, electronic ignition systems, and precision engineering components. India Nippon Electricals Ltd., established in 1985 as a joint venture between Lucas Indian Service and Kokusan Denki Co. Ltd, Japan, manufactures electronic ignition systems for two wheelers and portable gensets. Its products are fitted on vehicles manufactured by TVS Motors, Bajaj Auto, Hero Honda, Hero Punch and other two wheelers. Sundaram Dynacast Ltd., incorporated in 1993 as a joint venture between Dynacast International, UK., Brakes India and Sundaram Finance, to manufacture small precision engineering components at its Padi (Chennai) plant. It caters to the automotive, electrical, electronic, clock industries and writing instruments. For automobiles it produces tyre valves, spark plug terminal caps, components for two and four wheelers. It exports automotive and industrial fasteners.

TVS Cherry Limited, established in 1994 as a joint venture between TVS and Cherry Electric Corporation, USA, manufactures precision miniature, sub-miniature, selector switches and hall effect sensors for the appliances industry, office automation

[13] The firm was established in 1982 in technical and financial collaboration with Aktiengesellschaft Kuhnle, Kopp & Kausch, Germany. Its manufacturing plant is located in Chennai and Vellore (Tamil Nadu), and its R&D unit in Padi, Chennai.

and industrial applications. It also produces key switches and advanced performance/special purpose keyboards for the IT industry. India Japan Lighting Ltd., incorporated in 1996 is a joint venture between Lucas-TVS and Koito Manufacturing Co. Ltd., Japan, which is a company that has been in business for over 80 years and is a leader in lighting equipment in Japan. The joint venture manufactures headlamps, rear combination lamps, signal lamps and other small lamps. The factory is located at the outskirts of Chennai.

TVS Motor Co. Ltd. is one of the largest growing companies in India and is the largest manufacturer of the sub 100 cc two wheelers in the world. It exports its range of products to 17 countries worldwide. Its products include motorcycles, mopeds, scooterettes, and scooters. It originally started as TVS – Suzuki, a joint venture between the TVS group and Suzuki Motors of Japan and started manufacturing Suzuki 100cc motorcycles in 1984. During 1999-2000, TVS – Suzuki was amalgamated with Sundaram Auto Engineers Ltd., an unlisted TVS group company. Suzuki ceased to be a shareholder of the company in the year 2000-2001.

Likewise, the Rane Group has many group firms manufacturing automotive components in Chennai. For example, its flagship firm, Rane Engine Valves Ltd., was established in 1959, manufacturing engine valves, valve guides, tappets, crank shafts for compressors and clutch boosters, which are exported to Australia, the Far East, Germany, Iran, Italy, Middle East, U.K. and U.S. Other main group firms include Rane Brake Linings, Rane Madras, Rane NSK Steering Systems, the Rane TRW Steering Systems, producing a wide range of products, such as brake linings, disc pads,

clutch facing and railway brake blocks, valves for internal combustion engines, seat belts, power steerings,. hydraulic steering pumps, safety seat belt system and emergency locking retractors. Rane Brake Linings Ltd., has developed asbestos free material, and has also developed and commercialized new formulations for the new range of vehicles. Kar Mobiles Ltd., established in 1974, is the second largest manufacturer of valves for internal combustion engines in India. It has technical collaboration with TRW, the U.S. Its exports constitute 50 percent of its turnover and it is the first firm in India to be designated as vendor by the General Motors, the U.S. Furthermore, Rane TRW Steering Systems Ltd., established in 1987, is a 50:50 joint venture with TRW and has technical collaboration with UNISIA JKC, Japan. It produces integrated power steerings, power racks and pinion steering, hydraulic steering pumps, safety seat belt systems and emergency locking retractors. Rane NSK Steering Systems Ltd., established in 1995 and started production in 1997. It also is a 50:50 joint venture with NSK Japan, producing solid steering columns, energy absorbing and collapsible columns, tilt and telescopic steering columns, intermediate shafts and universal joint assemblies. Clearly, these industrial houses (conglomerates) have played a critical role in developing Chennai's auto cluster.

Ashok Leyland Ltd. (ALL), established in 1948 as Ashok Motors, the second-largest manufacturer of medium/heavy commercial vehicles in India today, also initially started to assemble Austin car parts in India. In 1955, however, it entered into an agreement with Leyland Motors, U.K., to manufacture Leyland vehicles and changed

its name to Ashok Leyland.[14] ALL's manufacturing plants are located at Ennore (Chennai), Ambattur (Chennai), Hosur (Tamil Nadu). Recently it has also established plants outside Tamil Nadu—in Bhandara (Maharashtra), Hyderabad (Andhra Pradesh) and Alwar (Rajastan). During 2003/04 it produced 12,996 commercial vehicles in the medium and heavy category and exported 1,604 vehicles. ALL and Sundaram Industries (TVS group) have together joined hands with Irizar of Spain, to float a joint venture company, Irizar TVS, to manufacture bus bodies in India. The assets of TVS Coach (the erstwhile JV of Sundaram Industries and ALL), which owns two bus body building factories in Tamil Nadu have been transferred to the new joint venture company, Irizar TVS in which all the three partners have equal shareholdings.

Interestingly, therefore, except ALL, the lead firms in the Chennai auto cluster are rather than assemblers, all component manufacturers that were established in the 1960s, long before India's motorization started, making Chennai quite unique, compared to other auto clusters in India or elsewhere.

5.2.4 Industrial Estates and Small Firms

The Chennai cluster also comprises of small industries. The entrepreneurial skills of many small firms have contributed to the success of the auto cluster (Sridhar 2002). Chennai has several industrial estates, providing factory space at relatively low rents and other facilities to firms operating there. The Guindy industrial estate – the largest in Chennai – was established by the State government in 1958 in a 100 acres plot.

[14] The Hinduja Group and IVECO, Italy (a subsidiary of Fiat) acquired Leyland, UK in 1987 thus making Land Rover Leyland International, UK as the holding company of ALL. The Holding company holds 50.9% of stake in ALL s equity.

The estate provides technical services like mechanical, metallurgical and chemical testing laboratories, tool rooms, forging and a heat treatment shop and a wire drawing unit. It also has a library and technical information section. Chennai also houses other industrial estates at Ambattur, Arumbakkam, Villivakkam, Kodungaiyur, Madhavaram and Perambur. Currently, the smaller firms have also tended to globalize and started exporting to large MNEs.

Two factors facilitated the globalization process of the small firms operating from several industrial estates located in Chennai in recent years. First, the presence of a large number of IT firms in Chennai that have enabled them to take advantage of Business to Business Commerce (B2B commerce). Second, because of the decision of the U.S. government to discourage or even prevent the establishment of forging and casting firms, several MNEs have been outsourcing these activities to overseas firms, and Chennai has been a beneficiary of this emerging practice.

5.2.5 Recent Growth of the Information Technology Industry and the Auto Cluster

Furthermore, in the 1990s onwards, the growth of IT industry in Tamil Nadu complemented that of the auto components sector (Tewari 2003). The Chennai auto cluster increasingly moved into the production of parts with IT-enabled systems for OEMs as well as for their suppliers. Further, the rise of IT capabilities among local firms in Tamil Nadu has made it easier for non-proximate regional suppliers in the auto components sector to work closely with distant customers and their multi-locational networks (Tewari 2003). Thus, Tamil Nadu firms developed an advantage in bidding

for export contracts for small, standard parts on-line and receiving requests for quotas (RFQs) from global players like GM and Ford.

The good performance of the Chennai components industry did not result automatically from a neo-liberal deregulation of the economy since 1991 or from the arrival of MNEs in the auto sector. It occurred due to the way the government handled the deregulation of the auto-sector: the current success of the industry is mainly due to the pace and the sequencing of the government's liberalization of the sector, which was highly graded and strategic (Tewari 2003).

5.2.6 The Arrival of Global Assemblers in the 1990s

Following the de-licensing by the government of the auto industry in 1993, the automobile industry witnessed rapid transformations with the entry of many global players into India in the 1990s, making the domestic market increasingly competitive. During 1996 and 1999, the arrival of Ford, Hyundai and Hindustan Motors Ltd. (HML) (via a licensing agreement with Mitsubishi Motors)[15] further transformed the Chennai auto cluster, as they have established passenger car production and assembly operations in Chennai. They have invested $1.5 billion in Tamil Nadu (Tewari 2003) and have established a combined capacity of 230,000 cars per year: Hyundai has invested about $1 billion, Ford about $400 million and HM-Mitsubishi about $150 million. Hyundai has succeeded in emerging as the second most important car manufacturer after Maruti Udyog Ltd. (MUL) in a very short period. Ford in Tamil Nadu from its very inception

[15] Hindustan Motors's Chennai plant is engaged in manufacturing of Lancer cars in technical collaboration with Mitsubishi Motors, and in manufacturing and sales of the spare parts used in the Lancer cars.

has been concentrating on building its global platform apart from targeting the Indian market. Consequently, Ford and Hyundai are very active in the exports market. Thus, during January-December 2003, Ford exported 24,000 cars and Hyundai 30,000 cars. The arrival of these MNEs has clearly boosted the components sector in the Chennai cluster, as they are required to increase their local content. After the 1991 new economic policy and the 1991 new industrial policy, in its interest to promote FDI, the Indian government deliberately formed no specific policy on the automobile sector with respect to local content. While its Phased Manufacturing Program (PMP) was lifted in 1992, however, the government still implicitly demanded 50 percent local content in approving foreign collaboration proposals in the 1990s; this would rise to 70 percent after five years, often specified in the "Memorandum of Understanding" (MOU) signed with each new entrant on a case-by-case basis (Humphrey et al. 1998; Okada 2000).

Hyundai has set up a 100 percent subsidiary firm (its largest investment outside South Korea) in 1998. It initially brought about 14 South Korean component suppliers to the Hyundai plant in Korea, to supply components that are not available in Chennai. Nevertheless, in Chennai, these Korean component manufacturers have been sourcing materials and parts from small firms in industrial estates located in and around Chennai. Currently about 50 percent of the components are sourced by Hyundai from Tamil Nadu and about 85 percent of the components are sourced from India. Hyundai has about 70 major component suppliers; of these, only 14 are Korean joint ventures and the rest are mainly Tamil Nadu-based firms. Recently, Hyundai has announced a plan to build a second assembly plant in Chennai next to its current plant. The new plant will have an

annual capacity of 150,000 units and will be constructed on a 74.2 million square foot site. With this the Hyundai's manufacturing capacity in Chennai will increase to 400,000 vehicles. In addition to serving the Indian market, it will cater to the export markets in Europe, Latin America and he Middle East. During 2003/04, Hyundai produced 170,942 cars of which 135,008 were in the compact car segment, 34,698 in the mid-size segment (in the latter, Hyundai is the market leader, followed by Tata Motors, which produces 28,107 vehicles), and in the premium class segment, it produces 1,236 cars, while exporting 35,752 compact cars and 6,363 mid-size cars.

Ford imports some of the key parts but claims 75 percent local content. However, the local suppliers have joint ventures with US firms or have entered into technology licensing with US firms. Within two years of its operation in Chennai, Ford opted for global sourcing of components from Tamil Nadu. It also had short-listed global suppliers from Tamil Nadu. During 2003/04, Ford sold 45,035 cars of which 44,881 were mid-size cars and 154 premium cars, while exporting 25,000 mid-size cars.

In contrast to Ford and Hyundai, HM-Mitsubishi is mainly dependent on imported components from Japan; its local sourcing is only about 30 percent. The import intensity of HM-Mitsubishi is attributed to its very low volume and concentration on the luxury segment where price competition does not prevail (Tewari 2003). The other two producers have a presence in all the segments and recognize the importance of volume and hence their preference for Chennai and Tamil Nadu-based suppliers. Thus, agglomeration of the automotive component industry in Chennai,

mainly led by Indian business houses with foreign collaboration, preceded the entry of large assembler firms in the cluster. It is only in the last several years that foreign auto makers have become the lead firms.

In sum, several factors were critical in the formation and development of the Chennai auto cluster. First, the government intervention both at the Center and State levels played a crucial role in the emergence and later development of the Chennai cluster. In the late 1950s and early 1960, Tamil Nadu had very dynamic political leadership that was instrumental in bringing auto component firms to Chennai. The State government also established many industrial estates to promote small firms and ancillary units, many producing auto components.

Second, the presence of well-developed infrastructure, particularly access to a seaport, airport and other infrastructure facilities attracted entrepreneurs to opt for Tamil Nadu, and in particular, Chennai. Third, the presence of well-established Indian family-owned business houses in Tamil Nadu like the TVS group, the Rane group, and the Chettiars (who are mainly bankers and business men) further helped. Fourth, Chennai and other cities in Tamil Nadu enjoy a secure supply of a highly skilled workforce through several engineering colleges, including India's prestigious Indian Institute of Technology (IIT).

Fifth, small firms and ancillary units played a very important role in the development of the Chennai cluster. The TVS, Rane and the Amalgamations Groups set-up ancillary and component units in the late 1950s and early 1960s and were instrumental in developing industrial clusters in North Chennai. The TVS group in

particular, developed the Padi enclave at the outskirts of Chennai. These auto component manufacturing firms, targeted the all-India market and not the limited Chennai market from inception. The scale of operations of the two auto assemblers – Standard Motors (it has since gone out of business) and Ashok Leyland, were not large enough to sustain the component manufacturers. Having established themselves firmly and having developed industrial enclaves, these firms and the TVS group in particular, kept expanding their activities by continuously starting new ventures and adding new product lines to their existing ventures. Several small firms set up plants in the industrial estates to supply material and smaller components to these groups. The presence of these major component producing groups and small suppliers located in the industrial estates located in and around Chennai encouraged the entry of large global players like Ford, Hyundai and Mitsubishi in the late 1990s.

Finally, the emergence of the IT industry in Chennai and Tamil Nadu and the rapid development of the internet infrastructure have helped small and medium firms to globalize and take advantage of B2B commerce. In this respect, the patterns of development of the Chennai cluster differ considerably from other clusters elsewhere such as in Viet Nam and China (Kuchiki 2004), where a large assembling firm serves as the lead firm helping set up and develop ancillaries. Interestingly, by contrast, in the Chennai cluster, the direction of the development was different.

5.3 National Capital Region (NCR) Cluster

In the development of the NCR auto cluster consisting of Haryana, Delhi and some districts of Utter Pradesh adjacent to Delhi, Maruti Udyog Ltd. (MUL) played a

leading role. Therefore, this cluster, by and large, follows the traditional pattern of auto clusters led by assemblers that served as lead firms.

5.3.1 The Growth of the Passenger Car Segment and the Emergence of an Industrial Leader

Maruti Udyog Ltd. started in 1982 as a joint venture firm between the Indian government and a Japanese automaker, Suzuki Motor Corporation.[16] Maruti Udyog Ltd. set up its first plant in Gurgaon, then a newly developing industrial town in Haryana adjacent to Delhi, as a "greenfield" plant. It was the first modern assembly plant in India, as it was a close copy of Suzuki's Kosai plant in Japan, in terms of plant layout, equipment, the organization of production and the operating principle. It set up its second plant in Gurgaon in 1992, and third plant in NOIDA, also as part of the NCR, in 1999. The firm started its production by 1983. It has since emerged as the largest car manufacturer in India, by initially focusing on the small car segment, which had been virtually untapped in the Indian market until Maruti Udyog Ltd's entry. Maruti Udyog Ltd. cars were 21 percent cheaper than the lowest-priced existing passenger car produced by domestic manufacturers, yet offered much higher quality, more safety features and greater fuel efficiency (Humphrey et al. 1998; Okada 2000). In response to the increased variety in consumer tastes, in the early 1990s, the firm also diversified

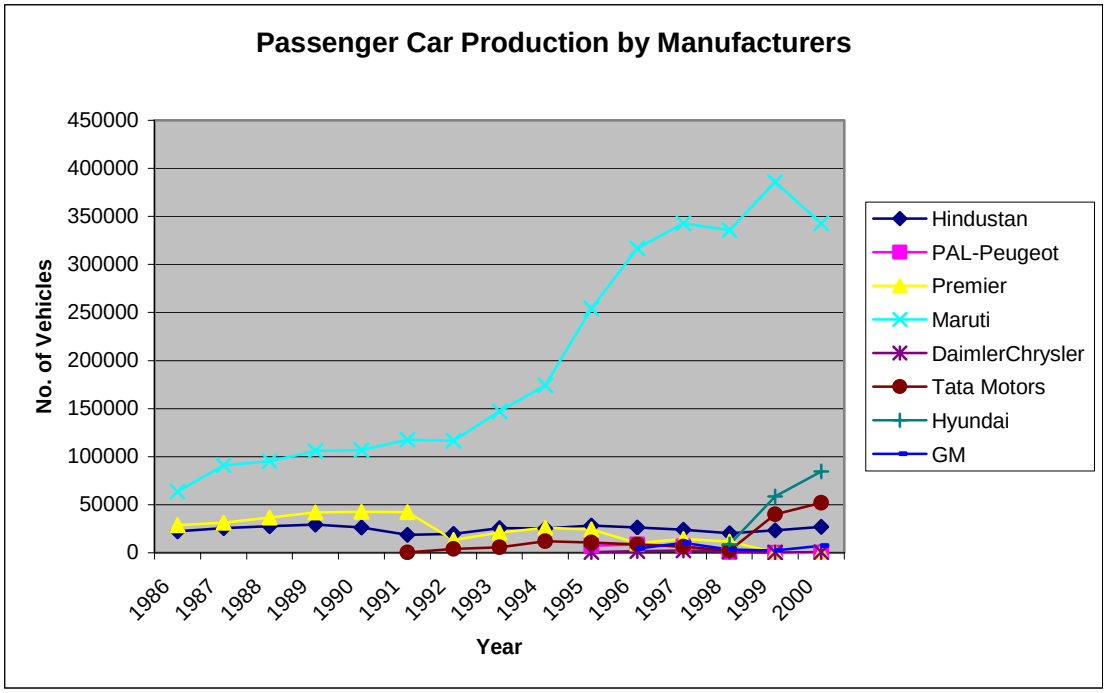
[16] Initially, Sanjay Gandhi, the elder son of then-Prime Minister Indira Gandhi, started Maruti Ltd., as a private firm to achieve his dream of producing a "national car." Due to some political problem, however, it never started operation. Indira Gandhi's government nationalized the firm in 1980, after the death of Sanjay to achieve her son's dream. Advised that the project would not succeed without the involvement of foreign technology, the government decided to have a joint venture, and signed joint-venture and license agreements with Suzuki in 1982 (Interview with a former CEO, Maruti Udyog Ltd., at Harvard, February 1998). MUL remained as a state enterprise until 1992, when the government's share of equity was reduced from 60% to 49.9%, in accordance with government policy change that allowed state enterprises to form joint ventures (Okada 2000). However, the government recently announced its policy to disinvest from MUL, allowing it to become Suzuki's subsidiary firm.

its product range, introducing new middle-sized passenger cars.

As Figure 1 indicates, the growth in the passenger car segment of the Indian auto industry has largely been driven by Maruti Udyog Ltd.. In 1996/97, it produced 336,811 passenger cars, accounting for 79.6 percent of the Indian passenger car market.[17] In 2003, it established the foundry plant of Suzuki Metal India Ltd, a joint venture between Suzuki Motor Corporation and Maruti Udyog Ltd.. Interestingly, even after the entry of many foreign car manufacturers in India since the mid-1990s which intensified the competition within the Indian market, Maruti Udyog Ltd. continued to remain dominant. By 2003/04, Maruti Udyog Ltd. increased its production up to 408,911 cars, of which 216,163 were compact cars and 14,384 mid-sized; it does not produce cars in the premium and executive segment. It exported in the compact segment 39,454 cars and in the mid-size segment 314 cars.

[17] MUL's *Annual Report 1996-97*.

Figure 1: Trends in Passenger Car Production in India by Manufacturer



Sources: AIAM, 1997; SIAM, 2002.

In addition to Maruti Udyog Ltd., in the 1990s, other foreign car manufacturers such as Daewoo Motors India Ltd. (a joint venture with Daewoo Corporation, Korea) and Honda Siel Cars India Ltd. (a joint venture with Honda Corporation, Japan) started their operations in the NCR. However, their contributions to the NCR cluster are too modest, as Daewoo was in operation only for a few years and ceased its operation after its parent in Korea failed, and Honda Siel started its production only in 2000/01 and its production volume is still very small (17,953 mid-size cars and 2,031 premium cars and exported 27 mid-size cars in 2003/04). Thus, the NCR auto cluster's development has been mainly driven by Maruti Udyog Ltd's. remarkable growth as shown in Figure 1.

5.3.2 Maruti Udyog Ltd.'s Supplier Development Strategy

Maruti Udyog Ltd.'s experience is unique in India particularly in terms of its system of procurements and enormous efforts to develop first-tier suppliers in its proximity and upgrade their capabilities. Maruti Udyog Ltd.'s supplier development was one of the key factors for reducing production costs, and thereby a key factor for the firm's remarkable growth (see Figure 1). It also became a successful model of transferring know-how of the non-*keiretsu* production system (Hattori 1996). And, given its dominance in the domestic car market, and a high rate of local content (96 percent for the "Maruti 800" and over 75 percent for other models) (Okada, 2000), it had a tremendous impact on the development of the automotive component industry as a whole, and in particular, that of the NCR auto cluster.

Both Maruti Udyog Ltd. and Suzuki hold equities to transfer technology and develop a long-term relationship in about a dozen Maruti Udyog Ltd. first-tier suppliers of key components. Several key suppliers of important bulky items like seats, fuel tanks, bumpers and instrument panels, such as Bharat Seats are present, in the same complex as Maruti Udyog Ltd.'s main plant in Gurgaon, allowing Maruti Udyog Ltd. to gain greater control over their operation and performance standards. Suzuki invested about 15 percent each in the equities of Bharat Seats, Macino Plastics, and Subros (a car air-conditioner manufacturer with collaboration with Denso). Maruti Udyog Ltd. also has a 10 to 15 percent equity share in Macino Plastics, Asahi Safety Glass and Sona Steering, about a 24 percent equity in Mark Auto Industry, and a 31 percent in Jay

Bharat. Moreover, Maruti Udyog Ltd. and Suzuki arranged a joint venture between local suppliers and Suzuki's suppliers in Japan. For example, Bharat Seats has technological ties with Howa Industry, a supplier of seats to Suzuki in Japan; Asahi India has ties with Asahi Glass; Sona Steering received technology from Koyo Precision Industry; and Subros received technology from Denso. Similarly, Motherson's was encouraged to collaborate with Sumitomo Denso to form a joint venture firm Motherson Sumi, and JVC with Daikin industry.[18] Furthermore, Maruti Udyog Ltd. has made enormous efforts to upgrade the capabilities of its suppliers (Okada 2004).

Table 5 shows the geographical distribution of Maruti Udyog Ltd.'s first-tier suppliers as of 1997. As the table indicates, about 60 percent of Maruti Udyog Ltd.'s first-tier suppliers are located within the NCR cluster. Apart from key suppliers housed in Maruti Udyog Ltd.'s complex, many other component manufacturers producing such items as lamps, mirrors, front and rear windows, clutches, shock-absorbers, front axles, leaf springs, wire-harnesses, gaskets, door locks, switches, piston rings, valves, air conditioners, wheel rims, are also located in the NCR. As of 1997, 58 out of the 404 Maruti Udyog Ltd. first-tier suppliers depended on Maruti Udyog Ltd. for more than 90 percent (in many cases 100%) of their sales.[19] Also, one

[18] This system differs from the Toyota style, where most component manufacturing firms either belonged to Toyota *keiretsu* or received technology from the Toyota related firms (Hattori 1996). This is because Suzuki, as a relatively small assembler in Japan, has a relatively supplier base at home, compared to other larger assemblers such as Toyota and Nissan. It has a "*kyoryokukai*" (supplier association formed by a car manufacturer) only for its small suppliers located near its plants (Fujimoto and Takeishi 1994). When MUL started its operation in India, few dedicated suppliers of Suzuki could afford to follow Suzuki to India to supply parts for MUL (Okada 2000).

[19] Data are from MUL's supplier database (1997). Thus, there might be some false reporting on the part of

third of 404 Maruti Udyog Ltd's. first-tier suppliers were established mostly within the NCR, after Maruti Udyog Ltd. started its operations in 1983.[20] With Maruti Udyog Ltd.'s remarkable growth (see Figure 1), which led to the rapid growth of the component industry, many second-tier suppliers have also proliferated in the same city as their customers (i.e., Maruti Udyog Ltd.'s first-tier suppliers). In other words, the NCR auto cluster emerged rapidly as Maruti Udyog Ltd. grew, mainly through Maruti Udyog Ltd.'s development of local suppliers.

Table 5: Geographic Distribution of MUL's First-tier Suppliers

Geographical Distribution:		# of Firms	% Distribution	Firm Size:		
City	State			Large	Medium	Small
Faridabad *	Haryana	77	19.1	12	36	29
New Delhi *	Delhi	71	17.6	29	22	20
Gurgaon *	Haryana	63	15.6	17	19	27
Chennai	Tamil Nadu	28	6.9	17	4	7
Mumbai	Maharashtra	23	5.7	11	4	8
NOIDA *	U.P.	16	4.0	5	2	9
Pune	Maharashtra	16	4.0	10	6	0
Bangalore	Karnataka	15	3.7	7	7	1
Coimbatore	Tamil Nadu	8	2.0	4	3	1
Old Delhi *	Delhi	7	1.7	3	2	2

suppliers to indicate their loyalty to MUL. The actual dependency might be thus lower.

[20] Data are from MUL's supplier database (1997).

Ludhiana	Punjab	6	1.5	2	4	0
Ghaziabad *	U.P.	6	1.5	1	2	3
Calcutta	West Bengal	5	1.2	4	1	0
Other Locations		63	15.6	32	23	8
Total		404	100	154	135	115

Notes: * refers to locations within the NCR. The data are based on MUL's supplier database as of January 1997.
Source: MUL's internal documents (1997).

Several factors explain Maruti Udyog Ltd's massive investment in its elaborate program of vendor development, involving stable and close supplier relations with its first-tier suppliers, equity participation in key suppliers, and promotion of technical collaboration between its suppliers with Suzuki's suppliers in Japan. First, the government's phased manufacturing program (PMP) mandated foreign firms to promote localization. Suzuki's MOU with its joint-venture partner, the Indian government, included its commitment to achieve 50% local content within the first three years, and 70% by the fifth year (Okada 2000). Maruti Udyog Ltd.'s initial focus on domestic markets rather than on exports, allowed it to compromise on the quality of the component products produced by local suppliers, which it could not afford if it were exporting its products. Second, the appreciation of the yen in the early 1980s, along with the high customs duty imposed on CKD (complete knock-down) (110% until 1991), made imported components from Japan extremely expensive. Maruti Udyog Ltd. knew that if it used CKD imports, it could not compete with other domestic producers.[21]

[21] The price of CKD was determined in US dollars, and thus the exchange rate between the US dollar and the Japanese yen significantly affected the cost of production (talk by Mr. R.C. Bhargava, former CEO of MUL, at Harvard University, February 1998).

Faced with the dilemma posed by the poor quality of locally-produced components on the one hand and the need to increase the local content on the other, Maruti Udyog Ltd. had no choice but to heavily invest in the development of the capabilities of its suppliers (Okada 2000). The development of suppliers has been particularly important for Maruti Udyog Ltd., given its high reliance on outsourcing which accounts for 80 percent of the value of a car, even higher than the level of outsourcing in Japan (70 percent).[22]

Third, Maruti Udyog Ltd. was the first firm to introduce a partial 'just in time' (JIT) system in India. This required Maruti Udyog Ltd. to source the dependable quality of component products, so as to be loaded without detailed on-site inspection and quality testing by Maruti Udyog Ltd. after their delivery, and it also required suppliers to be located near the car assembly plant, to allow frequent and on-time delivery. However, for most parts (where the units were not located near the Maruti Udyog Ltd. complex, Maruti Udyog Ltd. had to hold a week's stock at any time (Hattori 1996), Maruti Udyog Ltd. has a double sourcing strategy, due to the generally poor infrastructure (roads, electricity, and telecommunication), which often hampers on-time delivery, making it costly to rely on a single source for each component, and therefore making it difficult to fully adopt the JIT principle.[23]

Fourth, on a related point, while Maruti Udyog Ltd. had also sourced parts from a few large suppliers from the southern States such as Tamil Nadu, these suppliers, particularly those of bulky and heavy components, were motivated to establish new

[22] Fujimoto and Takeishi (1994) for the figure on Japan.
[23] In fact, Japanese managers think that the Indian automobile industry, including MUL, is still far from operating under the JIT principle (interviews with senior managers of MUL, Denso India, and the CEO of Toyota India Corp.).

plants close to their customers. This is partly both because of the increased awareness among first-tier suppliers of the importance of on-time delivery through the adoption of some elements of the JIT inventory system that Maruti Udyog Ltd. introduced, and because of an interest in reducing transport costs, including the payment of the octroi, which tax each State government levies on the consignments each time they cross the State border. Thus, given the intensified competition among component manufacturers, firms outside the NCR, such as Chennai-based Lucas-TVS, have also set up a plant near Maruti Udyog Ltd.'s plant. Indeed, with the introduction of the JIT concept, which aims to reduce assemblers' inventory costs, some first-tier suppliers with multiple customers started setting up new plants near their customers in different regions to cater to each of them. While this helps assemblers reduce their inventory costs, however, it also places some constraints on the suppliers, as they have to manage and finance simultaneous expansions in widely dispersed locations (Humphrey et al. 1998).

Fifth, many local small firms that could serve as ancillaries had already existed prior to Maruti Udyog Ltd.'s entry, although their technological levels were not compatible with Maruti Udyog Ltd.'s standards. Government policy since the 1960s aimed to protect and promote the Small Scale Industries (SSI), by providing various incentives, such as the allocation of plots in industrial estates at subsidized costs, electricity, and telephone connections, and by reserving many auto components to be produced only by the SSI sector (Okada 2000). This reservation policy forced auto manufacturers to buy rather than make these items.[24] Maruti Udyog Ltd.'s growth has

[24] As of 1997, more than 64 auto components were reserved to be produced by the SSI sector. Even after liberalization in 1991, the reservation policy for SSI continued, with only 7 items removed from the list by 1994

also encouraged many small-scale entrepreneurs to start business in close locations, taking advantage of such incentives provided to the SSI firms. Thus, about 60 percent of Maruti Udyog Ltd.'s 404 first-tier suppliers are small and medium enterprises (see Table 5).

Finally, Maruti Udyog Ltd.'s close collaboration with the government has facilitated the development of Maruti Udyog Ltd.'s local supplier base. The central government, the firm's joint venture partner, has protected and promoted Maruti Udyog Ltd. through various policy measures and concessions. Moreover, while being a joint venture partner, the central government did not politically interfere with Maruti Udyog Ltd.'s functioning, which was unusual in India. Likewise, the state government of Haryana also supported Maruti Udyog Ltd. in many ways. For example, in 1997, Maruti Udyog Ltd. set up a new supplier park close to its main plant in Gurgaon as a joint venture between Maruti Udyog Ltd. and the Haryana State Industrial Development Corporation (HSIDC) as part of the industrial model township developed by HSIDC, to house Maruti Udyog Ltd.'s 65 first-tier suppliers which produce essential and critical components for Maruti Udyog Ltd. cars, and to ensure an unhindered supply of these components. The cost of development of this industrial park, at nearly Rs. 100 crore (or approx. US $30 million), was shared between Maruti Udyog Ltd. and HSIDC. A tripartite plant-level committee comprising representatives from Maruti Udyog Ltd., the government, and HSIDC oversaw the processes of planning and implementation of this project.

(Okada 2000).

Maruti Udyog Ltd. has maintained a long-term close relationship with suppliers, based on reciprocal interactions, with a greater emphasis on quality and on-time delivery, and also provided the designs and drawings to them. Maruti Udyog Ltd.'s heavy investment in supplier development was rather unusual in India, because prior to Maruti Udyog Ltd.'s entry, during the inward-looking trade and industrial regime until the mid-1980s, a small production volume and absence of competition gave auto assemblers few incentives to strengthen the capabilities of their suppliers. Maruti Udyog Ltd. not only sent their shop floor employees to Japan for training but also encouraged their suppliers to follow its example (Okada 2004 for more detailed discussions). These practices have also contributed to the development of the NCR cluster.

As Table 6 shows, Maruti Udyog Ltd.'s remarkable contributions to the development of the NCR cluster through its supplier development is in part exemplified by the very high labor productivity of the auto sector in Haryana, which is nearly double that of the national average and the second highest among all the states after Maharashtra.

Table 6: Regional Disparity in Wages and Value Added per Worker in the Transport Equipment and Parts Sector, 1993-94 : Selected States

States	No. of Factories	No. of Workers	Annual Wages per Production Worker (US$)	Wage Index (All India=100)	Net Value Added Per Worker (US$)	Net Value Added Per Worker Index (All India=100)
All India	4,180	374,852	1,248	100	4,149	100
Bihar	125	27,223	1,428	114	3,018	73
Gujarat	250	15,983	672	54	2,630	63
Haryana	220	23,314	1,140	91	8,106	195

Karnataka	190	16,609	1,536	123	4,638	112
Maharashtra	767	55,762	2,112	168	8,275	199
Punjab	772	37,892	792	63	2,440	59
Tamil Nadu	548	65,625	1,164	93	3,991	96
Uttar Pradesh	305	32,995	1,104	88	3,253	78
West Bengal	215	59,608	1,080	86	1,944	47
Delhi	381	8,201	1,152	92	2,819	68

Notes: 1) Workers refer to all persons directly engaged in any manufacturing process, and do not include indirect workers or administrative and managerial staff.

2) The exchange rate is US $1 = 30.71 for 1993-94.

3) The total numbers of factories (4,180) and of workers (374,852) do not agree with the estimates provided by ACMA. This is partly because the factories covered in these statistics are only those registered with the government and do not include informal sector firms.

Sources: Okada (2000) (Constructed and calculated from Government of India, Central Statistical Organization, 1996. *Annual Survey of Industries 1993-94: Summary Results for Factory Sector*: Table 6-13).

In addition to Maruti Udyog Ltd., however, a couple of other assemblers are also located in the NCR, although their influence on the development of the NCR cluster has been much smaller than that of Maruti Udyog Ltd.: One is Daewoo Motors India, Ltd., and the other is Honda Siel Cars India, Ltd. Daewoo failed mainly because its parent company in Korea failed. Daewoo Motors India entered into a joint venture with Daewoo in 1994.[25] The collaborator, Daewoo Corporation, held 91.6% equity in the joint venture. One of the main features of the joint venture is that the manufacturing and marketing activities of the Toyota Dyna range of light commercial vehicles were not discontinued. The firm launched the Cielo model in July 1995, and its upgraded version in 1996. It created its production facilities at Surajpur, UP., with a capacity to produce 70,000 passenger cars per annum. The firm produced a total of a

[25] The firm was originally set up in 1983 as a part of the DCM group in collaboration with Toyota Motor Corporation, under the name DCM Toyota. The firm's Toyota range of commercial vehicles failed to meet the pricing requirement and the firm was in the red. Thus, the firm, in consultation with Toyota, started a new joint venture with Daewoo, Korea.

few thousand cars in India only for a few years.[26]

Honda Siel Cars India is a new unit and it started production only in 2000/01. In 2003/04, the firm produced 17,953 mid-size cars, 2,031 premium cars and exported 27 mid-size cars. While its sales have been increasing, its operation is still too modest to make a considerable contribution to the NCR cluster.

5.4 Chennai and NCR Clusters Compared

In several respects Chennai and the NCR auto clusters present interesting contrasts. First, the NCR cluster, by and large, confirms to the traditional pattern – the emergence of a lead firm (i.e., Maruti Udyog Ltd.) and its vital role in developing the components industry and the gradual development of a cluster. The Chennai cluster, by contrast, emerged with the establishment of large component firms like the TVS, Rane and the Amalgamations groups that from the beginning targeted the all-India market. While Chennai also did have assemblers such as Standard Motors and Ashok Leyland in the initial years, their scale of operations was small, and thus the components' manufacturing firms had to target the all-India market due to a small demand for auto components within the cluster. Moreover, the emergence of the auto component industry in the 1940s predated the arrival of these assemblers. As large component firms in Chennai had targeted the all-India market from the beginning, the components supplied from the cluster had penetration non only across the country, but even in another auto cluster, in the Mumbai-Pune belt in Maharashtra. Later on, only in the 1990s leading auto manufacturing multinationals like Ford, Hyundai and Hindustan

[26] However, its production facility is still intact and local sources suggest that it could be acquired by the Tata Motors.

(Mitsubishi) came to Chennai, being attracted by the presence of a well-established component manufacturing industry.

Thus, different factors have influenced the formation of the two clusters. First, Chennai has no assembly firm like Maruti Udyog Ltd. that served as the lead firm to form and develop the cluster, whereas in the NCR, Maruti Udyog Ltd. played a dominant role. Second, the presence of seaports was important for the formation of the Chennai auto clusters that initially relied on imports of components and materials. Third, the NCR, being the national capital, enjoys the closest links with the centers of power and patronage.

Nevertheless, in some other ways, the NCR cluster shares certain common characteristics with the Tamil Nadu cluster. For example, like Tamil Nadu, the NCR enjoys the presence of many engineering education institutions that supply a skilled workforce and notches a high score of HDI.

6. Differential Behavior of Cluster and Non-Cluster firms

The literature surveyed in Section 2 indicates that firms located in an industrial cluster enjoy several advantages like external economies, sharing of knowledge and information, technological environment, availability of skilled labor force, infrastructure and other environmental supports provided by the government and its agencies. As a result of these advantages provided by the cluster, the performance and conduct of the firms located in an industrial cluster could differ from those located outside a cluster. In the automobile sector, while many firms are located in Chennai, the NCR, and in the Mumbai – Pune clusters, there are also firms outside these clusters. We expect firms

located in these three clusters to behave differently from those located outside these clusters. We also expect inter-cluster differences in the performance of the firms inside and outside the clusters. Profit margins and productivity are considered as performance variables of the firms while advertisement intensity, FDI, exports, inventories, royalty and technical fee payments, import of materials and components and other foreign payments are taken as representative of conduct variables. The conduct variables mainly represent the international orientation variables, technology variables and product differentiation variables.

From the literature survey we identify variables that could discriminate firms in different clusters and other firms located outside the clusters. We cover only auto component firms and not the leading auto assemblers, as they are only a few auto assemblers. We classify firms into four groups according to their locations: (a) Chennai (including firms in surrounding areas in Tamil Nadu); (b) Pune-Mumbai (including surrounding areas in Maharashtra); (c) NCR; and (d) Other (other firms located outside the three clusters).

6.1 Variables Representing Performance

Some studies argue that firms located in a cluster should perform better in terms of profits, growth and productivity (Helsley and Strange 2001). If there are agglomeration advantages in the sample Indian firms, then these should show in their performance. In this section, we use the following two variables as performance indicators, namely, profit margins and labor productivity. All the variables are at the

firm level. The sample consists of component manufacturing firms, but exclude car manufacturers as there are only about a dozen car manufacturers in these clusters.

Profit Margins refers to gross profits as a ratio of sales turnover [(total revenue – total cost)/total revenue]. Some studies also use profit rates, namely, gross profits as a ratio of capital invested. However, this measure suffers from the well-known problems associated with the measurement of capital, appropriateness of the discount rate to be used in evaluating the heterogeneous capital stock of different vintages. We expect profit margins to be higher among firms that are located in a cluster.

Labor Productivity refers to productivity of a rupee spent on labor. We use this measure partly due to data constraints and partly due to theoretical considerations. Indian firms are not required to disclose the number of employees and consequently the balance sheet data does not report employment statistics. Thus, the denominator of the labor productivity variable, namely, the number of workers, is not often available. Nevertheless, they report the total emoluments paid to their employees. To overcome this problem, Kathuria (2000, 2002), calculates the average wage rates for different industries from the publication *Annual Survey of Industries*, and divides the wage bill of the firm by the average wage rate of the corresponding industry to obtain the number of workers in the firm. This method of obtaining the number of workers at the firm level has the following limitations. Since MNEs pay higher wages compared to the local firms, it could overestimate the number of workers in MNEs. Goldar et al. (2004) follow a similar method but assume that MNEs pay 10 percent more wages than the local firms. These methods also do not take into account the heterogeneity of the workforce and differences

in the skill content. Furthermore, several Indian firms, particularly in recent years, have been employing workers through labor contractors. The payments made to labor contractors come under labor costs but the workers employed through the contractors are not on the pay roll of the firm. Under these circumstances, we suggest that a variable like value added per unit cost of labor, that is, value added divided by the sum spent on labor would be a more appropriate variable, as in some other studies (Ray 2004, Caves 1992). We assume that firms should be more interested in the productivity of the sums they spend on labor rather than in an indirect measure of productivity of a representative person they employ.

Conduct Variables

Advertisement refers to advertisement expenditures as a ratio of sales turnover. We have used sales turnover to normalize for the size factor. In other words we use advertisement intensity. Since all the sample firms are component manufacturers, we expect established firms in prominent clusters having durable (long-term) relationship with vehicle manufacturers/assemblers to advertise less as they do not need to look for customers. On the other hand, firms located outside the clusters need to advertise more to inform customers and other firms.

Exports refer to exports to sales ratio, export intensity. In theory, firms located in clusters are likely to mainly deal with other cluster firms and are expected to have a durable relationship with the vehicle manufacturing firms. Therefore, they may not look actively for the export market. Hence, we expect firms located outside the clusters to export more.

FDI refers to the share of foreign promoter's investment in the total equity capital of the firm. The FDI literature surveyed in Section 2 suggests that multinationals might gravitate to agglomerations and invest more in clusters. Nevertheless, our discussion on the Chennai cluster shows that the Chennai component manufacturing firms, in particular the TVS group and the Rane group went for non-equity strategic alliances with multinationals rather than an equity alliance. Therefore, it is difficult to predict the outcome of this variable in differentiating cluster firms from others.

Inventory refers to inventory to sales ratio. We expect firms in clusters that are dominated by multinational vehicle manufacturing firms, like Ashok Leyland, Ford, Hyundai and Hindustan Motors (with Mitsubishi involvement) in Chennai, and MUL and Honda in NCR, to have lower inventory holdings as these clusters have developed a culture of low inventory and JIT delivery systems. Other firms that do not belong to a cluster might hold more inventories as they have to ship their products to customers in different regions.

Sales refers to sales turnover as a proxy for the size of the firm. We expect the cluster firms to be of a larger size and enjoy higher turnovers.

Material Import refers to the import of components and materials as a ratio of sales. Firms that supply to multinationals might use more of imported materials as the quality standards are likely to be more stringent and India need not produce all the high quality materials. As discussed earlier this could also represent embodied technology imports.

Tech Import refers to the payments of royalty and technology fees as a ratio of sales. We expect technology payments to be higher among firms in clusters where the vehicle

manufacturing is dominated by large multinationals as they expect the component firms to keep pace with new technology. These imports are referred to as disembodied technology imports.

The conduct variables are by and large related to technology and globalization. *Tech Import* refers to import of disembodied technology in the form of blue prints or licensing fee for patents, etc., against royalty and technology fee payments. *Material import* refers to embodied technology transfer, that is, technology is embodied in the inputs imported like components and high tech materials. *FDI* could be interpreted as intra-firm transfer of technology. Likewise, *Advertisement* could also be interpreted as a variable denoting product differentiation, as the literature on multinational enterprises uses advertisement expenditures to denote product differentiation (Caves 1996, Lall and Siddharthan 1982). The firm differentiates the product through technology acquisition and informs the prospective customers through advertisement.

6.2 Econometric Analysis

Data Set

For empirical analysis we use the *Capital Line* database, one of the most well-cited firm-level databases available in India, providing data for about 8000 firms registered in India (this includes multinationals registered in the Indian Stock Exchanges). Our sample consists of all the automobile component manufacturing firms listed in the *Capital Line* database, covering the period 1998 – 2005. However, we deleted firms (or observations for certain years) that were producing a very low volume of output or showed zero value addition. This could be due to two reasons: first, these

firms could be new and had not yet commenced normal production; for these firms we deleted the initial years where the value addition is very low or zero; and second, these firms could have stopped production. We have not used a balanced panel as that does not take into account the entry and exit of firms. In the Indian case, it is important to take into consideration the entry of new firms as well as the exit of inefficient units. In fact the main objective of the liberalization measures introduced in India in the early 1990s is to attract new entry and increase competition. Therefore, we have considered an open panel.

Table 7 presents the group means and standard deviations of the firms in the four groups for the performance and conduct variables. It does not show the statistical significance of the differences between the three groups. That is presented in Table 8 where logistic regressions are presented using a multivariate model. Bivariate testing is not appropriate as it is important to examine the statistical significance of a variable in the presence of the other variables.

Table 7: Group Mean and Standard Deviation of the Four Groups

	Others	Chennai	Pune-Mumbai	NCR
Variables	Mean/SD	Mean/SD	Mean/SD	Mean/SD
Performance Variables				
Profit Mar	0.029 O.501	0.069 0.551	0.584 5.571	0.071 0.146
Labor Prod	2.484 1.813	2.742 4.468	2.762 1.968	2.936 1.694
Conduct Variables				
Advertisement	0.0070 0.015	0.0023 0.0049	0.0064 0.019	0.0016 0.0035

Exports	.1120 (.172)	0.0687 0.123	0.037 0.070	0.051 0.087
FDI	11.06 22.86	5.319 12.331	12.505 21.214	10.140 18.707
Inventory	0.196 0.187	0.152 0.244	0.218 0.630	0.139 0.127
Sales	97.05 198.90	138.108 152.79	124.381 168.996	134.462 132.476
Material Import	0.046 0.069	0.077 0.094	0.057 0.173	0.084 0.107
Tech Imports	0.003 0.0068	0.0049 0.009	0.016 0.150	0.0049 0.0079

Source: authors

As Table 7 shows, some of the Maharashtra firms appear to be trading-cum-manufacturing firms as their gross profits in relation to sales are very high. Therefore, we concentrate more on the NCR and Tamil Nadu clusters and other non-cluster firms.

The mean values of profit margins are higher for the cluster groups than for the 'other' non-cluster group. This result is valid even if we ignore the Maharashtra cluster. Whether this result is statistically significant in a multivariate analysis or not will be known in the logistic regressions. The results presented in Table 7 show that being part of a cluster positively influences the performance of the firms and they do better. Profit margins are more than double that of the non-cluster firms. Furthermore, productivity per rupee spent on labor is also higher for the firms located in the three clusters compared to the non-cluster firms.

With regard to the conduct variables, the table shows that firms in Tamil Nadu and the NCR spend much lesser on advertisement (in relation to their sales turnover) compared to the firms in the other two groups. This result is also expected as the firms

located in Tamil Nadu and the NCR are well-established and reputed firms and enjoy multinational clientele. For them additional returns from extra advertisements is likely to be low. On the other hand, the firms in the other two groups are relatively new and needs to advertise more to establish themselves in the industry.

The non-cluster firms enjoyed higher export intensities compared to the firms located in the three clusters. This result is also not unexpected. Firms in the three clusters supply mainly to car manufacturing units within the cluster and also to other firms located in other clusters. The non-cluster firms need to go-in for the export market to expand their activities.

Chennai firms have lower FDI (foreign equity participation) compared to the other three groups. We attribute this to historical factors. The main Chennai-based business houses were set-up in the late 1950s and early 1960s. By the time India liberalized FDI, the Chennai firms were firmly established and well recognized and could attract foreign strategic non-equity alliances and were not forced seek for foreign equity participation. MNE theories suggest that the transaction costs in transferring technology are higher when dealing with relatively new firms compared to established and reputed firms. The theory further suggests that where transaction costs are high MNEs will prefer FDI and not licensing of technology (Dunning 1993, Teece 1977, Siddharthan and Safarian 1997).

Firms in Chennai and the NCR had a lower inventory to sales ratio compared to the other two groups. This is also anticipated. The need for low inventories and JIT delivery are better appreciated in clusters dominated by vehicle manufacturing

multinationals. The main vehicle manufacturers in the Pune cluster are Indian firms. Lower inventories in Chennai and the NCR could be attributed to the spillover effects of MNEs.

The non-cluster firms are much smaller than the clustered ones. The average size of the Chennai firm is much larger than that of firms in the other three groups; NCR comes second followed by Pune and the non-cluster firms come last. The Chennai firms discussed in Section 5 catered to the India market, and they supplied components to all the major vehicle manufacturers located in different parts of the country, including those in the NCR and the Pune-Mumbai clusters. The result confirms our description in Section 5.

Chennai and NCR clusters import more of materials and make more technology payments compared to the other two groups. It is possible that the firms located in these two clusters produce more sophisticated and technology intensive goods and therefore need to import high quality materials and frequently upgrade their technology through technical fee and royalty payments. It is also possible that the leading multinationals like Ford, Hyundai, Hindustan Motors (Mitsubishi) and MUL to whom they supply the components require higher standards in terms of technology and sophistication. Low technology payments by component firms in Pune could also be due to the dominance of the domestic auto manufacturers, such as Tata Motors that extensively carry out in-house technological development of even components involving its suppliers. By and large, Table 7 indicates that with regard to performance and conduct variables, the Chennai and NCR clusters display similar

trends and that these two clusters are very different from the "other" group of firms that do not belong to any cluster. The firms in the Pune-Mumbai cluster come somewhere between the non-cluster firms and those in Chennai and the NCR clusters. The firms in Pune-Mumbai cluster mainly supply to Indian vehicle manufacturers and that could explain their differential behavior.

6.3 Logistic Model and Multivariate Analysis

In Tables 8 and 9 in all the equations the dependent variable takes the value of either zero or one. In such cases, Ordinary Least Square estimates are not appropriate and therefore logit or probit models are suggested. We have used logit models.[27] The maximum likelihood estimates of the logit model are presented in Tables 8 and 9.

[27] Probit models also yielded similar results.

Table 8: Logit Model Results: Maximum Likelihood Estimates
Inter-Cluster Differences

	Chennai-NCR	Chennai-Pune	NCR-Pune
Equation	1	2	3
Constant Z Stat	-0.581 (-1.25)	-0.886* (1.72)	-0.235 (-0.41)
Profit Margin	-.430 (0.999)	-0.450** (-2.30)	-1.579* (-1.72)
Labour Prod	-0.035 (-0.87)	-0.050 (-0.92)	0.078 (0.99)
Advertisement	22.841 (1.05)	-68.22*** (-4.01)	-63.25*** (-3.47)
Exports	1.081 (1.25)	4.943*** (3.27)	4.347*** (2.89)
FDI	-0.020*** (3.19)	-0.033*** (-4.57)	-0.017*** (-3.03)
Inventory	1.006 (1.26)	-0.483 (-0.92)	-1.040 (-0.84)
L Sales	0.099 (1.08)	0.325*** (3.06)	0.116 (1.08)
Material Import	-0.488 (-0.52)	8.787*** (4.27)	9.278*** (4.70)
Tech Imports	11.700 (1.03)	-10.697 (-0.79)	-5.631 (-0.66)
LR Stat	20.09***	94.72***	83.85***
NOBS	541	431	458

Table 8 presents results on the inter cluster differences and Table 9 on differences between firms that are located inside clusters and those outside the clusters. In Table 8, Equation 1, firms located in Chennai take the value 1 and those located in the NCR take the value zero. In Equation 2, firms from Chennai take the value 1 and those from Pune-Mumbai take the value zero. In Equation 3, firms inside the NCR take the value 1 and firms in the Pune-Mumbai cluster take the value zero.

In Table 9, Equation 1, firms in the three clusters (Cls) take the value 1 and the other firms outside the three clusters take the value zero. Equations 2 to 4 compares firms from each of the three clusters to firms located outside the three clusters. In all the equations firms outside the three clusters take the value zero and the firms in the respective clusters takes the value one.

As seen from LR statistics all the equations in both the tables have good fits and they are all significant at the 1 percent level. As anticipated Table 8 shows that firms located in Chennai and the NCR behave in a similar fashion. Except for the FDI variable no other variable has emerged significant in the logit analysis. As explained earlier the significance of FDI in the equation is due to historical reasons. Except for this single difference, the two clusters appear to be homogeneous. Nevertheless, as seen from Table 9, firms located in the two clusters behave differently from the firms located outside the clusters. The results of equations 1, 2 and 3 in Table 9 are similar further reinforcing the similarity between the Chennai and NCR clusters, and firms located outside the clusters. Equations 2 and 3 in Table 6 clearly show that Pune-Mumbai cluster behaves differently from the Chennai and NCR clusters.

Table 9: Logit Model Results: Maximum Likelihood Estimates
Cluster and Non-Cluster Differences

	Cls-Other	Chennai-Other	NCR-Other	Pune-Other
Equation	1	2	3	4
Constant Z Stat	-0.104 (-0.28)	-2.025*** (-3.89)	-0.512 (-0.96)	-0.464 -0.84
Profit Margin	-0.037 (-0.35)	-0.680 (-1.49)	-0.626 (-0.91)	0.754** (1.96)
Labor Prod	-0.010 (-0.34)	-0.021 (-0.44)	0.034 (0.44))	-0.051 (-0.71)
Advertisement	-30.35*** (-4.22)	-93.09*** (-4.78)	-93.15*** (-4.37)	-4.621 (-0.68)
Exports	-3.604*** (-5.88)	-2.399*** (-3.04)	-3.352*** (-3.90)	-6.194*** (-4.54)
FDI	-0.012*** (2.91)	-0.037*** (-4.72)	-0.015*** (-2.47)	0.004 (0.78)
Inventory	-0.362 (-0.84)	-0.778 (-0.86)	-2.385*** (-2.42)	-1.846* (-1.67)
L Sales	0.370*** (4.69)	0.636*** (5.66)	0.297*** (2.81)	0.191** (1.89)
Material Import	4.870*** (3.75)	7.923*** (4.41)	7.426*** (4.54)	1.329 (0.60)
Tech Imports	20.885* (1.81)	31.867* (1.65)	27.666* (1.70)	26.622** (1.88)
LR Stat	118.45***	128.64***	134.44***	58.25***
NOBS	946	489	516	406

In Table 9, the performance variables, namely, profit margins and productivity have not emerged as significant in differentiating firms belonging to the three clusters from those located outside the clusters in the presence of the conduct variables. It is quite possible that firms located in these two clusters (Chennai and the NCR) enjoyed higher performance indicators mainly because of their conduct variables and when they are introduced directly, the performance variables turn out to be insignificant. Thus, Chennai and NCR firms enjoyed better profit margins and productivities mainly

because they used better material and constantly upgraded their technology and when these two variables were used in the equation along with the performance variables, the performance variables loose their significance.

Equations 2 and 3 in Table 9 show that firms located in Chennai and the NCR clusters spend much less on advertisements compared to the firms that are not part of the three clusters. This, as mentioned earlier while discussing Table 7, is as anticipated. Furthermore, Chennai and the NCR firms also spend much less than the firms located in Pune-Mumbai on advertisements. Besides, firms in these two clusters also export less compared to the firms located in Pune-Mumbai and non-cluster firms. These two variables, namely, advertisement intensity and export intensity are significant in all the relevant equations at the 1 percent level. Likewise, FDI is also significant in all the equations except equation 4. Inventory sales ratio is significant only in equation 3, indicating firms in the NCR hold less inventory compared to the non-cluster firm. In Table 7, Chennai firms also held less inventories but it has not emerged important in the multivariate analysis. The average size of the firm as represented by log sales has emerged significant at the 1 percent level in all the three (equations 2, 3 & 4) that differentiate the non-cluster firms from the three respective clusters. Thus the larger size of the firms located in the three clusters observed in Table 7 has emerged significant in Table 9. Table 9 further shows that Chennai and the NCR firms are more import (import of components and materials) intensive than are the other two groups. This variable is also significant at the 1 percent level. However, when it comes to technology imports, it is significant at only the 10 percent level. In other words, Table 9 by and large,

confirms all the findings of Table 7, except for the performance variables.

In sum, firms located in Chennai and the NCR clusters behave alike with respect to the performance and conduct variables considered in the study. Further, firms in these two clusters behave very differently from those located outside the three clusters. The behavior of the firms located in Pune-Mumbai lies somewhat in-between these two.

7. Conclusion and Main Lessons of the Study

Indian industrial clusters exhibits some interesting patterns of cluster formation. We find that industrial clusters are largely concentrated in three regions, namely, Chennai (Tamil Nadu), Pune-Mumbai (Maharashtra), and the national capital region (NCR), across different manufacturing sectors, although in addition to them, Hyderabad (including its surrounding cities) in Andhra Pradesh has a cluster of the pharmaceutical industry. All these clusters are multi-industry clusters and their continued growth supports Jacobs (1969) emphasis on urban diversity in contrast to urban specialization.

Our study of the auto clusters in Chennai and the NCR found interesting differences in the patterns of formation in these clusters. The formation of the Chennai cluster was mainly driven by large component manufacturers in the late 1940s and the 1950s, many of whom were member firms of large Indian business houses. Agglomeration of auto component manufacturers occurred largely because of the access to seaports, and access to a pool of educated workforce, and the strong leadership of the State government who actively promoted the industry in the region. Access to seaports was critical in its initial years, due to the industry's heavy reliance on imported

materials and parts. Thus, the pattern of development of Chennai cluster considerably differs from the "flowchart model" presented by Kuchiki (2004), wherein the creation of industrial parks and zones attract anchor firms to locate first, and as the cluster develops its capacity in terms of human, physical and institutional infrastructures, anchor firms in turn play a central role in bringing related firms into the cluster (Kuchiki 2004).

While conforming to his capacity building argument, Chennai's experience considerably differs from Kuchiki's model with respect to the role of the anchor firms. The component manufacturing firms that came first in the late 1940s did not heavily depend on the two vehicle manufacturers that existed in the cluster in their initial years. From inception, the component manufacturers had targeted the all-India market, due to a small volume of production in the industry as a whole. Thus, due to their small production volume, these two vehicle assemblers played very limited roles in developing the cluster. The key component manufacturers also avoided joint ventures and FDI participation in the subsequent years because of the Indian government's policy that restricted FDI until the mid-1980s. Thus, key anchor firms in the Chennai auto cluster have been mainly component manufacturers that were established in the 1960s, rather than assemblers. Thus, this component manufacturers-led formation of the Chennai cluster is quite unique, compared to other auto clusters in India or elsewhere. Assembler firms started playing leading roles in cluster development only in the late 1990s, when global players such as Hyundai, Ford, and Mitsubishi came to Chennai to start their production.

By contrast, the auto cluster in the NCR was mainly created by a single assembler firm, MUL, as an anchor firm, and thus, the pattern of this cluster, by and large, confirms Kuchiki's (2004) flow chart model. The related firms, in terms of auto component manufacturers were actively developed by the anchor firm. MUL was motivated to actively develop its first-tier suppliers by various policy factors, such as the requirement to increase local content, mandated by the Indian government; high duties on imported parts; and the reservation of various items for production by the domestic small-scale firms. Moreover, being the national capital, the NCR enjoys the closest links with the centers of power and patronage, which has favored MUL, the central government being a joint venture partner. The contrasts of the Chennai and NCR clusters, therefore, suggests that the presence of inter-cluster variations in the patterns of the formation even within the same industry, and that such inter-cluster variations are partly explained by the historical and policy conditions under which firms, particularly, the lead firms must operate.

On the other hand, the two clusters share some common features, such as the creation of industrial zones and the availability of high levels of human skills in these clusters. In both clusters, the state government actively intervened in the creation of industrial estates, which helped many small firms to locate in the clusters, and the development of infrastructure.

The study also brings to light certain other aspects such as the role of the state, namely, industrial licensing and location policies, and the role of political leaders in influencing industrial location. Until 1991, industrial location was not a free choice of

firms guided by commercial consideration. Industrial licensing policy decided on the State where a particular industry would be located, and within the State, the State government influenced the exact location.

Furthermore, the study reveals the interdependence of and interrelationships between industries located in a cluster. In Chennai, IT firms located in the cluster have helped the small and medium automotive firms become globally competitive. Thus, multi-industry clusters have an advantage.

The econometric analyses carried out in this study confirmed that being part of a cluster positively influences the performance of the auto component firms and those belonging to a cluster perform better. Results of the analyses showed that productivity per rupee spent on labor is also higher for the firms located in the three clusters than in the non-clustered firms, and that the non-clustered firms have a higher export intensity than that of firms located in the three clusters. They also reveal that both the performance and behaviors of clustered firms largely differ from non-clustered firms and that both firms that are located in Chennai and those in the NCR clusters are similar in terms of these performance and conduct variables. On the other hand, firms in the Pune-Mumbai cluster behave differently from those in Chennai and the NCR clusters.

However, the performance variables, i.e., profit margins and productivity did not differentiate firms belonging to the three clusters from those located outside the clusters in the presence of conduct variables. But, Chennai and the NCR firms enjoy better profit margins and productivity, mainly because they used better material and constantly upgraded their technologies. Moreover, firms in Chennai and the NCR

spend much less on advertisement than those outside these three clusters. Besides, firms in these two clusters also export less than firms in the Pune-Mumbai cluster and those outside clusters. Our analyses also show that the firms in the NCR cluster hold less inventories than in the non-cluster firms. They also found that Chennai and NCR firms are more import (import of components and materials) intensive than the other two groups. These analyzes clearly suggest the advantage of clustered firms over the non-clustered ones. The behaviors and performance of the Chennai and NCR clusters are somewhat alike.

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