Human Capital and Development

A Tale of Two Cities; Software Sector in Bangalore and Hyderabad

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October 10 2010

I Introduction

TW Schultz ended his Nobel lecture with the lament that “we in the high-income countries have forgotten the wisdom of Alfred Marshall when he wrote – knowledge is the most powerful engine of production; it enables us to subdue Nature and satisfy our wants”. In the current day parlance of economists, knowledge is referred to as human capital, and is now widely recognised as an input that is largely responsible for the growth in national income that has surpassed the growth of land, raw labour and physical capital. Schultz also identified the sources of growth of human capital including formal education, on the job training, health facilities that enhance life expectancy and stamina of individuals and adult education. Amongst these, human capital investments in education at all levels and on the job training have been extensively researched. Whilst schools and universities are the principal institutions that provide formal education, the firm, the farm and industry in general provide on the job learning. The firm and the industry of which it is a part not only facilitate learning by doing, but also learning by what others are doing, as Jagdish Bhagwati puts it. These mechanisms not only generate and augment human capital, but also facilitate its transfer and spread to a wide body of human agents.

The presence of firms producing similar products and services in close proximity to each other is most conducive to the generation and spread of human capital. A mere flocking together of firms in a specified geographical area does little towards the formation of human capital. Agglomeration of firms has to be spontaneous and not promoted with various sorts of fiscal subsidies, if it is to perform the function of generating and spreading knowledge. Put differently, it is a cluster of firms that takes shape in response to a variety of socio-economic factors that facilitates the generation and spread of human capital.

This paper discusses the factors that promote clusters and the role of clusters in the generation and spread of human capital This is a topic that has attracted the attention of economists writing on India’s economic development (Okada and Siddharthan 2008, Basant, 2002), but not as much as it deserves, considering the zeal of some policy makers for establishing clusters . The analysis in the paper is based on a comparative study of software firms in the two neighbouring south Indian cities – Bangalore and Hyderabad.

Some of the features of the software industry, especially the human capital intensity of its production process and the interaction between human agents in the industry, are especially relevant for the discussion of the role of clusters in the birth, growth and dissemination of human capital. In the main, the paper argues that whilst the software producing firms located in Bangalore display the characteristics of a genuine cluster, those located in Hyderabad are much less of a cluster. The second section of the paper discusses the nature and factors that promote clusters drawing upon the work of Krugman, Porter and Marshall. The third section reports on the structure and size of the software industry in Bangalore and Hyderabad. The fourth section analyses the nature of the software industry and its implications for human capital development and diffusion. The fifth section discusses nature and origins of the firms in the two cities and the claims of the two groups to the status of a cluster. The last section summarises the main conclusions of the paper.

II The Economics of Clusters

The discussion of the economics of location of economic activity and agglomeration dates back to Von Thunen (1826), the German economist who suggested that agricultural products that are perishable and have to be transported speedily to the market are produced nearer to the market than those goods that are bulky and much more durable. Based on a number of restrictive assumptions, the model outlines the location of economic activity around a central market based on transport costs.

The economics of clusters, much more broadly conceived than Von Thunen's location model, has had a revival with the birth of new growth models, new trade theories centred on imperfect competition and the new economic geography models of agglomeration of economic activity. It is also suggested that the advent of globalisation has lain to rest explanations of the location of economic activity based on the hallowed doctrine of comparative cost advantage.[i] The new economic geography model of agglomeration developed by Krugman (2002) draws upon the work of Von Thunen and that of geographers in modelling the location of economic activity. Krugman's analysis incorporates both transport costs and wage rates; if transport costs outweigh labour costs, firms locate in more than one place and labour is distributed amongst different locales, but as transport costs decline, firms locate in low wage cost regions and export to the other

regions. As agglomeration evolves in the low cost regions, real wages and employment increase.

A feature of the new geography models as also of the new growth theory and new international trade theories is the assumption of imperfectly competitive economic structures. Firms compete on the basis of product differentiation and can experience increasing returns to scale. These assumptions that reflect reality depart from the usual ones of perfect competition and constant returns to scale, typical of growth and trade models in vogue until the advent of the new growth theory and new trade theories in the 1990s. Indeed, Alfred Marshall's discussion of industrial organisation too assumed constant returns to scale at the firm level and perfectly competitive markets. It is on the basis of these assumptions that the neo-classical theories of growth suggest that growth rates between the high and the low income regions would converge; high growth regions with high capital to labour ratios would meet with diminishing returns, much more so than those regions endowed with relatively low amounts of capital relative to labour. The new growth theory contests the assumption of diminishing returns to capital that forms the basis of the neo-classical convergence thesis and argues that whilst diminishing returns may occur at the firm level, the industry or the region as a whole may experience increasing returns. This assumption of diminishing returns at the firm level but increasing returns at the industry level that confers decreasing costs in production on the firms that make up the industry is based on the existence of external economies or externalities in production. Externalities thus explain the presence of increasing returns at the industry level, though individual firms in the industry may be subject to diminishing returns. It is also possible for firms to experience increasing returns to scale if they operate in highly imperfectly competitive markets with each of the firms producing differentiated products.

The presence of externalities is intertwined with the formation of clusters. It is the presence of firms producing differentiated products in a given industry that generates externalities and externalities attract new firms and workers to the cluster and enhance it. Alfred Marshall recognised the importance of externalities in the development of industries. He categorised the economies arising from the increase in the scale of production of any goods into two categories; those that depended on the general development of the industry are external economies and those that depended on the enterprise and efficiency of individual enterprises are internal economies.

Marshall did not distinguish between pecuniary external economies and technological external economies; this distinction was developed later (Scitovsky, 1954). Technological externalities arise through the interdependence of firms through non-market mechanisms where as pecuniary external economies arise through the market mechanism. Inventions and improved techniques of production that are often in the nature of non-rivalrous public goods, freely available to one and all, are in the nature of technological externalities. A reduction in the price of the final goods and/or increased price for inputs, as a consequence of the growth of the industry as a whole, are classed as pecuniary external economies.

It is noteworthy that both technological and pecuniary externalities arise from the growth of the industry or the general development of the industry as Marshall put it. Growth of the industry, needless to say, is dependent on growth in productive efficiency of the firms that constitute the industry, resulting from the differentiation of existing products, the invention of new products and growth in managerial efficiency including marketing skills. In short, growth of the industry is dependent on the growth of human capital. The issue then is whether or not clusters are the mechanisms to promote the growth and development of human capital. Specifically, can clusters be formed and promoted through public policy initiatives or are their birth and growth dependent on factors that are specific to geographical regions? Michael Porter, the Harvard management expert and economist, is known for his advocacy of clusters. As two of the critics of Porter's advocacy of clusters put it, "as the celebrated architect and promoter of the idea, Porter has been consulted by policy makers the world over to help them identify their nations' or regions' key business clusters or receive his advice on how to promote them" (Martin and Sunley, 2003). There is nothing wrong in approaching Porter for advice on identifying potential clusters; the issue however is how to identify them. Porter (Porter[ii]1998, Basant, 2002) and others identify geographical proximity of firms, interconnections between firms and commonalities and complementarities between firms as the key characteristics of clusters. Could all these features be developed with public investments or do clusters evolve in response to socio-economic and geographical factors specific to certain regions? The software clusters in the city of Bangalore in the state of Karnataka and the city of Hyderabad in the state of Andhra Pradesh provide a case study for an analysis of this issue. It is also noteworthy that the software sector, because of its nature and characteristics, provides an ideal case study of human capital development and cluster formation.

III The Case of the Software Industries in Bangalore and Hyderabad

In many respects, the software sector is ideal for analysing the contribution of clusters to the growth of human capital. The sector is human capital intensive in its production process, much more so than any other industry. A large part of the total expenditures of software producing firms is made up of wages and salaries of the software engineers. Apart from buildings and hardware, the industry requires very little fixed physical capital.

Another feature of the software sector is the range and differentiated nature of products the industry produces. The firms in the industry produce a range of products including application software, system software, and programming software. Besides, within each of these groups, individual firms are able to cultivate niche markets such as software for the banking industry, for education institutions and for the medical profession. Firms in the industry can thus be segmented on the basis of both the sort of specialist software they produce and the specific segment of the industry in which they operate.

These features of the software sector are admirably suited to promote the growth and dissemination of human capital or human skills. The product and labour segmentation of the industry described above suggest that the structure of the industry more or less resembles that of universities. Just as academic economists such as mathematical economists, trade specialists and labour economists specialise in specific areas within a discipline, software engineers too specialise in specific areas of a generic industry. Again, just as academics commune with each other and learn from each other, software engineers too benefit from each other's experience and training. This they do both through formal seminars and conferences organised by their trade associations such as the NASSCOM and the technology park administrators where the firms are located, and also through informal networks. Besides, just as academics move between universities in search of fame and fortune, software engineers too move between companies. The rate of such turnover of employees between firms depends not only on the salaries they receive, but also on the facilities for training, on the job learning and working conditions provided by the firms.

These and other features of the software industry suggests that the workers in the various firms are in the nature of what the 19th century Irish economist John Cairnes christened as non- competing groups. Cairnes's purpose in formulating the concept of non-competing

groups was to argue that prices in the market are not always determined by pure competition; an element of rent enters the price formation process. Rents for specific groups are preserved because of non competing nature of groups of labour. A feature of non-competing groups of labour is that there is very little vertical mobility of labour. Each labourer finds a niche depending on his/her education and social status and once the occupation is chosen, the labourer stays put in it. As Cairnes put it “The man who is brought up to be an ordinary carpenter, mason or smith, may go to any of these callings, or a hundred more, according as his taste prompts or the prospects of remuneration attracts him; but practically he has no power to compete in these higher departments of skilled labour for which a more elaborate education and larger training are necessary” (Cairnes 1874). Software firms are non-competing in the sense that each of the firms has its niche products and customers, and hence do not compete with each other. Their employees though can exchange generic information relating to the industry and in so doing, enhance the productivity of the industry. It is thus that they generate technological externalities.

It is also the case that there are gradations of software firms ranging from those that produce say application software to those that produce sophisticated programmes.These differing firms would be non-competing in the sense that Cairnes formulated the concept. However, as Cairnes himself noted, workers in a lower order firm may through sheer exertion, extraordinary energy and self denial can escape from the bonds of their original position. In other words, they can train themselves to graduate to firms producing superior products. It is also possible as Marshall (1907), building upon Carnes’s work, showed that each of the non-competing groups can institute specific training programmes that can result in pecuniary externalities and increasing returns.

It is these features of the software industry that promote the growth and dissemination of human capital. It is also these features of the industry, especially its human capital intensity and the structure of the industry which is diversified, but grounded in a common foundation of generic knowledge that contribute to the formation of clusters. Software firms tend to agglomerate in regions that are endowed with pools of trainable labour that they require. But then, as stated earlier, clusters, if they are to be successful in the building up of human capital and diffusing it, should evolve in a socio-economic climate that promotes their evolution; they cannot be instituted by policy dictat and incentives of various sorts.

This is not to say that clusters do not require any form of external assistance at all; they do, but such external assistance alone cannot result in efficient clusters that are capable of promoting the generation and diffusion of human capital.

1V The Bangalore and Hyderabad Clusters

Origin and Growth

There are quite a few, though not abundant, studies on the software industry in India. The reference point of most of these studies is the software sector in Bangalore now known as the Silicon Plateau of India. Bangalore, the capital city of Karnataka with a population of around 8 million people, is known for its spacious gardens and salubrious weather. The city well known as the pensioner's paradise was to be transformed into the Silicon Plateau of India with the birth of the software industry in the city around the mid-eighties. Hyderabad, the capital city of Andhra Pradesh with a population of 6.8 million people, was according to the biographer of the city Narender Luther, conceived by its founder as a replica of heaven on earth. It is now home to bio-tech industries and a software cluster.

The birth of the software sector in Bangalore dates back to the mid eighties when Texas Instruments, a 100% export oriented unit, set up shop in the city. The presence of Bangalore and the state of Karnataka at the head of the league tables of the industry cannot be dismissed either as a historical accident or a result of fortuitous circumstances. There is a long list of factors responsible for the emergence of Bangalore as the centre for the software industry in India. These include the Karnataka government's initiative in establishing a software technology park in 1977, reinforced by the Software Technology Parks Scheme of the Central government in the mid eighties, the presence of a large number of science and engineering teaching and research institutions, the presence of a large number of public enterprises including Hindustan Machine Tools and Bhararth Electronics, the contribution of the Indian Diaspora in the Silicon Valley in California to the growth of the sector, state support for infrastructure, the cultural ambience of the city of Bangalore and its salubrious weather. (For a detailed review of the state support for the industry, see Basant, 2006)

The central government industries such as Hindustan Machine Tools, Bharath Electronics and Indian Telephone Industries Ltd established during the 1950s and the 1960s were all

publicly owned. The choice of Bangalore for the location of these industries was dictated by strategic reasons of defence and security. There were also several hardware firms in the city, another proximate reason for software firms to gravitate to the region. Indeed, the presence of manufacturing firms of various sorts including Hindustan Aircraft Ltd and Mysore Electrical industries date back to the 1940s - the days of the British Raj. Thus Bangalore has had a history of being host to a varied set of industries.

One of the main reasons for the attraction of Bangalore as a locale for industries is the large number of scientists and engineers it produces, many more than most other states (Table 1).The tradition of higher education in science and engineering also dates back to the days of the Raj. The first of several engineering colleges that dot the city now was established by Vishweshvaraya, one of the top level administrators and an early advocate of industrialisation during the days of the Raj, as early as 1917, when Mysore University was also established.

Karnataka has a total number of twenty universities, 152 engineering colleges 114 medical colleges and 248 polytechnics. Bangalore is home to the reputable Indian Institute if Science, referred to as the Tata Institute after its founder Jamshadjee Tata, established in 1909, known for its research in aeronautical engineering and the physical sciences. Besides the software industry, the city also hosts more than ninety of the 180 bio-tech firms in India. As Basant (2006) states, Bangalore is also home to a number of firms manufacturing machine tools, electronic equipment and bio-technology products. The educational and cultural ambience of the city, once known as the pensioner's paradise because of its salubrious weather and space, is succinctly captured by the well known sociologist the late MN Srinivas in his introduction to a book on Bangalore (2000)

> **"**Bangalore is intellectually vibrant, a multitude of institutions of higher learning and research providing homes for scientists and other specialists in a variety of fields. A perusal of the list of seminars, talks, discussions, plays, musical and other performances, exhibitions and religious events in the daily newspapers provide the curious reader with an idea of the city's deep interest in cultural and intellectual aspects of life'.

Sunil Khilnani's observation that "Bangalore is a cosmopolitan city with a sizeable middle income group whose incomes are derived not from land and inherited property, but from investments in education and the group actively encourages the pursuit of wealth based

on education, enterprise and skill" echoes Srinivas's observation on Bangalore (Khilnani, 1998). This pursuit of education, especially engineering and medical education, also resulted in the large scale migration of educated Bangaloreans to the US and the UK during the decades of the sixties and the seventies. These professionals, unable to find suitable and remunerative jobs at home, migrated to the US and the UK, lured by the jobs on offer from the National Health Service for the medical graduates in the UK and the space programme in the US for the engineers. A number of these migrants were to actively participate in the birth and growth of the Silicon Valley software cluster in California. The Diaspora in the Silicon Valley has been a major factor in the growth of the software sector in Bangalore. These include both the to and fro migrants and those that have returned to Bangalore (see Balasubramanyam and Balasubramanyam, 2000). The Diaspora also contribute to the growth of the sector in yet another indirect fashion. Many of them head the operations of multinational firms in Bangalore; according to one source, 71 of the 75 multinationals in Bangalore Software Technology Park were headed by Indians who had lived and worked overseas, especially in the US (Ghemawat cited by Basant, 2006). These Diaspora who head foreign firms in Bangalore and other locations could be a significant channel for the dissemination of human capital, their expertise and knowledge of methods of operations and market intelligence would be of immense benefit to Indian firms. Their cultural affinity to the Indian engineers and entrepreneurs is of course a major factor in the effective transmission of technology and know-how to the Indian engineers and firms (Wei and Balasubramanyam, 2006).

Table 1 Number of Institutions of Higher Education and Number of Engineering and Polytechnic Students 2005-06

States/UTs	University		Deemed University	Institutions of National Importance	Research Institutions	Arts, Science & Commerce Colleges	Eng., Tech., & Arch., Colleges	Number of Engineering & Technical students (Thousands)	Number of Engineering Students Per 1000 population
	Central	State							
2	3	4	5	6	7	8	9	10	11
Andhra Pradesh	2	14	5	0	5	1603	278	379	4.9
Karnataka	0	16	7	0	1	930	134	265	5.1
Kerala	0	7	2	1	1	189	99	118	3.7
Maharashtra	1	19	20	1	54	1018	193	173	1.7
Tamil Nadu	0	17	16	2	1	693	269	504	8.1
Delhi	4	1	10	2	1	68	20	27	0.8
India	20	216	101	13	140	11698	1562	2358	2.3

Source: Ministry of Higher Education, Government of India.

There is much to be said for each of these reasons that explain the birth and growth of the software sector in Bangalore. There is, however, a view first expressed by the Economist magazine of London that the software sector in India in general has benefited from benign neglect by the state. As the Economist put it, the sector was left alone mostly because the policy makers did not understand the industry. This tongue in cheek comment may have a grain of truth. The industry may have escaped unnecessary bureaucratic rules and regulations such as the ones that prevailed during the Licence Raj. It has however received state support for setting up satellite facilities and benefited from state support for higher education (Balakrishnan, 2006 Basant, 2006). The contention of some writers that the sector has vastly benefited from the state and in fact, from state regulation of industry may be an exaggeration. Allied to this view is the one that attributes the birth of the industry to the departure of IBM from India in the year 1973 because of its unwillingness to comply with the Foreign Exchange Regulation Act (FERA) that required foreign firms to shed the majority of their equity in favour of local firms. The programmers that were made redundant by the departure of IBM are reported to have set up software firms**.** This view is contested by Rafiq Dossani (2006) who argues that it was domestic firms, often with the expertise provided by India's Diaspora in the developed countries that set up software firms and by 1981, there were 21 firms with annual exports of $4 million. Many of these firms later moved to Bangalore in the face of growing land values in Mumbai. Dossani also contests the often expressed view that state support was an essential significant factor in the growth of the software industry in India. He convincingly argues that the industry took birth and grew despite the hostile government policies towards private enterprise. All this suggests that Indian enterprise and expertise found a niche in the newly evolving IT industry, a novel and complex area of economic activity that my have flummoxed the bureaucrats as the Economist suggests.

The large number of educational and research institutions in the city, the presence of a number of industries specialising in the production of machinery and equipment, the cultural ambience of the city and state support rather than interference all taken together do suggest that Bangalore has all the ingredients for a successful cluster capable of fostering human capital development. A study by Srinivas (1977) cited by Basant reports that all the domestic and foreign firms located in the software technology parks have had some form of contact with research laboratories or institutes in Bangalore. One third of the

firms surveyed by the author also stated that the institutes provided new ideas that helped them to design and invent new products.

There are though those that argue that none of these reasons add up to much. They note that although Bangalore does possess a number of engineering institutions, the link between software firms and these institutions is not just weak, but absent. And the quality of education imparted in the institutions of higher learning in the state of Karnataka and in India in general leaves a lot to be desired (D'Costa, 2006). It is also argued that there is no collaboration between the software firms in the city and that the industry is much too heavily oriented towards export markets.

These observations on the structure of the industry and the nature of the education institutions are astute, but they need to be qualified in the context of the structure and stage of development of the Indian economy in general. The links between universities and the software firms are weak precisely because most, though not all, academic institutions in Bangalore lack a tradition of research and they are ill equipped to be trouble shooters or partners of software firms. But they do perform a significant service for the software firms; they produce engineering graduates that can be trained on the job. They act as a filter; they sift the intelligent and capable students from the rest. They save the software firms considerable search costs. In fact, the engineering graduates that are successful in the interviews and tests administered by the software firms may be over-qualified for the jobs they are initially required to do. Their academic training in mathematics and engineering may be much more extensive and advanced than that required for the software industry. This may be no bad thing as these are the research minded graduates capable of learning by doing and pushing the frontiers of knowledge. It may not be feasible to implement the Stanford/Silicon model in Bangalore, but there may be no need to do so. Software firms especially the large and reputable ones such as Infosys and Wipro, provide the sort of training the young graduates need. The cluster has evolved because of this sort of proximity of software firms to educational institutions in the city. Just as the Sheffield cutlery trade as Marshall (1907) noted " is due chiefly to the excellent grit of which grindstone is made", software firms turn the engineering graduates into software engineers, the graduates are like the grit out of which grindstone is made. And when the industry took birth around the mid-eighties, most firms were producing products at the lower end of the range, over the years they have moved up the ladder.

There may not be much collaboration between software firms because they are in the nature of non-competing groups identified by Cairnes discussed earlier. Each of the firms has its own niche market, some specialising in software for banks, some in software for airlines, and some in software for health providers and so on. Such is the nature of the trade they ply that they neither collaborate nor compete with each other. This sort of lack of collaboration does not in any sense rule out the spread of external economies. In fact, most external economies are generated by the very presence of technology intensive industries producing similar but not identical products and processes. Such externalities are generated in the software sector through informal networks of software engineers fostered by clubs, pubs and organised seminars and conferences. Bangalore, because of its ambience noted by the sociologist Srinivas, facilitates such informal networks. Much of the knowledge involved in software production is tacit knowledge which can only be exchanged with face to face contacts between the engineers. This sort of communion between young software engineers is facilitated by the cultural ambience of Bangalore. Another channel for the spread of human capital via externalities is the turnover of personnel in the sector. This too occurs because of exchange of information about salaries and working conditions amongst the engineers in the industry. Such turnover, however, facilitates knowledge promotion, though it imposes costs on the software firms. Turnover of personnel that was fairly high in the initial years of the industry is now reported to have declined, mostly because of the efforts of the firms to retain the human capital they had trained.

In sum, Bangalore exhibits many of the socio-economic features to be found in the Silicon Valley in California. Saxenian's (1994) observations on the valley, though with some dilution, may not be too farfetched to describe the environment in Bangalore that promotes human capital dissemination

> "It is not simply the concentration of skilled labour, suppliers and information that distinguish the region. A variety of regional institutions - including Stanford University, several trade associations and local business organisations, and a myriad of specialised consulting, market research, public relations and venture capital firms - provide technical, financial, and networking services which the region's enterprises cannot afford individually. These networks defy sectoral barriers; individuals move easily from semiconductor to disk drive firms or from computers to network makers……And they continue to meet at trade shows,

industry conferences, and the scores of seminars, talks and social activities organised by local business organisations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established and new enterprises are conceived. This de-centralised and fluid environment also promotes the diffusion of intangible technological capabilities and understandings". To borrow Marshall's words Bangalore's attractions to software firms may be summed up as it is all in the air

The Hyderabad Cluster

Both the city of Hyderabad and the state of Andhra Pradesh (AP) of which it is the capital city present a contrasting socio economic picture to that of Bangalore and the state of Karnataka. Elsewhere, we refer to the model of development pursued by Karnataka as the elitist model and the one pursued by Andhra Pradesh as the populist model. (Balasubrmanyam and Balasubrmanyam, 2009). AP model of development reflects the state's comparative advantage and resource endowments centred on agriculture. The admirable Human Development Report for AP (2007) prepared by the Centre for Economic and Social Studies (CESS), located in Hyderabad, notes that AP was the first state to introduce the green revolution in agriculture. The growth in rice output following the introduction of the new rice varieties has justly earned the state the sobriquet "rice bowl of India". Another notable achievement of the state is its success in reducing the levels of poverty, especially rural poverty, which according to some estimates is about 10%, a figure much lower than that in most states and substantially lower than in Karnataka estimated at 23.85% (Mahendra Dev and Ravi 2007). That which is admirable about the state's record on poverty is that the reduction of poverty is largely a result of a state-wide rural poverty eradication programme based on social mobilisation and empowerment of poor rural women. The programme aims at enhancing assets, capabilities and the ability of the poor to deal with shocks and risks. The record of the state in controlling the rate of growth of population is also far superior to that of most other states, again an outcome of the work of NGOS and women's self help groups rather than the traditional route of promoting literacy amongst women. These and other achievements of the state are to be attributed to the tradition of a vigorous pursuit of equity through agitation for land reforms and land redistribution and struggle for the rights of the backward castes and communities.

This tradition of struggle for equity in a largely agriculture oriented state sets it apart from Karnataka that is dominated by high tech industries and services that the state owes to its history in large part as stated earlier. It is for these reasons that the birth and growth of the IT sector in Hyderabad is somewhat of a superimposition on a city that lacked an inherent comparative advantage for growth of services and manufacturing. As the Human Development Report (2007) states "AP does not have a strong background and tradition of industrial development, like the neighbouring state of Tamil Nadu in terms of entrepreneurship, technical skills and infrastructure".

It is against this background that the software cluster in Hyderabad should be assessed. The comparative advantage of the state of AP and its capital city lies in agriculture based industries; the socio-political ambience of the state is centred on the pursuit of equity, especially promoting the economic interests and well being of the socially disadvantaged. These facts were recognised by its political leaders on until the appearance of Chandra Babu Naidu on the political scene. Naidu, who was the chief minister of the state from 1995 to 2004 shifted the focus of economic policy from the pursuit of equity centred on the development of agriculture to one of growth centred on IT. The software sector took birth mostly because of his zeal for spreading IT throughout the state. It is a well known fact that the software sector in Hyderabad owes a great deal to his zeal and perseverance**.** He had a planned strategy of development centred on information technology. An economist by training, he put the public finances of the state in order by raising the price of subsidised rice from Rs 2 to Rs 3.50 per kilogram, increasing tariffs on electricity and scrapping prohibition. Naidu's ardour for liberal economic policies and technology-led development centred on the private sector were instrumental in the generous provision of loans from the World Bank and the Department for International Development of the UK to fund Naidu's technology centred projects. The Bank is reported to have provided $266 million per annum during the late nineties and the DFID provided another £230 million spread over three to four years. Such disbursements by external agencies directly to a state government by-passing the central government in Delhi, attests to the autonomy over policy Naidu exercised, mostly because of the number of seats his party held in the Lokh Sabha, the lower house of the Indian Parliament. Naidu also managed to lure external investors such as Microsoft to establish research centres and a Business School in Hyderabad, linked to Kelloggs Business School in the US. He bought the services of

McKinley, the international management consultants to prepare a document titled Vision 2020 outlining the policies to be put in place to promote the development of AP. The consultants accorded information technology a major role in attaining his objective and he warmly embraced the recommendations of the consultants. The incentives provided for investment in the IT sector include non-applicability of labour laws, non-applicability of pollution control laws and non applicability of statutory power cuts. Some of the other incentives provided are allotment of land, power tariff rebate for small and medium enterprises, rebate on cost of land, physical infrastructure such as power, water, sewerage and roads and telecommunication infrastructure (Nirnajana Rao, 2009). All this amounts to a sizeable package, but as Nirnajana Rao notes, there is no estimate of the explicit and implicit subsidies given to the sector.

It is arguable if the software sector would have been established but for Naidu's active support and indeed zeal for turning Hyderabad into a centre for technology. Bangalore too did have state support, but not the sort of direct intervention of the state government in procuring external aid and assistance, nor did the sector receive the large volume of subsidies and fiscal exemptions that the sector in AP enjoys. Admittedly, the software sector in Hyderabad has registered impressive growth and its total exports of Rs 325 billion in the year 2008-09 was surpassed only by Bangalore (Rs 703 billion) and Mahahrashtra (Rs 423 billion). The sector can also boast of an impressive growth performance and employment record. It is also noteworthy that a study by NASSCOM reports that Hyderabad scores over Bangalore and in fact over other software locations in the quality of its infrastructure. Whilst Hyderabad is ranked number one amongst the various locations of software firms in the country, Bangalore ranks number 6. It is a well known and much lamented fact that the infrastructure in Bangalore, especially roads and power supply, are woefully inadequate. Software, however, is not a transport intensive service and most companies in Bangalore have instituted emergency power supply facilities. The issue though is one of the capabilities of a cluster in generating externalities and promoting human capital development, without a heavy dependence on state subsidies.

The software sector in the two cities, one founded and formed by entrepreneurs with a relatively low level of state support and the other with substantial state support, open up several issues for analysis. The principal issue is whether a software cluster with

extensive state support yields high rates of social dividends, principally the birth and growth of human capital necessary for growth and development of the region where the sector is located.

IV Implications of the economics of clusters for the Hyderabad and Bangalore Software Cluster

The essential features of successful clusters are that they evolve in response to market opportunities in specific regions that are capable of imparting a comparative advantage to specific industries or groups of firms. The import of the foregoing is that because of its history, its geographical location and its social and cultural ambience, Bangalore was an ideal locale for the software cluster. Although there is a software cluster in Hyderabad, it is not as vibrant as the Bangalore cluster. It is smaller in size judged by production and exports and its productive efficiency is not as high as that of the Bangalore cluster (Table 2)

Table 2: Characteristics of Software Industry: Andhra Pradesh and Karnataka: 2008-09

	Andhra Pradesh	**Karnataka**	**All India**
Units (2008-09)	1,408*	2,085	10,305
Software Exports (Rs. million)	325,090	749,290	2,173,480(E)
Manpower (2008-09)			
Direct	251,786	554,000	2,200,000 (E)
Total Investments (Rs. million)	37,390	30000	

Source: STPI, Annual Report various issues

The size of the sector in Bangalore, judged by the number of firms, number of employees, total production and exports, is much larger than that in Hyderabad.[iii]

Admittedly, Hyderabad too attracts its Diaspora to invest in the software sector. Indeed, the number of Andhra emigrants in the Silicon Valley is as high as one in four of all the immigrants from India. There is no data to show that a sizeable number have returned home to Hyderabad. Although there are no precise figures on the returning Diaspora to Bangalore, it is estimated to be around 3000 per year. Also the state of Karnataka attracts a lot more immigrants from other parts of India than AP.

Table-3: In Migration into the Four Southern States (1991-2001)

		In- Migration (0-9 years)				
	%Total Population	**Total**	**%Rural Population**	**Rural**	**%Urban Population**	**Urban**
Andhra Pradesh	**76,210,000**	**(number)**	**55,401,060**	**(number)**	**20,808,940**	**(number)**
Total	0.55	421,989	0.37	206,774	1.03	215,215
Northern	0.27	207,087	0.17	93,196	0.55	113,891
Southern:	0.26	198,629	0.20	108,510	0.43	89,119
Karnataka	**52,851,000**		**34,889,471**		**17,961,529**	
Total	1.66	879,106	0.85	296,010	3.25	583,096
Northern	0.58	305,321	0.33	115,845	1.05	189,476
Southern:	1.02	537,828	0.49	172,508	2.03	365,320
Kerala	**31,841,000**		**23,574,075**		**8,266,925**	
Total	0.74	235,087	0.58	136,878	1.19	98,209
Northern	0.14	45,441	0.09	21,639	0.29	23,802
Southern:	0.55	175,143	0.46	108,986	0.80	66,157
Tamil Nadu	**62,406,000**		**34,922,002**		**27,483,998**	
Total	0.43	270,473	0.22	76,818	0.70	193,655
Northern	0.10	60,142	0.03	11,959	0.18	48,183
Southern:	0.27	171,088	0.14	49,708	0.53	145,842

Source: Census of India 2001

The number of migrants into the urban areas of Karnataka (mostly Bangalore) is relatively high and this is mostly on account of the software sector. Bangalore has an advantage over Hyderabad in many other respects including the longstanding presence of a number of higher education institutions. The institutions in Andhra are of a more recent vintage, mostly because the rulers of Hyderabad in the past took little interest in promoting education, though they were keen on the arts and architecture. Narender Luther, the historian of Hyderabad, writes that in the latter half of the 19 century "The state did not do anything to impart education or to provide public health. Whatever schools existed were private, mostly denominational. The medium of instruction was mostly Persian and what was taught centred mostly around theology and writing of the script" (Luther, 2006). The now reputable Osmania University was set up in 1919 and until 1948, the medium of instruction in the university was Urdu and not English. This contrasts with the emphasis placed on education by the Maharajas and Dewans of Mysore, now Karnataka. Apart from several public and private schools, they were responsible for the setting up of the Engineering College and the University of Mysore as early as 1911.

All this is not to say that the city of Hyderabad is backward in any sense. It is just that its history and antecedents are different from that of Bangalore. Its comparative advantage in pharmaceuticals and science based industries is well known. The internationally known pharmaceutical firms in Hyderabad date back to the 1980s. The state of AP has well known entrepreneurs in a variety of food products industries, most of them from the coastal areas. In general, the state's comparative advantage seems to rest in agro-industries and science based industries such as pharmaceuticals, than in services. Indeed, judged by the number of enterprises or the gross value added per worker in the service sector, AP lags behind the other three southern states as well as most other states in India (Table 4).

Table 4 Service Sector in India, 2006-07: Economic Characteristics of Enterprises						
	Enterprises		**Workers**		**Gross Value Added (Rs.)**	
	Number	**Percent**	**Number**	**Percent**	**per enterprise**	**per worker**
High Performers						
Gujarat	68,261	5	152,042	5	152,737	68,824
Haryana	36,495	3	65,457	2	124,059	69,170
Maharashtra	138,363	11	434,821	15	264,970	108,343
Punjab	44,779	3	71,761	2	90,936	56,743
West Bengal	134,211	10	229,590	8	70,687	42,281
Average	**84,422**	**7**	**190,734**	**7**	**140,678**	**69,072**
Southern States						
Andhra Pradesh	111,674	9	294,690	10	183,210	86,414
Karnataka	46,635	4	430,982	15	1,761,753	335,079
Kerala	133,946	10	224,220	8	70,579	42,173
Tamil Nadu	137,098	11	266,065	9	103,298	53,673
Average	**107,338**	**8**	**303,989**	**11**	**529,710**	**129,335**
Laggards						
Bihar	69,417	5	103,722	4	62,050	41,077
Madhya Pradesh	64,985	5	117,872	4	64,187	35,109
Orissa	29,950	2	59,458	2	71,477	36,006
Rajasthan	55,315	4	92,188	3	83,318	49,994
Uttar Pradesh	219,192	17	342,688	12	60,468	41,586
Average	**87,772**	**7**	**143,186**	**5**	**68,300**	**40,754**
Average of 14 states	**92,166**	**7**	**206,111**	**7**	**225,981**	**76,176**
Total 14 states	1,290,321	100	2,885,556	100		
All India	1,400,966		3,098,090		170,073	86,876

Source: NSS Reports No.528/ 529:

Estimates of output and employment multipliers per unit increase in software output for a number of Indian states (Table- 4) show that in the case of Karnataka, the output multiplier is high relative to the employment multiplier, whilst the reverse is the case in AP. The NCAER study that has produced these interesting estimates argues that the data shows that in the case of states where the output multiplier is higher than the employment multiplier, there are vertical linkages between software and other sectors, whilst in the case of states where the employment multiplier is higher, and there are horizontal linkages. This may be so, but the high employment and low output multipliers also indicate low productive efficiency in the use of software in industries and sectors that are linked to the software sector.

Table 5: Software sector-Output Multiplier and Employment Multiplier

State	**Output Multiplier**	**Employment Multiplier**
Delhi	1.41	2.35
Chandigarh	1.92	1.49
Maharashtra	3.22	0.32
Andhra Pradesh	1.15	3.87
Karnataka	1.45	0.23
Kerala	1.64	2.56
Tamil Nadu	1.46	0.67
Punjab	1.11	2.27
Haryana	1.62	2.00
Rajasthan	1.42	5.40
Uttar Pradesh	1.31	1.43
West Bengal	1.41	2.18
Orissa	1.38	4.34
Madhya Pradesh	1.84	5.45
Gujarat	2.25	1.30

Source: National Council of Applied Economic Research Development Report 2002

[5]

The structure of AP's economy, its history and its institutions are very different from that of Karnataka. The sort of ingredients that Bangalore possesses for the development of the software cluster is largely absent in Hyderabad and so are the attributes needed for the generation of externalities in the sector discussed earlier. The main difference between the cluster in Bangalore and the one in Hyderabad is that the former has evolved on the basis of the comparative advantage the city possesses for the birth and growth of an export oriented service industry, whereas the latter is sponsored and cultivated with substantial volumes of state investment.

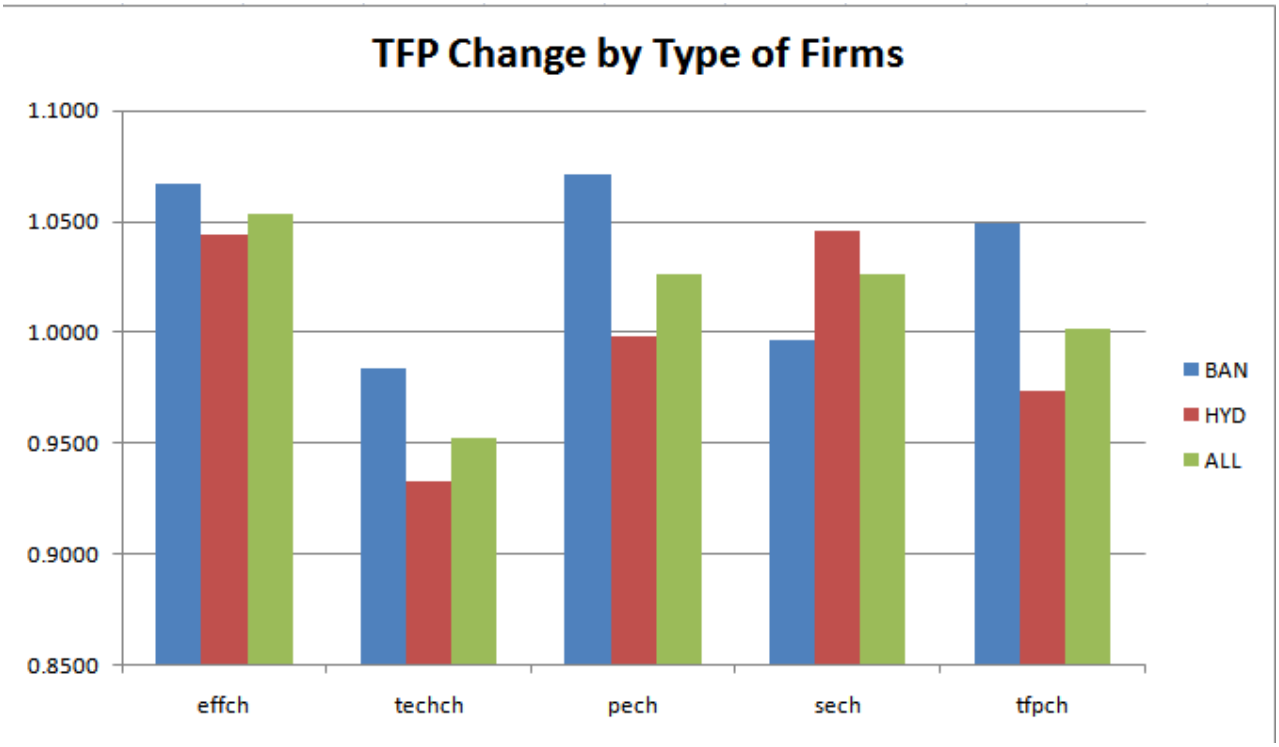
In the absence of detailed data on the extent of state subsidies and assistance the Hyderabad and Bangalore clusters receive, the social rates of return to public funds invested in the two clusters cannot be estimated. One other piece of evidence in support of the hypothesis that the Bangalore software cluster may be superior to Hyderabad in productive efficiency and human capital formation is based on estimates of Total Factor Productivity and its components (Table 6).

Table 6: Total Factor Productivity Change; Bangalore and Hyderabad Firms

	BAN	HYD	ALL
effch	1.0668	1.0440	1.0530
techch	0.9837	0.9326	0.9520
pech	1.0710	0.9987	1.0260
sech	0.9961	1.0454	1.0260
tfpch	**1.0495**	**0.9737**	**1.0020**

effch ; Efficiency Change
techch; Technological Change
pech; Pure Technical Efficiency Change
sech; scale efficiency change
tfpch;Total Factor productivity Change

Ban; Bangalore Firms
HYD; Hyderabad Firms



The results shown in Table 6 and the chart 1 are based on estimates of Malmquist productivity indices for a sample of software firms in Hyderabad and Bangalore for the years 2000 to 2006.The Malmquist indices provide an estimate of total factor productivity change and the factors contributing to the change in terms of technological change and technical efficiency change. Technical efficiency change or the ability of firms to extract the maximum amount of output from a given set of inputs is further sub-divided into pure technical change and scale efficiency change. The estimates shown in Table 6 suggest that (a) Total factor productivity(TFP) for the sample of firms in the Bangalore cluster is higher than that for the firms in the Hyderabad cluster (2) whist there is not much to choose between the two clusters in terms of efficiency change or the optimal combination of inputs in response to input prices, much of the technical change in the case of the firms in the Bangalore cluster is on account of pure technical efficiency whilst it is pure scale effects that contribute to technical change in the case of the Hyderabad firms. It is noteworthy that pure technical change is mostly on account of human skills. This piece of evidence again supports the hypothesis that knowledge formation and productivity growth tend to be relatively high in the Bangalore cluster. It should though be noted that these estimates of Malmquist productivity indices, whist they do support the hypothesis argued in the paper, are by no means conclusive. The number of firms in the Bangalore sample

are only 16 and in the case of the Hyderabad sample 26. Also the data provided by Prowess does not include the number of employees, the wage bill data for each of the firms is used as a surrogate for labour inputs. Detailed analysis of human capital formation and efficiency change in the two software clusters requires not only statistical data on a sufficiently large sample, but also a set of case studies. This is the agenda for the next phase of research on the software clusters in the two cities.

V Conclusions

This paper has discussed the contribution of clusters to human capital formation in the context of the software firms located in Bangalore and Hyderabad. Analysis of clusters has a long history dating back to Marshall and Arrow followed by the work of Krugman and Porter. Transport costs, wage rates and interdependence of firms are cited to be the major factors promoting the growth of clusters. Transport costs do not play a major role in the formation of software clusters as the industry is not heavily dependent on transportable inputs nor does its output require cost intensive transport facilities. A feature of the industry is its human capital intensity. Access to efficient, easily trainable labour, recognised by Marshall, is one of the factors that promote agglomeration of firms. The endowments of educated labour which is a historical inheritance, is one of the major factors that account for the Bangalore cluster. So also is the ambience of Bangalore that favours the location of software firms and the formation of the cluster. The nature of the industry and the cluster in Bangalore are ideally suited to generate the sort of technological externalities and to a lesser extent, pecuniary externalities discussed by Marshall and Krugman. The Hyderabad cluster, though a recognisable presence, may not be in the same league as the one in Bangalore, mostly because of its history and the absence of a natural ambience required for the agglomeration of knowledge intensive software firms. Indeed, the software cluster is the result of heavy fiscal subsidies and the zest for spreading information technology facilities throughout the state of Andhra Pradesh by its technocratic chief minister Chandra Babu Naidu. Available data shows that the Hyderabad cluster is not as vibrant as the Bangalore cluster despite the presence of a number of major players in the industry including foreign owned firms.

The record of Hyderabad on development including reduction of poverty, however, is superior to that of Karnataka. One factor amongst others in its development record is the astute use of IT in promoting development objectives in the rural areas. Hyderabad could have had access to the sort of IT services it has deployed in the rural areas without the heavy investments in the software industry. Here again, importation of software services from more efficient producers may be much more welfare enhancing than producing it at home. AP is known for its village level initiatives in utilising the services of non-governmental organisations and micro-finance agencies. Its success in reducing the rate of growth of population and the level of poverty in the state are also notable achievements. It is worth pondering whether or not AP has deviated from its natural comparative advantage in agriculture and manufacturing and ventured into software, where its advantages are not all that obvious. By the same token, it can be argued that Bangalore has stumbled on to the area of its comparative advantage by virtue of fortuitous circumstances. It is argued by Hyderabad based economists that the crucial test of the benefits of the software sector in Hyderabad is its contribution to social development (Ramachandriah, 2003, Niranjana Rao, 2009). The sector appears to have passed this test, but the state could have allocated its resources much better by purchasing the IT services form the neighbouring state of Karnataka than producing it at home. The contrasting experience of the two states suggests that production of human capital should not be an end in itself, it has to be put to use in an imaginative manner to promote development objectives.

It should be noted that many of the propositions in the paper, such as comparison of productivity of labour, rates of return to capital invested and total factor productivity between firms located in Bangalore and Hyderabad, await statistical tests. Basant's study does compare the Bangalore cluster with that of other clusters and finds that the Bangalore cluster reaps several advantages over the others because of its proximity to customers, access to skilled labour, presence of hardware and software suppliers, better access to training facilities and access to R&D institutions. These are also the factors that have contributed to the superiority of the Bangalore cluster. It should, however, be noted that a definitive analysis of the proposition put generally that clusters are born and not made awaits a much more detailed statistical analysis. It is ironic that the data needed for such an analysis is not provided by the IT centres of Bangalore and Hyderabad or by the professional trade organisation NASSCOM.

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[i] 1 The doctrine of comparative costs is an inviolable law cast in terms of opportunity costs of economic activity. Globalisation may have dramatically altered the sources of comparative advantage economic agents enjoy, but not put to rest the doctrine of comparative advantage.

[ii] There are a number of definitions of clusters; they all emphasis geographical proximity of firms to each other, interdependence and linkages between firms

[iii] The available data on the industry is sparse, that which is available may suit the purposes of businessmen but not that of academic researchers. The NASSCOM Directory available on line on the payment of a fee is much less user friendly and incomplete than the hard copy whose publication was suspended some years ago. The State Government web site relating to the Industry though better than that of NASSCOM, does not publish a comprehensive set of data.