Regional Skill Supplies and Location of Firms: The Case of Information Technology Industry in India

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10. March 2010

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I acknowledge the funding provided by Student Stipendship Programme@Sarai, CSDS New Delhi for conducing this research. However all views expressed are mine and I am responsible for all errors and omissions.

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Abstract:. *The "new economic geography" of the IT industry is shaped by two characteristic features of the industry, smaller size of the firms and zero transportation costs of its products that provide its ability of being a 'footloose' industry. The IT industry could locate itself in a region on the basis of two factors, namely, the nearness to large markets that ensures steady demand for its products, and the nearness to its factors of production. The importance of proximity to large markets in the case of Indian IT industry is only marginal as the IT industry, mainly dominated by the computer software segment, is a highly export oriented industry. There are reasons, however to believe that the location of firms in the ICT industry would be based on the supply of its crucial factor of production, namely, skilled labour. The IT industry being a skilled-labour-intensive, export-oriented industry it is by reducing the cost of labour, relative to capital, that it can reap comparative advantage benefits. Moreover, the skill requirement of this industry being very flexible and is subjected to fast rate of obsolescence it remains important for the firm, in order to have uninterrupted production, to locate itself in large pools of skilled labour. Correlations drawn between the location of firms and regional supply of skills tend to support the hypothesis that the quantity and quality of skills supplied in a region could determine the location of firms in a region and clustering of firms to a city*

Key Words: Skill Supply, Information Technology Industry, Location, Region, India, Economic Geography, Agglomeration Economies.

JEL classification: R1, R11, L25,L86,J44

I.I Introduction

Agglomeration of economic activity has generated renewed interest among the regional economists and geographers in the recent years. This improved interest has been at least partially due to the "new economic geography" that links regional industrial clustering with that of international trade and global production. Firms tend to concentrate at specific geographic locations as a result of increasing returns to scale as the scale of production in the firm, industry or the region increases. Scale economies, has been argued to take effect through various channels such as spillovers between firms that share the same locality, (Henderson, 1974), workers learning from one another,(Lucas,1988); demand-linkages between firms that

are created by the interaction of fixed production costs and transportation costs (Krugman,1991) etc.

Within the ongoing international division of labour, capital has become the mobile factor traversing across space zones in search of maximizing the competitive advantage by reducing costs and maximizing production and sales. In the new economic framework of 'flexible production systems' it is a known fact that the developing economies with abundant supply of cheap and skilled labour are increasingly becoming production locations for many 'low value adding' links of the global production chain.

The driving sector of this new economy, namely, the Information Technology Industry is characterized by two factors, smaller size of the firms and zero transportation costs of its products that provide its ability of being a 'footloose' industry. The IT industry could locate itself in a region on the basis of two factors, namely, the nearness to large markets that ensures steady demand for its products, and the nearness to its factors of production. The importance of proximity to large markets in the case of Indian IT industry is only marginal as the IT industry, mainly dominated by the computer software segment, is a highly export oriented industry. There are reasons, however to believe that the location of firms in the ICT industry would be based on the supply of its crucial factor of production, namely, skilled labour. The IT industry being a skilled-labour-intensive, export-oriented industry it is by reducing the cost of labour, relative to capital, that it can reap comparative advantage benefits. Moreover, the skill requirement of this industry being very flexible and is subjected to fast rate of obsolescence it remains important for the firm, in order to have uninterrupted production, to locate itself in large pools of skilled labour.

Many studies done earlier also illustrate the significance of labour supply in the location decision of firms. Carlton (1983) had concluded that new firms are likely to choose a city where the own industry employment is larger. Nakmura's (1985) estimation of production functions for Japanese manufacturing industry to see whether total factor productivity is higher in a regional industry when own-industry employment is high had concluded that own industry employment positively affected productivity. Dumais *et al*. (1997) had suggested that firms are attracted to regions that have a relatively abundant supply of workers they are likely to hire.

This research pertains to empirically verifying the above said proposition that the new economy industries that are characterized by flexible production, export orientation and skilled labour intensity are prone to choosing their location mainly on the basis of skill supplies. Section II explores the location patterns of software firms. Section III looks into the regional patterns of skill supplies. Section IV analyses the linkages between regional supplies of skill and location of IT firms. Section V draws conclusions from the discussion.

II. Software firms and their Location

During the last decade ICT sector has emerged as one of the most vibrant sectors in terms of output and export growth in the Indian economy recording U.S. $ 8671 Million in 1999-00. The Software segment, an export-oriented industry, dominates the ICT industry, with more than 65 per cent of the revenue accruing from this segment. The demand for Indian software exports arises from factors such as, shortage of skilled workers in U.S., lower labour cost in India and the 12 hour time gap between U.S. and India which makes it possible to have 24 hour working days in the U.S. through networking.

The software industry world over is known to exist in clusters such as the Silicon Valley .In India 97 percent of the software firms are working from Metropolitan cities and their suburbs. The regional distribution of software industry is highly skewed even among the metropolitan cities, with about 87 percent of the firms clustering in and around the Mega cities of Delhi, Mumbai, Calcutta Bangalore, Chennai and Hyderabad in 2000-01(See Table 1).[1] Locating the firm within the cluster provides them with superior or lower cost access to inputs, which maximizes their productivity while sourcing outside the cluster, would mean higher transaction costs. The very high extent of clustering of firms can be understood from the fact that there hardly exists any firm outside these regional clusters. For instance, of the 62 firms that were in Andhra Pradesh, 60 were in Hyderabad alone (See Table 2). Such clustering of firms have had significant impact on their average revenue earning as well, with the average revenue of states, that have these clusters, recording much higher than the other states.

There are however considerable differences among the mega cities on their relative share of software firms. While Delhi and its suburbs had nearly a quarter of all firms, Calcutta had only about 4 percent of firms. The southern region of Karnataka, Tamil Nadu, Andhra Pradesh and the western region of Maharashtra had a concentration of more than 62 percent of all firms within these regions. This points to the fact that apart from high degree of clustering the industry itself is highly localized to certain regions.

In order to rank the regions according to their level of technology an index was built. The directory of software companies in India published by the NASSCOM provides information on different areas in which each of the firm specializes. As a first step we have divided different areas of specialization by the firms in terms of their innovation potential into three groups high, medium and Low. Having divided the areas into three categories we have assigned different weights (1 for low, 2 for medium and 3 for high) to them. Thus we have a matrix of a_{ij} (where a_{ij} $\in$ 0, 1) activities in which the firms actually specialize and another matrix of w_{ij} (where w_{ij} $\in$ 1,2,3) their weights, following, which a technology index, was built for the firms[2]. Further, the average technology level of region was calculated by taking the sub regional average of firms.

[1] The NASSCOM directory covers only firms that have more than 20 workers Hence it is possible that a large share of the software firms, which are small scale firms are not enumerated.
[2] See Joseph and Abraham (2002) for details on the Technology Index

Average Index of Technology of Firm = $\sum a_{ij} w_{ji} / n_c$ where i =1 to 626, j = 1 to 50

Average Number of activity of a firm in the City = $\sum a_{ij} / n_c$

Number of Firms in City = n_c where c is the c th city

Table 1 Location of Software Firms in cities 2000-01

	No.of Firms	Percentage Share of Location	Average Number of activity	Index of Technology
Ahmedbad	12	2.0	10.8	22.1
Bangalore	113	18.1	11.2	21.3
Calcutta	23	3.7	11.9	22.7
Chennai	65	10.4	11.4	21.5
Delhi/Gurgaon/ Faridabad/Noida	152	24.3	10.7	19.6
Gandhinagar	2	0.3	13.0	25.5
Hyderabad	60	9.6	11.6	21.8
Kochi/ Trivandrum	10	1.6	6.7	12.4
Mumbai	133	21.2	11.1	20.7
Pune	14	2.2	12.9	27.4
Others	42	6.7	11.0	20.0
All India	626	100.0	11.20	20.8

Source: NASSCOM Directory of Software and Services , 2000-01

Table 2 Location of Software Firms in States 2000-01

State	No. of Firms	Percent share	Average Revenue of Firms (In Rs. Crore)
Andhra pradesh	62	9.9	265.8

Bihar	2	0.3	0.5
Chandigarh	3	0.5	25.1
Chattisgarh	1	0.2	4.0
Delhi(NCR)	152	24.3	274.5
Goa	2	0.3	7.5
Gujarat	19	3.0	46.5
Karnataka	113	18.1	697.3
Kerala	9	1.4	44.9
Madhya Pradesh	6	1.0	12.7
Maharashtra	151	24.2	719.7
Mizoram	1	0.2	0.0
Orissa	2	0.4	0.5
Pondicherry	1	0.2	16.4
Punjab	2	0.3	6.4
Rajasthan	4	0.6	15.3
Tamilnadu	70	11.2	627.5
Tripura	1	0.2	6.0
Uttar Pradesh.	2	0.3	92.0
West Bengal	23	3.7	90.2
Total	626	100	469.5

Source: NASSCOM Directory of Software and Services, 2000-01
Note: Firms in NOIDA, Gurgaon, and Faridabad are accounted to Delhi

Average Index of Technology: From the index (see Table 1) it is evident that the highest Index is achieved in Pune. In other words the firms in Pune in general are able to achieve a higher level of Index that combines both depth (Technology level) and spread (Number of activites) in the Information Technology Sector.. Most firms lie within the Index range of 20 and 23, where the major IT cities such as Bangalore, Mumbai, Calcutta, Chennai and Hyderabad fall. Prominently Delhi and its surrounding cities and Kochi/Trivandrum in Kerala were below the 20-point cut off. It would be safe to argue that the firms in these two regions performed poor in terms of technology achievement.

Average number of activities of a firm in the city -: The firm in the IT industry is not a single product firm. It is highly diversified and is involved in the production of many goods and services at a time. NASSCOM, had accounted fifty different activites that the firms in the IT industry are involved. Table 1 shows the average number of activites of a firm in the respective city. The average number of activites of the firm in the national level is around 11. The average number of activites of the average firm in most metro cities is around 11 activites. Here again,

Delhi, Kochi /Trivandrum have number of activites that are less than 11.Pune, Gandhinagar, Calcutta and Hyderabad have numbers that are above 11.

To summarize, the IT firms are largely clustered in and around mega cities. Their regional location is also skewed towards the southern region and western region of the country. There is considerable intercity difference in terms of level of technology and revenue earnings. Further, revenue earnings, technology level and innovative capability of the firm seem to be correlated.

III.I Regional Skill Supplies

Analytical Framework

Skills can be categorized on the basis of their Inter-Industry mobility. 'Specific skills' are limited to particular industries while 'General skills' have high potential for inter – industry mobility. Workers with General skills do routinised work at lower ends of value addition in the production chain. Workers with general skills acquire such skills typically by attending non-professional school/collegiate education. Specific skills are those specialized skills that are required to meet non-routinised forms of work, at the higher ends of value addition in the production chain. Professional, technical and higher academic education provide such specific skills that are specialized in specific industry. Such specific skills can also be acquired by 'On-the-job' training and 'learning –by – doing'.

In the specific case of software product development different types of skills can be identified:[3]

1. Basic technical skills such as coding sand programming languages, which can be learned in codified form.
2. System skills including ability to break down complex systems and coding tasks into discrete components.
3. Advanced or High end technical skills- including mathematical and scientific knowledge
4. Innovative technical skills –creative interdisciplinary and other technical abilities needed for new product development.

[3] Tsang, Ted (2001)

Skill supply has two facets –the creation of skills and the application of skills. Creation of skills takes place in the particular institutional setup of educational system discussed in the above paragraph. Since skill is embodied in the worker himself, the application of skill refers to the employment of the worker in an economic activity that exploits his skills appropriately so as to increase the productivity and growth of a particular economic activity. Thus while the first facet essentially brings to its purview the issues of education and training the second facet bring in the issues on the stock and flow of workers of varied skills.

Regional skill supply originates from two spatial sources –local skill supply and skill supply of the migrant worker. For analytical purposes, apart from assessing the existing stock of skills, comprehending the structure of such skill imparting institutions would provide insights into the local supply of skills since local supply of skills is determined by the skill imparting institutions of the region. But this is not so in the case of migrant workers, as migrant workers reach their destination with embodied skills. However understanding the skill patterns of migrant workers in a region could offer perceptions into the industrial structure of a region as well as the gap between demand and supply of locally available skills in the region.

III.2 Skill supply of local Workers

1. Stock of skills

The regional distribution of non-agricultural workers in urban areas is more or less equal at 27-28 percent in the Southern, Northern and Western regions of the country, while eastern region has a very low share of 15 percent and N.Eastern region have only 2 percent of the total urban workers in the region (Table 3). Even when the total share is equal for the South, West and North, nearly one third of the urban illiterate workers are concentrated in the urban areas of northern region. On the other hand the concentration of literate population in the northern region is lesser than the South and the West, which points to the fact that regional labour pool is skill biased in the southern, western and northern region with northern region biased towards less skilled workers and the southern and western region biased toward more skilled workers. The eastern region and N.Eastern region have literate workers approximately equal to the share of total workers indicating marginal or no skill bias among the working population in these regions.

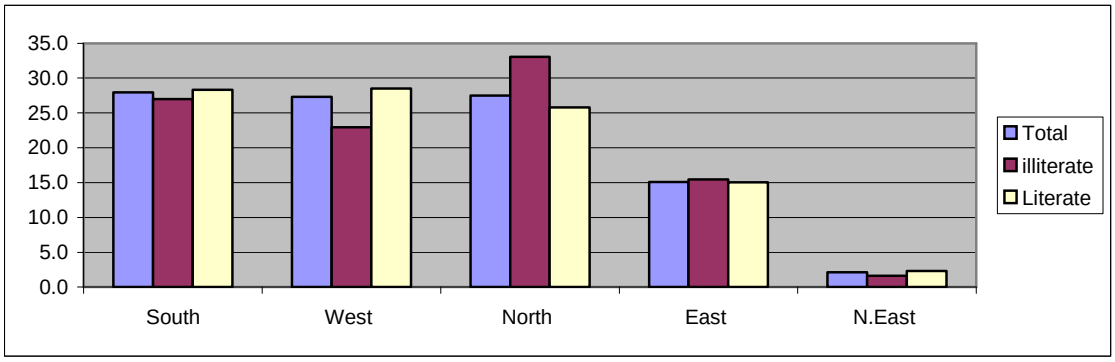
Table 3

Regional Distribution of Non-Agricultural Workers in Urban Areas According to Level of Education-1991

	Total	Illiterate	Just Literate	Matriculation Or less	Higher Secondary or Equivalent	Diploma/ Certificate (non-technical)	Diploma/ Certificate (Technical)	Graduate/ PG (non-Tech)	Graduate/ P.G. Degree or Diploma (Tech)
South (4)	27.95	26.97	29.12	30.12	21.79	38.92	38.32	22.20	33.37
West (4)	27.31	22.92	29.45	29.89	24.03	38.74	33.02	24.96	26.49
North (6)	27.50	33.05	23.41	22.99	37.40	16.18	19.89	32.43	24.99
East (3)	15.08	15.44	15.52	14.67	14.47	5.32	7.65	18.00	13.38
N.East (8)	2.15	1.62	2.50	2.32	2.31	0.83	1.11	2.40	1.77

Source: Census of India, 1991, Economic Tables

Graph-1



Disaggregating the literate working population reveal that the southern region alone claim more than one third of the country's technically educated workforce, both at the diploma and the degree level. The western region follows this for technically skilled work force. But when it comes to general education at the graduate/P.G. level the northern region has a clear lead over all other regions. Thus even among the literate workers there seems to be a regional skill bias**.** The country's technical skills are largely distributed in the southern and western region while the country's general skills are more concentrated in the northern region.

Further dissaggregation of the technically skilled working population into various technical skills show that in the case of both Technical Diploma holders and Engineering skills southern region had a much larger share in comparison to the rest of the country (See Table 4). The southern and western regions together had more than 70 percent of the technical diploma

holders and nearly 65 percent of the engineers of the country. It clearly brings out the regional concentration of the engineering skills, one of the most important inputs for industrial activity.

Also, the ratio of technical diploma holders to that of graduates show that for every hundred graduates more than 27 technical diploma holders were employed in the southern region. This ratio could be interpreted as a technical skill intensity measure for the lower skill levels. Since both graduate and diploma courses are 'first degrees' it could be inferred that the workers holding such degrees are involved in less skill demanding activities than those who undertake courses that are more intensive and have longer duration such as the Engineers or who hold a second degree such as post-graduation. At the higher skill levels, technical skill intensity ratio is even higher at 57 engineers per hundred P.Gs in the south. The disparity between the northern region and the southern region is sharpest in the technical skill intensity at the high skill level. The greater intensity of non-technical, general skills in the northern region vis-à-vis the southern and western region would restrict the growth of skill intensive industries in the northern region and could encourage labour intensive industries to locate in the regions with larger skill pools.

Table 4

Regional Disparities in Technical Skills of Main Workers in Urban areas - 1991

	Share of Diploma (Tech) holders	Share of Engineers	Ratio of Diploma (Tech) to Non-tech Graduate	Ratio of Engineers to Non- tech P.G
South	38.3	32.8	0.27	0.57
West	33.0	31.2	0.21	0.43
North	19.9	20.2	0.11	0.14
East	7.7	14.0	0.06	0.35
N.East	1.1	1.7	0.07	0.35

Source: Census of India, 1991, Economic Tables

The following Table illustrates the skill dispersion of main workers among various types of human settlements in the India. As the level of school education rises from illiterate to higher secondary level the share of workers having higher levels of education get higher in all urban areas, including metropolitan cities and Mega cities. From the graph below it is clear that as the rural share of school educated workers decline at successive levels of education the largest gainer is the Mega cities. As the level of education reaches graduation and beyond the share of

workers get increasingly concentrated in the urban, metropolitan and mega cities. Among the skilled workers the single most concentration of skills is found in the case of engineers. More than 44 percent of all engineers are located within the six-mega cities of the country. The metropolitan cities also have a high share of engineers in comparison to its total share of workers. Apparently as the level of education increases workers tend to be increasingly concentrated in the urban areas. Moreover, the technically skilled workers, especially engineers and medical practitioners seem to be maximally concentrated in the mega cities and other metropolitan regions of the country.

Table 5

Regional Distribution of Skills of the Main Workers-1991

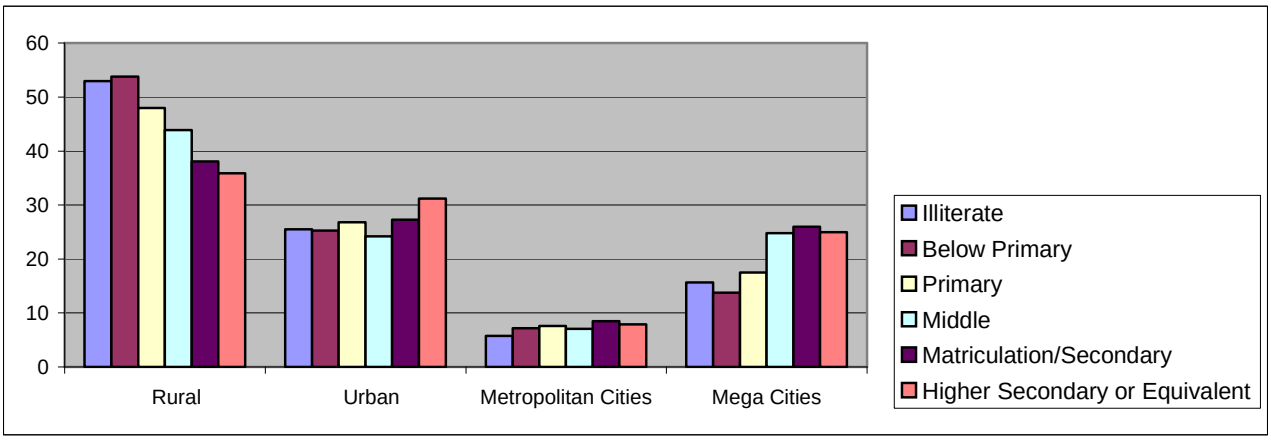
	Rural	Urban	Metropolitan Cities	Mega Cities
Total	44.1	26.9	7.6	21.4
Illiterate	53.0	25.5	5.8	15.7
Below Primary	53.8	25.3	7.2	13.8
Primary	48.0	26.8	7.6	17.5
Middle	43.9	24.2	7.1	24.8
Matriculation/Secondary	38.1	27.3	8.5	26.0
Higher Secondary or Equivalent	35.9	31.2	7.9	25.0
Diploma or Certificate (non-technical)	56.7	28.5	6.3	8.5
Diploma or Certificate (technical)	36.8	30.0	9.7	23.4
Graduate Degree (Non-Tech)	23.9	29.2	10.8	36.0
Post Graduate Degree (Non-Tech)	23.2	40.6	12.5	23.6
Graduate/P.G. Degree or Diploma (Tech)				
1.Engineering	14.4	27.1	15.1	43.4
11.Medicine	22.5	32.3	12.4	32.8
111.Agriculture and Dairying	33.6	38.3	16.7	11.3
1V.Veterinary	34.3	44.9	7.7	13.1
V. Teaching	45.0	32.4	5.9	16.7
VI. Others	51.2	34.9	3.9	10.0

Note: Each region corresponds to the percentage exclusive to that region. Thus urban areas do not include areas under metropolitan cities or mega cities and metropolitan cities region do not include the mega city regions

Source: Census of India, 1991, Economic Tables

Graph 2

Regional Distribution of Skills of the Main Workers-1991



III.3 Creation of skills

a. Secondary Education

Specialized education starts at the higher secondary level of education (SeeTable 6). So it would be appropriate to look into the regional spread in higher secondary education. Northern India has the largest share of higher secondary schools at 45 percent. However it is remarkable that in northern region even when share of total enrollment had declined from 40 percent in 1990-91 to 36 percent in 1995-96 the share of all students enrolled in science streams have increased from 30 percent to 39 percent. This clearly points to deepening intensity of science education at higher secondary level in the northern region during the period. Southern region also experienced very similar trends with total enrollment share increasing from 25 to 29 percent and share of enrollment in science education increasing from 35 percent to 38 percent.

However in the case of western, eastern and N.East states though the share of number of higher secondary schools remained approximately the same the share in both total enrollment and enrollment in science streams declined from their respective levels in 1990-91.The decline in enrollment in science streams in eastern India had been the most drastic, which fell from 14 percent to 7 percent during the period.

Table 6
Regional Share of Enrollment and No. of Schools at +2 classes

	1990-91			1995-96		
	Enrollment in Science	Total Enrollment	No. of schools with +2	Enrollment in Science	Total Enrollment	No. of schools with +2
South	35.3	25.4	19.1	38.2	28.6	19.1
West	19.1	20.5	23.7	14.7	21.6	24.4
North	29.8	39.6	44.2	38.6	35.9	45.4
East	13.7	12.5	9.7	6.9	11.2	7.5
N.East	2.1	2.0	3.4	1.7	2.8	3.7
	100.0	100.0	100.0	100.0	100.0	100.0

Source: Education in India, Vol 1(s), 1995-96, 1990-91

The following Table 7 expresses the relative position of science education at the higher secondary stage vis-à-vis the rest of the streams. Intensity of science thus has been measured as the number of student enrolled in science streams at the higher secondary level divided by the total enrollment in all streams. The intensity of science education at the all India level increased from 26 percent in 1990-91 to 30 percent in 1995-96. Science intensity has been maximal in the southern states, and found increasing too from 37 percent to 41 percent. The northern states also recorded an increase in the intensity from 20 percent to 33 percent. All other regions West, East and N.East experienced decline in the intensity of science education. The increasing intensity of science at the all India level with a clearly skewed pattern of education concentrated to the north and south would certainly have regional growth and development implications.

Table 7
Intensity of Science enrollment at +2 classes

		Less than 0.2	0.2-0.4	0.4-0.6	0.6-0.8	0.8-1	Total intensity
South	1990-91	0	2	4	0	0	0.37
	1995-96	0	3	3	0	0	0.41
West	1990-91	1	5	0	0	0	0.25
	1995-96	2	4	0	0	0	0.21
North	1990-91	3	5	0	0	0	0.20
	1995-96	3	3	2	0	0	0.33
East	1990-91	1	3	0	0	0	0.29
	1995-96	2	2	0	0	0	0.19
N.east	1990-91	3	4	1	0	0	0.28
	1995-96	3	3	0	1	1	0.19
Total	1990-91	8	19	5	0	0	0.26
	1995-96	10	15	5	1	1	0.30

Source: Education in India, Vol 1(s), 1995-96, 1990-91

To discern the disparities in higher secondary education according to size of cities all states were divided into three types: States that had the presence of Mega cities, states that had no mega cities but had metropolitan cities and states that no metropolitan or mega cities in them. The indicators of potential for technical and engineering skills such as intensity of enrollment in science streams show that the maximum intensity in 1990-91 was in the case of states with Mega cities followed by states with metropolitan cities and lastly by other states. However during the period 1990-91 to 1995-96 the intensity of metropolitan city states increased from 21 percent to 32 percent (See Table 8)**.** Moreover, apart from the fact that the intensity in other states declined from 21 percent to 19 percent the gap between the mega and metropolitan cities and other cities have widened during the period. During the same period the share of total enrolled students in higher secondary education declined from 45 to 41 percent in metropolitan city states, while the share of both mega cities and other states increased. The redistribution of science students is leading to marginalisation of regions without the presence of large cities.

Table 8

Higher Secondary Enrollment
Distribution and Intensity According to presence of cities in States

	Science intensity		Science enrollment distribution		Total enrollment distribution	
	1990-91	1995-96	1990-91	1995-96	1990-91	1995-96
Mega	0.33	0.32	56.3	51.0	45.7	48.9
Metro	0.21	0.32	36.6	42.8	45.2	41.3
Others	0.21	0.19	7.1	6.1	9.2	9.9

Note: Mega – States with the presence of Mega cities, Metro- States with the presence of metropolitan cities but no mega cities, Others- States with no presence of either mega or metropolitan cities
Source: Education in India, Vol 1(s), 1995-96, 1990-91

b. Tertiary Education

Beyond the higher secondary school level of education the pattern of education bifurcates into various specialized skill imparting and training institutions. As discussed above, on the basis of their inter-industry mobility of skills education could be classified as general education and specialized education. Both types of education have varying levels of training depending on the course content and years of education. General education at the post school level starts at

general graduation courses imparted at the college level, which, at advanced level reaches to Post graduation and Doctoral training. Specialized education at the post school level are such courses that provide occupational training as engineering, medicine etc. Here too the level of advancement in specialized training vary on the basis of course content and years of training. Thus the level of skill training received by a Diploma holder may be comparatively less to that of an Engineering holder, though both may work in the same industry. By virtue of this superior achievement in skill the engineer is often placed higher in the job hierarchy in comparison to the diploma holder.

At the general graduate level of education the science intensity continues to be highest in the southern region at 31 percent(See table 9). There is wide regional disparity in graduate education between south and the rest of the regions. At the Postgraduate education level there is a general rise in the science intensity across all regions, except eastern region. However in terms of the percentage share of total gradates the southern region has one of the smallest share, consisting of only 21 percent and Postgraduates accounted only for 14 percent of the total post graduates. While more than 41 percent of all postgraduates were being enrolled in the northern region, followed by the western region at 24 percent. It seems there is a great regional divide in the skill training and hence in skill supply. From the graph below it is clear that at each higher level of education in the general education stream there is a secular decline in the share of the southern region. The northern states have the highest share in both graduates and postgraduates. The western region, though less than the northern region have a rising share of enrollment as the level of education increases. Thus it points to the fact that as the level of general education increases beyond the 12^{th} class, at each higher level of education, an increasingly larger share of the total enrollment gets concentrated in the northern region followed by western region while the share keeps continually declining in the southern region.

Table 9

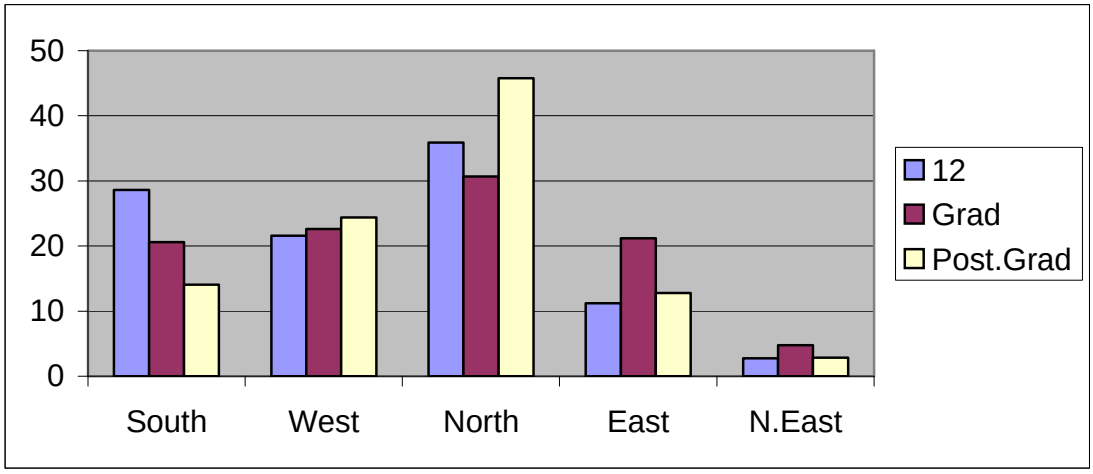
Regional Share of Enrollment and Intensity of Science at Post School Levels in General Education Streams-1996-97

	Enrollment Share

	Science intensity		Graduation		Post Graduation		Doctoral
	Graduation	P.G.	B.Sc	TOTAL	M.Sc	TOTAL	PhD
South	0.36	0.41	33.1	20.6	22.8	14.1	19.0
West	0.16	0.17	16.3	22.6	16.9	24.4	12.4
North	0.19	0.26	26.8	30.7	47.0	45.8	60.3
East	0.21	0.19	19.7	21.2	9.7	12.8	6.6
N.East	0.19	0.32	4.1	4.8	3.7	2.9	1.8
All India	0.22	0.25	100.0	100.0	100.0	100	100.0

Source: Selected Educational Statistics, 1997

Graph 3
Regional Share of Enrollment at Post School Levels -1996-97



The classification of the states into mega city states, metro city states and other states reveal that the intensity of science education is the highest in the mega city states at both graduation and post graduation level(See Table 10). However, as revealed in the graph below, at successive levels of education the share of mega city states decline continually. On the other hand as the level of general education rises the share of enrollment in metro city states increases. The share of metro city states at 45 percent and 59 percent for graduate and postgraduate enrollment is much higher than that of the mega city states. Here again the share of enrollment in general education tends to get concentrated in the metro city states as the level of education rises and in turn it tend to get diverged from the megacity states.

Table 10

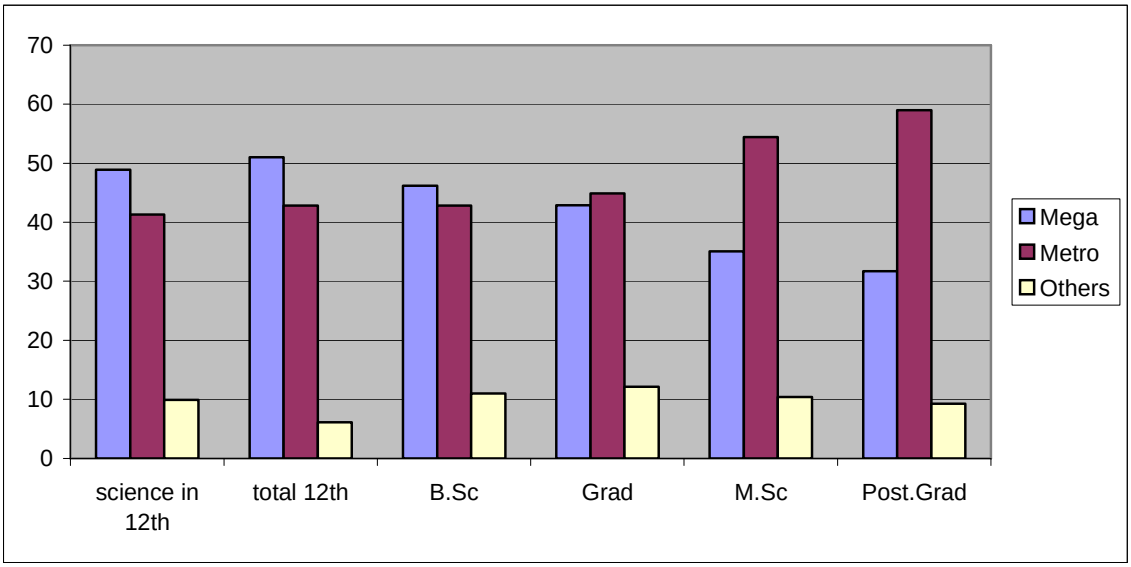
Share of Enrollment and Intensity of Science at Post School General Education Streams According to Presence of Type of City in State: 1996-97

	Graduation			Post Graduation		
	Science Intensity	**Science Enrollment share**	**Total Enrollment Share**	**Science Intensity**	**Science Enrollment Share**	**Total Enrollment Share**
Mega	0.24	46.2	42.9	0.28	35.1	31.7
Metro	0.21	42.8	44.9	0.23	54.4	59.0
Others	0.20	11.0	12.1	0.28	10.4	9.3

Source: Selected Educational Statistics, 1997

Graph 4

Regional Share of enrollment at various levels of general education –1996-97



Note: The share in 12th class is calculated from the data for the year 1995-96.

The location of engineering skills is highly concentrated in the southern region (See Table 11). In 2001 more than 57 percent of all engineering degree enrollment and 46 percent of all technical diploma were done in the southern region. Moreover the concentration of enrollment for engineering had been rising over the years in the southern region, from 45 percent in 1991 to 57 percent in 2001. Correspondingly the share of all other regions has declined from their respective shares over the years, except in the case of northern region, which increased from 12 percent to 18 percent during the period 1995 to 2001. The regional changes in the share of enrolment for diploma courses also showed similar trends though at a marginal scale in comparison to the engineering degree.

At the state level, the highest concentration of engineering degree intake was in the four states of Tamil Nadu, Andhra Pradesh, Karnataka and Maharashtra respectively in 2001. While the share in Maharashtra and Karnataka declined during the period 1995-2001 the share correspondingly increased in Tamil Nadu and Andhra Pradesh.

From the distribution of technical institutions it tends to suggest that there the southern region have a much larger share of technically skilled working population than any other region. Further, this concentration of technical skills in one single region of the country is only escalating over the years.

Table 11

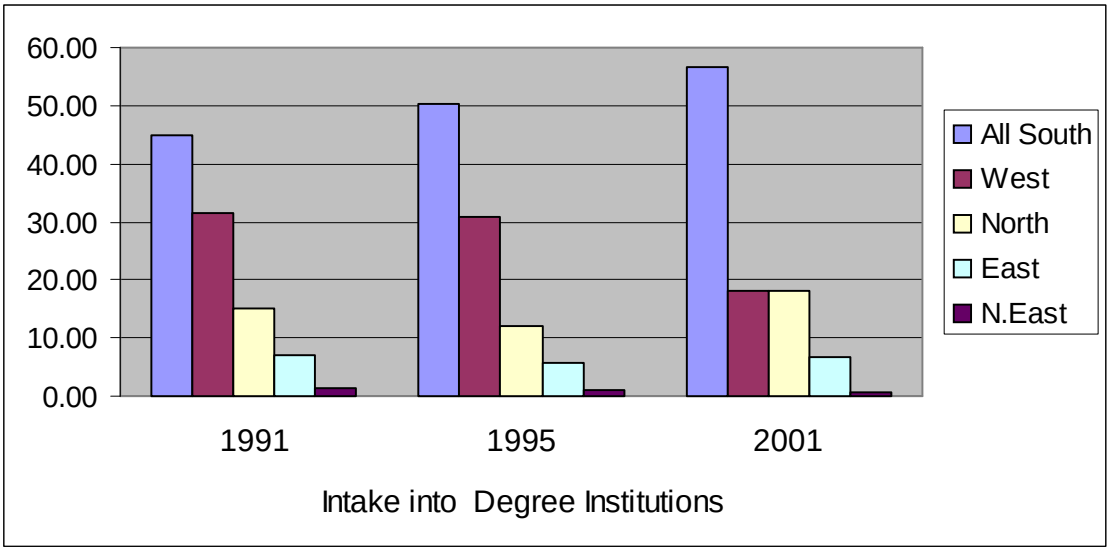
Regional Distribution of Enrollment in Technical Institutions

	Intake into Engineering Degree			Intake into Diploma		
	1991	1995	2001	1991	1995	2001
Andhra Pradesh	6.98	8.26	17.87	7.77	7.32	6.49
Karnataka	21.20	21.35	11.23	14.36	19.17	15.64
Tamil Nadu	12.87	16.05	22.00	15.98	15.86	20.14
All South	44.88	50.26	56.60	41.49	46.37	46.09
Maharashtra	25.54	25.19	13.08	20.50	17.42	16.19
All West	31.62	30.92	18.11	26.99	23.34	22.37
Delhi	1.64	1.21	0.98	1.83	1.93	2.25
Uttar Pradesh	4.46	3.44	6.89	9.37	8.87	5.08
All North	15.20	11.91	18.17	22.15	21.17	18.37
West Bengal	3.26	2.09	2.98	4.37	3.13	2.66
All East	7.08	5.83	6.58	7.79	7.54	6.87
N.East	1.22	1.07	0.53	1.59	1.58	6.30

Source: Technical Manpower Profile 1995;IAMR, New Delhi;1998
AICTE Website: www.aicte.ernet.in

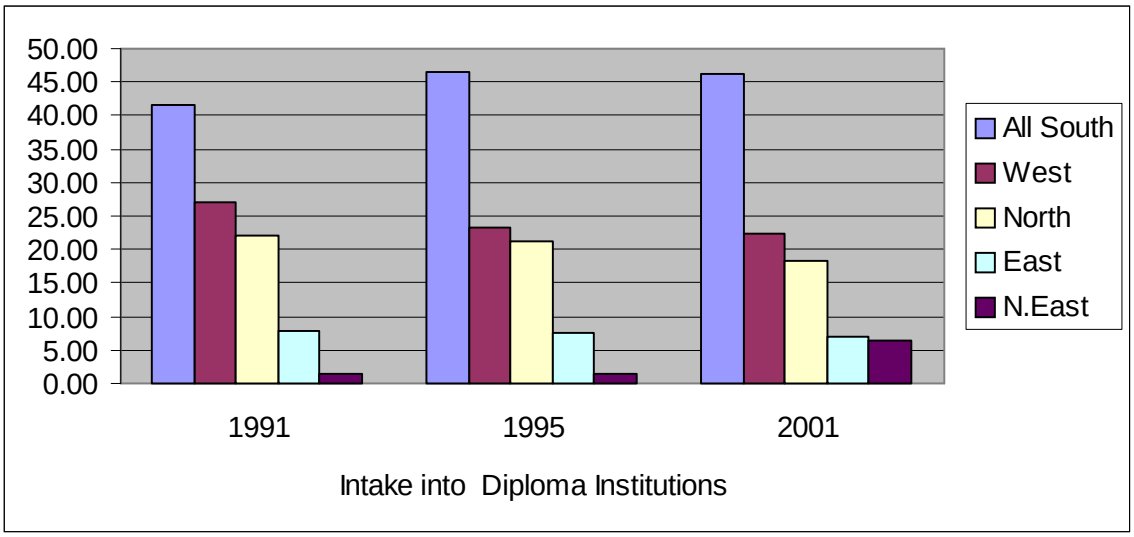
Graph 5

Regional Distribution of Enrollment In Engineering



Graph 6

Regional Distribution of Enrollment In Technical Diploma



In order to look into the relative supply of specific skills to that of general skills, ratio of engineers to general graduates, ratio of diploma enrollment to general graduates and ratio of postgraduate engineers to general postgraduates were calculated (See Table 12). Karnataka had the highest share of engineers, diploma enrollment and postgraduate engineers relative to that of graduates, which was followed by Tamil Nadu and Maharashtra in that order. All regions recorded a rise in the ratio during the period 1991-95 except in West Bengal, which declined

even from its already marginal relative share of engineers, and diploma holders in 1991. The relative share of engineering skills in the region has important implications for the location of IT enabled sector.

The IT– enabled sector is largely dependent on general skills, with supportive technical skills. Therefore it could be argued that the firm would ideally locate in region where there is abundant supply of both technical skill and general education skills. But the firm would be looking for relatively larger shares of general skills than technical skills

Table 12

Regional Technical skill Intensity

	Graduate Engineers per 100 General graduates		Diploma holders Per 100 General graduates		Post graduate engineers per 100 general post graduate
	1991	1995	1991	1995	1991
Andhra Pradesh	1.65	3.67	3.37	5.73	1.94
Karnataka	4.55	11.26	5.64	17.82	4.99
Tamil Nadu	3.20	8.26	7.27	14.38	4.31
South	3.01	6.73	5.09	10.94	0.03
Maharashtra	2.37	4.55	3.48	5.54	0.70
West	1.80	3.50	2.82	4.65	0.01
Delhi	0.96	1.03	1.95	2.90	4.08
Uttar Pradesh	0.57	0.93	2.17	4.22	0.61
North	0.89	1.38	2.36	4.33	0.01
West Bengal	0.77	0.67	1.88	1.77	3.00
East	0.55	0.68	1.10	1.54	0.01
N.East	0.39	0.57	0.94	1.70	0.00

Source: Technical Manpower Profile 1995;IAMR, New Delhi; 1998
Selected Educational Statistics, 1992,1995;Ministry of Human Resource Development, Government of India
Out turn of Scientific and Technical Manpower in India, 1984-89; Vol2;HRD group; CSIR, New Delhi, 1993
Note: Post graduate engineers in the last column has been calculated using the data of post graduates engineers in 1989 and general post graduates in 1991

Further disaggregating the engineering degree level education into engineering courses that are utilized maximally in the Information Technology sector it is found that most of the IT related engineering courses had already attained, by 1989(Table 13), a high level of concentration (74 percent in Computer science, 72 percent in Electronics and communication) in the four states

of such as Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra of which three are in the southern region. During the period 1989-2001 the concentration in the southern region increased in both IT related engineering streams. New courses that came up such as Information Technology, Electronics and Electric, and Electronic engineering also experienced very high concentration in the southern region. But the share of Maharashtra had declined in both computer science and Electronics and communication during the period 1989-2001.The concentrations of IT related engineering courses are located in the three states of Andhra pradesh, Tamil Nadu and Karnataka. Also, their regional share had been rising over the last decade.

Table 13
Regional Distribution Of Information Technology Related Courses Enrollment-2000-01

	Computer Science and Engineering		Electronics and Communication		Electrical and Electronic	Electronics	Information Technology
	1989	2001	1989	2001	2001	2001	2001
Andhra Pradesh	10.81	19	13.08	24.3	36.4	2.2	17.8
Karnataka	14.91	10.6	13.59	28.1	38	2.7	24.4
Tamil Nadu	22.24	21.5	19.73	13.2	10.9	1.6	10.1
South	52.58	56.9	51.19	72.9	92.1	6.5	57.7
Maharashtra	26.2	12.3	17.3	1.6	0	63.3	12.6
West	28.9	16.9	21.8	5.2	0.2	68.7	18
Uttar pradesh	2.95	7.1	7.03	6.6	2.8	9.7	6.3
Delhi	9.46	1	3.11	1.2	0.3	0	1
North	14.05	19.5	15.72	16.7	6.1	22.5	18.3
West Bengal	2.9	2.8	9.2	2.9	0	0	3
East	4.5	6.2	10.7	4.7	1.3	2.4	5.8
N.east	0	0.5	0.5	0.5	0.2	0	0.2
Total	2442	8078	76558	60693	26035	6722	54929

Source: AICTE Website: www.aicte.ernet.in
Out turn of Scientific and Technical Manpower in India, 1984-89; Vol-2;Human Resource Development Group; CSIR, New Delhi, 1993

III.5 Skill Levels of Migrant Workers

In Table 14, row 1 represents the share of total migrant workers in the metropolitan cities of India to that of the migrant workers in All India categorised according to the level of education. row 2 represents the share of total migrant workers in the metropolitan cities of India to that of the migrant workers in the urban areas of India categorised according to the level of education. The rows starting with State names represent the distribution of migrant workers in the metropolitan cities with metropolitan cities clubbed according to the state they belong to.
(for ex. Hyderabad and Vizhakapatnam are clubbed together to represent the metropolitan population of Andhra Pradesh)

Table 14

Distribution of Migrant Workers in States with Metropolitan Cities According to Level of Education- 1991 (All figures in Percent)

		Panel 1-Less Skilled Migrants				Panel 2 – Skilled Migrants			
	Total	Illiterate	Literate But Below Matric	Matric but Below Graduate	Less Skilled Workers	Diploma Certificate (Tech)	Graduate Degree /post Graduate (Non-Tech)	Graduate/ P G. Degree or Diploma (Tech)	Skilled Workers
1.Total India	31.8	32.8	34.3	31.1	32.8	27.1	29.5	23.3	27.9
2.Urban India	43.1	47.5	46.8	41.6	45.1	38.4	36.3	33.3	36.0
Andhra Pradesh	6.8	6.6	4.1	6.6	5.5	18.3	11.2	12.9	12.5
Bihar	0.4	0.2	0.2	0.4	0.2	0.2	1.2	0.7	0.9
Delhi	18.1	26	15.3	16.5	18.4	8.5	18.8	16.5	17.0
Gujarat	8.5	8.6	10.4	7.9	9.1	4.5	5.8	7.6	6.0
Karnataka	7.2	5.6	5.7	8.3	6.5	12.9	8.8	12.8	10.0
Kerala	0.9	0.2	0.8	0.9	0.7	3.5	1.6	2.1	1.9
Madhya Pradesh	3.2	3.2	2.7	3	2.9	4.7	4.9	3	4.5
Maharashtra	31.4	24.6	36.8	35.1	33.2	29.2	22.5	22.3	23.4
Punjab	1.9	3.4	1.6	1.8	2.1	0.6	1.1	0.9	1.0
Rajasthan	1.7	1.6	1.4	1.6	1.5	0.6	3.1	1.7	2.5
Tamil Nadu	8.8	4.3	8.8	10.7	8.3	13.9	9.9	12.3	10.9
Uttar Pradesh	2.1	1.8	1.4	2.3	1.8	1.3	4.6	3	3.8
West Bengal	9	14	10.8	5.1	9.7	1.8	6.6	4.2	5.5

Source: Census of India, 1991,Migration Tables

Even when the distribution of migrant workers confirms largely to the size of the cities the migration pattern of workers vary vastly according to their level of skill. Panel 1 and Panel 2 represents the share of unskilled+ semi-skilled migrant workers and share of the skilled migrant workers, respectively, in the metropolitan cities according to the State they belong to. Largest share of migrant workers in Metropolitan cities , both skilled and less skilled had

migrated to Maharashtra. But, migration pattern of workers is highly skill differentiated in most states. The Metropolitan cities in Andhra Pradesh, Karnataka, and Tamil Nadu attract a much larger share of skilled workers in comparison to less skilled workers to their cities. While the Metropolitan cities in West Bengal, Maharashtra and Gujarat attract larger share of less skilled workers than skilled workers. The remaining regions attract workers of both levels of skills at approximately equal shares.

Further disaggregation shows that some metropolitan cities show wide intra-skill variations. For example, Delhi attract nearly 26 percent of all metropolitan cities' illiterate migrant workers to its metropolitan region while it attracts much lesser shares at all other levels of skills. Similarly Metropolitan cities in West Bengal accommodate 14 percent of all illiterate migrant workers and 11 percent of 'below Matric' migrant workers. But the share of more skilled migrant workers are much lesser compared to the above. These points to the fact that migration of workers to metropolitan cities in India is skill differentiated.

IV. Skill Supplies and The location of IT firms

In order to draw relation between regional skill supplies Pearson's correlation coefficients were calculated at two stages. First, to understand impact of supply of skill on the location of a firm in a region correlated were drawn between number of firms at state level and number of respective causative variables. Second, to further capture the impact of these causative variables on clustering of firms to a city correlations were drawn between location of firms within the city and the respective causative variables. Indicators of skill were conceived at different levels of skill pertaining to software development, total workers, tertiary workers and technical educated workers. In the case of skill training, the relation between various levels of education enrollment and firm location were tested.

The number of firms in the city seems to be positively correlated to skill stock in the cities. However more important than the total workers are the ability of the city to attract migrant workers to the city that determine the stock of ICT firms in the cities. It is also important that it is the stock of technical migrants workers that provide the maximum impetus for firms to

agglomerate in particular city. The impact of the skill training within the region have only marginal impact on the firm agglomeration in the city.

However at the state level the stock of labour in the urban regions have a positive and significant impact on the firms locating within the state. Migration also has a significant and positive impact on firm location pattern, but the impact is loess in comparison to the migration impact on cities regarding firm agglomeration. Skills training at the technical level, both genenral engineering courses and computer engineering course have a [positive and significant impact on the location of firms in the state. In the state level, it is not the intensity of technical education that attract firms but it is rather the stock of skills that are available in the region the firms.

Table 15

Correlates of regional distribution of firms

	City	State
Tot. Workers	0.3814	0.5798*
Tertiary workers	0.4431	0.6285*
Technical workers	0.5902	0.7725*
Tot.emp.migrnts	0.8004*	0.7734*
Tertiary educated migrants	0.9595*	0.7208*
Technical migrants	0.9884*	0.7677*
generaledu	-0.0009	0.4261
Techedu	0.2021	0.6996*
Techint	0.2480	0.3018
Compedu	0.2676	0.7079*
Compint	0.4407	0.3478

Note: * denotes 5 percent Signifance level

V. Conclusion

This study had investigated into the regional supply of skills and creation of skills at various skill levels that pertain to development of the IT sector. The regions were classified into two spatial dimensions, one based on geographical location and other based on type of human settlement. The southern and western regions of the country were richer in supply and creation of skills in comparison to other regions. A great skill divide appears to exist between the northern region on the one side and the southern and the western regions on the other. The northern region had a bias towards general education while the southern region had greater supply and production of specific skills. In terms of human settlements the skills were maximally concentrated within the six mega cities of the country. Here too, there is a perceived skill bias with a much greater share of general skills being supplied and created in the lower urban forms than in the mega cities while technical skills were locally created or migrated into the mega cities. Correlations drawn between the location of firms and regional supply of skills tend to support the hypothesis that the quantity and quality of skills supplied in a region could determine the location of firms in a region and clustering of firms to a city. There seems to be a method of selective elimination of certain skills and educational categories from the space of mega cities in India. The mega cities themselves being regional nodes of a global production system with functional dependence with other spatial nodes there seems to be a systematic method of skill differentiation and elimination within large cities. Skill differentiation, specialization and elimination are ripening the large cities into regional functional nodes replicating the colonial core-periphery relation in new forms using new technologies.

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