

***REGIONAL INNOVATION SYSTEMS (RIS) IN CHINA***

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### Summary

Three major economic regions exist in China – Pearl River Delta (PRD), Yangtze River Delta (YRD) and Bo Hai Rim (BHR) – and have number of important and striking similarities. The success of regional innovation systems in China has its roots in the following three factors. First, the central government has strongly supported the regions by providing a framework and resources for the various types of zones, industrial parks, science parks and incubators where national science and technology programs have often been involved. Second, foreign direct investment and the increasingly closer industrial and technological links with the neighboring countries have given strong impetus to regional development through technology transfer, management skills and extensive links to global markets. Third, the directed but often spontaneous development of technological and industrial clusters has provided the basis for further development.

In any country, and particularly in a country like China with its extraordinary size and diversity, technological innovation will take place in a number of its regions that are likely to become spatial innovation systems. Huge amounts of innovations - of a gradual and incremental nature - are already taking place in manufacturing firms all over China, although primarily in the dynamically evolving coastal areas. These firms have often agglomerated into geographical clusters and are found in many industrial sectors.

A number of such clusters are evolving into centers of strong innovative capability. They are still weakly linked and inadequately supported by actors within the state-level innovation systems. However, a natural formation of three major regions in China have prompted provinces and cities within them to act as midwives to bring out an environment that can deliver not only incremental innovations but also breakthrough innovations in future-oriented industries. A number of regional development programs and projects play an important role in this process and has the potential of enhancing needed and strong links between local clusters, foreign technology sources and national programs.

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In any country, and particularly in a country like China with its extraordinary size and diversity, technological innovation will take place in a number of its regions that are likely to become spatial innovation systems. Huge amounts of innovations - of a gradual and incremental nature - are taking place in manufacturing firms all over China, although primarily in the dynamically evolving coastal areas. These firms have often agglomerated into geographical clusters and are found in many industrial sectors. A number of such clusters are evolving into centers of strong innovative capability. They are still weakly linked and inadequately supported by actors within the state-level innovation systems. However, a natural formation of three major regions in China have prompted provinces and cities within them to act as midwives to bring out an environment that can deliver not only incremental innovations but also breakthrough innovations in future-oriented industries. A number of regional development programs and projects play an important role in this process and has the potential of enhancing needed and strong links between clusters, foreign technology sources and national programs.

External connections to other businesses, to component suppliers and to researchers are as important for these regions as internal ones. Three regions in China, where policies and structures reflect an ongoing regionalization, also emphasize science and technology as essential components. They are Yangtze River Delta (YRD), the Pearl River Delta

(PRD) and a third region - the Bo-Hai Rim (BHR), towards the north also along China's coastal line, although less clearly defined nevertheless very important. A very large number of units within the regions are through foreign direct investment and trade closely linked with overseas associates. Many industrial clusters have sprung up inside the regions and have in many places become budding technological springboards for indigenous technological development, supported by regional and national initiatives. The regions represent not only provincial ambitions but also attempts to forge various elements of a national innovation system that includes national programs, universities and FDI. There are great expectations in China that the industrial clusters that have mushroomed through massive FDI will evolve from being purely operational clusters into technological clusters that will fuel an innovative environment.

## **Introduction**

China in the early 1980s departed from a policy of sustaining a National Innovation System (NIS) and accepted a Global Innovation System by allowing a massive inflow of foreign direct investment (FDI). Subsequently foreign companies, which are now increasingly wholly-owned foreign enterprises, have come to play a significant role in China's high-tech industrial development. Furthermore, they now dominate China's high-tech exports for which functional industrial clusters are essential having sprung into existence all along China's coastal line and currently often also further inland.

China in long-term perspective expects that the massive inflow of FDI will significantly contribute to extensive export earnings and to substantial new employment in local areas. The policy makers also expect that a large number of technological clusters will come into being and become self-generating in their support for future innovations in China. Such clusters are already appearing in a number of cities which in their turn are integral parts of provinces. These are on their own attempting to consolidate groups of provinces into regional innovation systems. It is worth to consider the future role of regional innovation systems and the evolving clusters within them. This will provide new insights on China's acceptance of entering into a global innovation system by accepting the immense inflow of FDI.

Regional development in China with its tendency to cluster is being influenced by three crucial forces that include commercial/economic as well as political elements. First, China has accepted and encouraged a massive inflow of foreign direct investment by which the government and its agencies endeavor to meet overall economic as well as regional and technological advances.

Second, it has accepted and encouraged close economic and industrial relations with outside areas, first with Hong Kong to be followed in a more extensive way by Taiwan and Korea and to a lesser extent with Japan. Hong Kong, now part of China, Taiwan and Korea have initially developed closest contacts with nearby provinces which correspond to the Pearl River Delta region, Yangtze River Delta region and the BoHai Rim region, respectively.

Third, these forces have been reinforced by national and regional policies to establish different types of industrial and technological zone/parks, often complemented by provincial and municipal initiatives.

The increasing level of FDI in China and its sophistication, particularly in the IT industry, has naturally prompted development of clusters for various types of specialization. Their character has mostly been of an operational nature in order to serve an export sector. It is the natural expectation of technology policy makers in China that the present clusters, with high-tech dominated by foreign MNCs, transform themselves into technological clusters fuelling an innovative environment in the country.

Politicians in many countries have been fascinated by the idea of creating a duplicate of the Silicon Valley and China is no exception. They have all been attracted by the apparent ability of clusters not only to support technological development through their innovative activity but also to generate employment and contribute to GDP growth. Furthermore results from historical studies of economic development show that national economic growth is directly related to successes in economically strong regions.<sup>2</sup>

Studies of clusters have in the past often revealed a distinct geographical concentration as one important characteristic. Realistic assumption being that specialised skilled labour and specialised sub-contractors may be attracted towards a region once a critical mass of firms within the industry is attracted there. However, clustering in high-tech sectors may take on a completely different pattern as it will, aside from a geographical concentration, also have to include sectoral or functional characteristics. Such clusters would often have to be understood as sub-clusters in networks that span across not only sectoral but also geographical boundaries. Under such circumstances functional proximity takes precedence over geographical closeness which has in the past been seen as the key cluster characteristic. Newly emerging clusters in China primarily fall in the category of functional proximity ones.

Looking back into earlier stages of industrial development it is important to understand that industrial plants as such are no longer the geographical concentration of complete production as was previously the case. Normal at the time it is rather the enabling structures and information flows that signify the efficiency of a system. Thus, knowledge flows and linkages have become key elements in knowledge-based production. A concept that could shed light on high-tech clusters is the **competence block**, which is defined by a minimum set of competencies that are necessary to profitably identify, generate, select, exploit and expand business ideas. These competencies jointly exist in an interactive structure of customers, inventors and innovators, entrepreneurs and industrialists. A competence block becomes fully operational, or complete, when it has a critical mass of activities, which attract competent actors for all its various functions. A dynamic

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<sup>2</sup> Pollard, Sydney, *Peaceful conquest: The industrialization of Europe 1760-1970*, Oxford University Press, 1981

competence block generates a large number of contenders, which will not only include winners but also losers. A competence block would be defined in the following way<sup>3</sup>.

It is the total infrastructure needed to *create (innovation), select (entrepreneurship), recognise (venture capital provision), diffuse (spillovers)* and commercially *exploit (receiver competence)* new ideas in clusters of firms. *The competence bloc is dominated by human-embodied competence capital* that determines the efficiency characteristics of all other factors of production, including the organisation of all economic activities that constitute the competence bloc. This means that the choice of market and hierarchical organisation is part of the competence bloc. Above all, the definition includes the institutions of the market that are needed to activate innovations, entrepreneurship and venture capitalism ... Competence bloc formation concerns the dominant intangible human-embodied competence associated with a particular industrial success, and only secondarily the physical dimension of production.

The competence block is dominated by human capital and information flows and is fundamentally different from the **development block** concept that was developed by Erik Dahmén<sup>4</sup>. His concept designates a cluster or a network of integrated activities primarily in manufacturing and distribution where strong economic synergies have evolved over time. Another related concept is the **technology system** as defined by its (technological) inputs. The institutional infrastructure of a technological system is a set of arrangements - both regimes and organizations, which directly or indirectly support, stimulate and regulate the process of innovation and diffusion of technology. A technological system is assessed on its ability to generate productivity by applying a set of (generic) technologies.

The competence block is assessed by its general ability to generate and exploit new knowledge ignoring where in an economic system knowledge is created and exploited – as it is directed or even controlled by the preferences of customers. A competence block would often include various technological inputs, and technological systems would many times be necessary and integrated components.

A successful competence blocks cannot be deliberately designed, although economy policy instruments such as creating institutions and influencing business conditions would have an important impact. A competence block that has reached a critical mass would function as a magnet for actors and firms. Although actors have to be present in the competence block they could seek attachment, which could be geographically close to key actors, but actors could also remain dispersed as agents in a network that is dynamic and inventive in knowledge creation. Thus, a competence block could often be labelled a **functional cluster** or a **sectoral cluster** in which geographical co-location plays a submissive role. Functional clusters, or competence blocks, are an outcome of an ongoing globalisation that is creating a new international division of labour, which is characterised by flows in which information and (human-embodied) intelligence play a very important

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<sup>3</sup> Eliasson, Gunnar & Eliasson, Åsa, The Biotechnical Competence Bloc, *Revue d'Economie Industrielle*, 78 – 4 Trimestre (1996), p. 14

<sup>4</sup> Dahmen, Erik. 1971. *Entrepreneurial Activity and the Development of Swedish Industry, 1919-1939*, Homewood, Ill.: Richard D. Irwin.

role. Flows are distinguished not only by their functions or contents but also by their forms, which are shaped by political, economic, cultural and social factors.

In promoting regional development it is essential to gain an understanding not only of the threshold for critical mass that promises dynamic regional development. It is even more important to gain an understanding of what components are most important to trigger the dynamic development, and that in the recent past has characterized the coastal regions in China. Naturally, the creation and improvement of physical infrastructure is important. However, the organizational and social infrastructure is equally if not more important and it is closely tied to services that are essential in modern industrial societies. They include all types of telecommunications and financial services, access to a wide range of subcontractors and service providers, and facilities for close interaction between suppliers and demanding customers.

Regions do not disappear in the era of globalization but become integrated with international networks that unite their dynamic activities. In light of this it is easy to identify city regions as the central dynamic cores in a network economy for which Stuttgart and Munich in South Germany provide good examples. Successful cities today exemplify the combination of technology, ways of organizing production, financial integration as well as social interaction. Such cities provide geographical closeness in two dimensions. First, they provide territorial closeness, which means both intensity and neighborhood. Second, they provide networks to other similar cities. As result such cities attract administration and control functions for all types of social and economic activities. They also foster the development of clusters for all types of specialized services. However, sub-national regions are often more important as they generally generate a critical mass for a wider variety of services.

When it comes to China the pattern of urbanisation has taken a different road both in comparison with already industrialised countries and with developing countries. While the industrialisation level is quite high, with some 50 per cent share of GDP, urbanisation level is still quite low, with some 30 per cent of the population living in urban centers. The modern city development in China has created four types of urban centres.

1. The early commercial and industrial development in China created cities like Shanghai, Tianjin, Wuhan, Guangzhou, Qingdao where foreign powers played an important role until 1949. These cities were only weakly linked to the hinterland, although they played a very important role as commercial centers and budding industrial agglomerations.
2. A second type of cities, located inland or away from major waterways may be connected with political and military power. They are exemplified by Xian, Chengdu, Jinan, Taiyuan etc., and were less dynamic and often very slow in their industrial development.
3. The third type of cities includes primarily emerging industrial and mining cities such as Tangshan, Datang, Anshan etc. They followed the development of infrastructure such as railways and the development of natural resources. Their expansion took place following the strategy of central authorities. They were

primarily developed as highly focused on certain products and generally lacked integrated service facilities.

4. A fourth type emerged recently and among them are the industrial cities that have been fuelled through the combination of heavy foreign direct investment, strong local support and new material and knowledge infrastructures. Outstanding examples are Shenzhen and Dongguan in Guangdong, Wuxi and Suzhou in Jiangsu, and Yantai and Weihai in Shandong.

Cities in the first and fourth category have been at the forefront in the rapid economic development that has taken place during the past couple of decades. Within them a number of clusters have been developed while the other two categories of urban centers have been outside the mainstream of change.

The regions and their clusters are now playing a significant role and their embedded innovation systems might greatly contribute to China becoming a technological superpower. In its early attempts to lay the foundation for an industrialized structure the People's Republic of China enthusiastically adopted a planned economy approach which was not only inspired by the Soviet Union but in all essentials was a carbon copy of policies and structures from that country. Changes took place after the break with USSR in the late 1950s, with attempts at decentralization and the loosening of centralized control during the Cultural Revolution. However, China's leadership remained committed to a planned economy style until major reforms were unleashed in the late 1970s. Foreign direct investment had until then played a very minor role in China's economic development and the provinces and cities under central direction like Shanghai had been very little in control of their destiny. This situation has changed dramatically from the early 1980s. FDI interests and regional interests, now bonded together, have produced a heavy demand and subsequent dependence on foreign technology.

The Beijing government wants to reduce this dependence and make the nation more self-reliant in developing its own technologies based on advanced research. This ambition rests in a desire to reap more benefits from the ongoing industrialization but also in a national objective to shape its defense capability without being overly reliant on imported technology. In doing so China has in a major way accepted to become a member of an open economic system and actively participate in globalization that in restricted sense "represents the increased speed, frequency, and magnitude of access to national markets by non-national competitors"<sup>5</sup>.

In a globalized economy greater attention must be given to a comparative advantage in the manufacturing of products and in providing services – an advantage that is increasingly being created by a nation or a region. Capturing and keeping a comparative advantage will require specialization. Technological clusters often play an important role and need a conducive environment that provides knowledge, supportive interaction and incentive structures to become successful.

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<sup>5</sup> Chen Shuxun & Wolf, Charles Jr., China. The United States, and the Global Economy: Introduction and Overview

Clusters thrive from a skilled and well-educated workforce, research and development with its resulting IPRs, business infrastructure and physical infrastructure. This will require a number of *policy measures*. First, labor and capital must increase in quality and quantity. Second, the environment for innovation and entrepreneurship must be given special attention to constantly renovate industrial structures. Thus, top-down policies which used to be dominant in China had to be replaced by cooperative relations between local and central institutions where central authorities subsequently have a diminishing role to play. The result has been that regions and also cities have been given a much larger control over various resources for R&D, including education.

## The Role of Development Zones

Distinct examples of different regional technological clusters may provide illustrations of specific characteristics of Chinese regional development. Throughout the past couple of decades the central government has been very influential in establishing various industrial and technological zones which all have strong regional dimension.

The government has selected a number of “intelligence-intensive” regions and adopted policies to gradually transform them into high-tech development zones with different characteristics. There are now 53 such zones that are expected to become bases for China’s high-tech industrialization.

In 1991 China launched 24 New and High Technology Industry Development Zones (NHTIDZ) which at the time were perceived to follow the Zhonguanzun model in Beijing. Two years later another 27 NHTIDZs were established, with an additional one that was set up in 1997. Of altogether 53 zones only a single one has an agricultural focus. Using the Chinese division of national regions the East, primarily the costal areas have 29 zones, the Middle which includes the Jilin and Heilongjiang provinces in the Northeast, has 14 zones while the remaining ones are located in the West. By referring to regions, the Bohai Rim region has 9 NHTIDZ, the Yangtze River Delta region has six and the Pearl River Delta also has six zones. By comparing provinces Guangdong is the leader with six zones followed by Shandong with five and Jiangsu with four. See table in appendix for details<sup>6</sup>. The following description provides an illustration of a general character of a NHTIDZ.

**Shijiazhuang High-tech Industrial Development Zone**<sup>7</sup> was founded in March 1991, and was one of the first national level high-tech industrial development zones and was designated by the provincial people's government as one of the eight key development zones in Hebei Province in 1998. With a planned area of 18 square kilometers, the Development Zone is divided into eastern section, western section and Liangcun section three sections, which are located in the east with broad developing future in the municipal planning and the intelligence-intensive southwest of Shijiazhuang.

<sup>6</sup>Cong, Cao, China’s High-Tech Parks in Transition, EAI Background Brief No. 153, April 24 2003

<sup>7</sup> Hebei Online, The Construction of Development Zones in Hebei, July 15 2004, (China Daily)

The Development Zone is located in the central area of the urban development planning as well as key development areas and investment hotspots with integration of science, industry and trade. Its geographic locations are extremely superb. Currently there are 1520 enterprises that have registered in the Development Zone with total investments in construction projects exceeding 25 billion Yuan of RMB, among which, there are 125 foreign enterprises with total investments of 1 billion US dollars and actual usage of foreign investment of 0.6 billion US dollars including investments from over 10 countries and regions such as the USA, Germany, UK, Italy, Japan, Canada, Sweden, Malaysia, Poland, Korea, Hong Kong, Macao and Taiwan.

In 2002, a gross income of 19 billion Yuan of RMB was realized from technology, industry and trade in the Development Zone. And among already established enterprises, output values from industries such as electronic information, bio medicine and new materials took over 70%.

Aside from the high technology industrial development zones China has another six programs, aside from Pudong New Area in Shanghai, all with the objective to support regional development<sup>8</sup>. These include special economic zones, open coastal cities, state-level economic and technological development zones, coastal economic open zones, export processing zones and bonded areas.

In 1988 the State Council decided to establish Shenzhen, Zhuhai, Shantou, Xiamen and Hainan as comprehensive economic zones which all have broad economic self-management. They provide easier entry for foreign investors with the purpose to attract foreign capital, provide access to advanced technology and international markets. An expected outcome is a close interaction between FDI enterprises, SOEs, collective and private enterprises.

In 1984 a number of coastal cities were designated to become open coastal zones - including Dalian, Qinhuangdao, Tianjin, Yantai, Qingdao, Lianyungang, Nantong, Pudong Area of Shanghai, Ningbo, Fuzhou, Guangzhou, Zhanjiang, Beihai. Their dense industrialization would facilitate China's further development and also more efficiently link the hinterland into China's modernization process.

Somewhat similar to special economic zone and open coastal zones China in the mid1980s established a number of coastal economic open zones at the Yangtze River Delta, Pearl River Delta and South Fujian Province Delta. They include 40 cities under provincial governments and 215 county-level locations. Special legal and financial provisions were made to attract FDI and advanced technology into the localities while at the same time increase export earnings.

<sup>8</sup> Mofcom, Economic Development Regions, January 20 2004  
([http://english.mofcom.gov.cn/article/200406/20040600239135\\_1.xml](http://english.mofcom.gov.cn/article/200406/20040600239135_1.xml))

Similar to NHTIDZs China has during 1984-2002 created 49 economic and technological development zones. Their locations include Dalian, Tianjin, Ningbo, Beijing and Harbin. The purpose is to speed up the economic development of such cities by drawing on their special advantages.

The Shanghai Pudong New Area has been singled out as a special case in China's regional development. There already exists a strong industrial foundation and admirable infrastructure and Pudong is seen as an outstanding example of regional development in China's modernization.

There are two other regional programs that should also be mentioned. One is bonded areas which exist in Pudong and also in Tianjin, Shenzhen Futian, Dalian, Guangzhou, Qingdao and Zhangjiagang. The purpose is, as in other countries to provide export-processing services that will support an export-oriented economy. In 2000 China established its first export processing zone and the number has in 2004 increased to 25.

Within national programs for regional development the New High-Tech Industrial Development Zones play the most important role in fostering China's continued drive for industrialization and technological advances. Statistics<sup>9</sup> from the Ministry of Science and Technology show that from 1991 until 2002, major economic indicators of 53 high-tech development zones in the country grew almost 50 per cent on a year-on-year basis, with an increase of total turnover volume from RMB8.7 billion (US\$1.06 billion) to RMB 1,533 billion (US\$186.9 billion) in 2002.

In the meantime, the number of workers employed in high-tech parks increased from 140,000 in 1991 to 3.49 million - an increase of nearly 25 fold. In its high-technology development MOST has emphasized, not only for NHTIDZ, that electronics and information technology should be given highest priority followed by bioengineering and new pharmaceutical industry.

Zhongguancun (ZGC) in Beijing has been seen as role model for the high-technology development zones in other parts of the country. ZGC benefited greatly from a situation of being in the center of a research environment where a number of high-level research institutes were located, mainly belonging to the Chinese Academy of Sciences. In the same area were also a number of colleges and universities of which the two most famous are Beijing University and Tsinghua University. The loosening of the planned economy in the early 1980s provided completely new possibilities for researchers to become entrepreneurs, also compelled to move because reduced budget allocations. Closeness to the central government and funding agencies in Beijing has continued to favor entrepreneurs, researchers and enterprises in Zhongguancun. The result is that ZGC has become the largest high-tech R&D centre in China and the largest distribution centre for IT products in north China.<sup>10</sup>

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<sup>9</sup> XIAO CAO, Plugging into high-tech, China Daily. September 20 2003

<sup>10</sup> Rowen, Report Summary on Zhongguancun, 2004

The significance of location is proven by the fact that a substantial share of grants under the ambitious national 863 program has been awarded to ZGC enterprises and neighboring research institutes and universities. The knowledge resources are impressive with about one half of ZGC working force having at least a bachelor degree, although with a high rate of mobility.<sup>11</sup> The close relations with universities that initially favored ZGC are undergoing evolution in the following three aspects. First, universities are increasingly focused on research and teaching and are less involved in enterprise creation. Second, research results that have a potential commercial value are moving to university science parks for incubation, and when ready for start-up subsequently shifting to industrial development parks. Third, as a consequence university teachers and researchers as individuals, rather than universities themselves will become participants in start-ups.

Industrial clusters that were originally dominated by FDI have prompted the involvement of domestic companies. This participation may expand and enhance the relationships between FDI and local enterprises and contribute to transfer of technology and management – the spillover effect.

### **Operational and technological clusters**

The manufacture process of many industrial products, for which electronics provide highly visible examples, has been divided into a number of discrete stages. This has given manufacturers generous possibilities to choose locations for each of the stage to meet demand for access to low-cost labor, market nearness, and closeness to supporting industries and easy access to research and development. Such opportunities explain why a number of production stages have migrated to developing countries, including China – in particular for final/stage labor-intensive assembly. The manufacture of hard disk drives (HDD), which are used in all computers, provides a good example. American companies, which played a dominant role in the sector, in the early 1980s assembled almost all HDDs in the US. This share had been reduced to five per cent in 1995 with South-East Asian countries taking on more than 70 per cent of the assembly operations.

Product development and assembly used in the 1980s used to be concentrated in one location. However functional differentiation has moved assembly to take place almost exclusively outside the country of origin and has become clustered predominantly in Singapore, with additional assembly operations in Malaysia and Thailand and more recently in China. Product development that used to be almost completely maintained at locations where HDD are manufactured has been modified through mergers and acquisitions, exemplified by Hitachi acquiring the HDD division from IBM.

The disaggregating of functional activities has led to global production networks (GPN) that can freely choose locations for various functions in the production chain. This has in a substantial number of locations generated industrial clusters of different sizes and functional orientation. The GPN for hard disk drives, as for many other products, has

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<sup>11</sup> *ibid.*

bred two different types of spatial concentration: operational clusters and technological clusters<sup>12</sup>.

OECD provides the following definition of clusters<sup>13</sup>.

Clusters can be characterized as being networks of production of strongly interdependent firms (including specialized supplier), knowledge producing agents (universities, research institutes, engineering companies), bridging institutions (brokers, consultants) and customers, linked to each other in a value adding production chain. The cluster approach focuses on the linkages and interdependence between actors in the network of production when producing products and services and creating innovations.

Earlier studies of HDD manufacturing clearly indicated that clusters in South-East Asia came into existence based on “economies of proximity in input-output relations: speed of throughput, product changeovers, increasingly specialized engineering and assembly labor. Operational clusters may on occasion be sources of new product ideas, but their principal goal is to achieve operational efficiencies, and any new technologies they create are meant to improve production processes of supply chain management<sup>14</sup>.”

Technological clusters signify the other end of a technology chain and represent places where innovations take place. This would include the co-location of activities that lead to the recognition of new market opportunities, the development of new technologies and the design of new products. Such cluster change over time as new firms enter into the technological field and new designs offer or demand major changes in global production networks.

Technological clusters, as observed in the manufacture of hard disk drives, are of two different kinds. One involves the design coordination between component makers and enterprises that are in charge of final products, while the other involves coordination between designers of critical product components. In the former type there is usually intensive interaction during the design stage for new products and the design and production of new product prototypes. In the latter type complementary technical changes may be needed in the manufacture of several components when new technology is introduced in one particular component.

Naturally, it happens that technological clusters lose their innovativeness which may reflect major changes in the market or management shortcomings or a combination of both. Similarly, operational clusters continue to undergo changes and may occasionally become redundant. Thailand that is still the world’s second largest producer (assembler) of hard disk drives is facing serious competition from operational and possibly technological clusters in China. The Business Times of Singapore in June 2004 reported

<sup>12</sup> McKendrick, David, Dispersed Concentration: Industry Location and Globalization in Hard Disk Drives, The Information Storage Industry Center, UCSD, Report 98-03 November 1998

<sup>13</sup>Roelandt, Theo J. A., & den Hertog, Pim (eds) Cluster Analysis & Cluster-Based Policy in OECD Countries, Hague/Utrecht May 1998

<sup>14</sup> *ibid.*

that Thailand will have to strengthen its education and research if it wants to compete with regional rivals, which today includes not only Singapore and Malaysia but also China.<sup>15</sup> An advantage of China, it is reported, is that makers of components for hard disk drives are establishing themselves in China, bringing them closer to their customers. All the major makers of HDD which include Seagate, Maxtor and Hitachi have increased their production capacities in China.

Hitachi activities in Shenzhen provide an interesting example of this process as the company in June 2004 announced that it would make a major investment in China building a factory to meet rising demand from makers of notebook computers, digital video recorders and portable electronic devices such as audio players.<sup>16</sup> The new plant will be located in Shenzhen and become operational by the end of 2005 and create 7,000 additional jobs in addition to the 4,500 that already work in Hitachi plants in the same city, which already produce magnetic recording heads and storage media.

The new plant will become a very important unit within Hitachi with have an annual production capacity of 30 million HDDs which should be seen in relation to expected production of 55 million units in 2005. The actor is Hitachi Global Storage Technologies (HGST) that was formed in January 2003 after Hitachi acquired IBM's hard-disk drive operations which gave the new company a global market share of around 20 per cent. HGST has manufacturing and research facilities in Japan, Mexico, the Philippines, Thailand, Singapore and Minnesota in the US, and has announced that the new plant in China will eventually have the capacity to make smaller hard disk drives to meet a growing demand for audio players and other digital electronic products. Thus, the merger of the HDD divisions of Hitachi and IBM will in a major way change not only structure but also location of manufacturing activities. This happens at a time when China is not only offering attractive manufacturing advantages but also becoming an exciting domestic market.

### Three Significant Regions in China

The early expectations that close industrial links, based on FDI, would come into existence between Taiwan and the cities across the Taiwan Straits – primarily in Xiamen and Fuzhou - did not materialize. In its place, and rather naturally, Shanghai has taken on the role to become the natural basis for Taiwan entrepreneurs and industrialists, thus playing a role to that of Shenzhen for the Chinese in Hong Kong. In early 2004 more than 400,000 Taiwan residents were living in Shanghai out of a total number of more than one million, not counting those who come only for shorter stays. This means that almost five per cent of the population in Taiwan is permanently residing on the Mainland. Although, not being able to solve their political relation, Taiwan and China have with Shanghai as a

<sup>15</sup> Thai disk drive goal needs support, The Business Times, June 16 2004

<sup>16</sup> Hitachi to build disk-driv factory in China, International Herald Tribute June 22, 2004

hub, entered into a close economic, industrial and technological partnership that is expanding day by day.

Still further to the North lies the Bohai region with important industrial cities in the provinces of Liaoning, Shandong and Hebei. Tianjin with the same status as province has emerged as an important technological and industrial centre with its good transportation and education facilities. Similarly to the situation in Shenzhen and Shanghai foreign direct investment has played an important role in the region's industrial development. Naturally, the closeness to the Korean Peninsula has attracted large numbers of investors from South Korea. After normalizing diplomatic relations in 1992 the two countries entered into a close economic partnership and China has for Korea become number one trading partner in both exports and imports. Trade between the two countries constituted 14 per cent of Korea's total trade in 2003.

The world can already see the emergence of three great urban spheres which have already become China's most highly developed areas—the lower Yangtze River delta, the Pearl River delta, and the Bohai region with Beijing and Tianjin. These regions have five per cent of China's total land area and some 20 percent of total national population. By 2025 they could account for two thirds of China's total GDP, a development that in all likelihood would attract large-scale migration. However, central and western China will probably in the meantime create their own urban belts and concentration of cities. A continued rapid urbanization might relieve some of the existing burden on nature, and China's land and exhausted ecology can be allowed to rest and recover, and the environmental debts incurred over thousands of years can gradually begin to be repaid.

Thus, there is a need, among the policy makers, to develop approaches that enable cluster industries to exploit economies of scope and scale. The need for developing new business models is more acute than in most other industrialised countries<sup>17</sup>.

The resulting industrialization of coastal China has generated highly efficient structures in a large number of manufacturing fields not easily to be found in other parts of the world. Manufacturers, whether they are domestic or foreign companies rely on clusters of component suppliers and China has increasingly become integrated into the global economy and an extensive supply chain draws on resources in a global setting.

The acceptance of foreign direct investment and its abundant availability combined with an acceptance of market forces have greatly contributed to the shaping of three economic regions in China. Naturally, local governments at provincial and lower levels have to a great extent contributed to developments of the three regions. This is being done through various means of attracting FDI, developing infrastructure and allocating land and other scarce resources. China joining WTO has contributed to a shift in the MNC investment focus with more and more foreign investors opting for mergers and acquisitions instead of launching new plants. Thus, more and more foreign investment has become wholly owned ventures instead of joint ventures. Some of the early investors have chosen to buy

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<sup>17</sup> Tamada, Tatsuru, The Challenge of Creating "Cluster Industries": In Search of New Sources of Added Value, NRI Quarterly Winter 2000, pp. 2-17

out their Chinese partner and take full control of the former joint venture. It is not yet clear to what extent it influences technology transfer and potential for absorption in the localities.

The high-tech trade statistics also reveal the relative importance of different regions in China. Shenzhen remains by far the dominant player with its exports of 2.0 billion against 2.3 billion in imports of high-tech goods, being trailed by Shanghai with its export of 1.5 billion against imports of 1.9 billion. The Yangtze River Delta region includes Jiangsu province with the cities of Wuxi and Suzhou having become important high-tech industrial centers. Jiangsu reported for July 2003 high-tech exports 1.7 billion against imports of 1.5 billion. Beijing for the same month reported high-tech exports of 0.4 billion against imports of 1.2 billion. Tianjin reported both high-tech exports and imports at the level of 0.4 billion.

In each of the three regions there exists a number of industrial clusters, often highly specialized and with close links to overseas investors, mainly from Hong Kong, Taiwan, Korea and to a lesser extent from Japan, the US and Europe. Information from such clusters provides useful insights on the dynamics of industrial development of the regions and its linkages with overseas industrial partners.

Provincial and local governments at city and county levels have vital role in economic and technological development. They control about 70 per cent of the state budget and have often their own development strategies, although frequently directed from the central government. The diversity and also autonomy is evident from the document<sup>18</sup> “Formation of Shanghai Knowledge Economy Strategies” which includes the following approaches.

1. As Beijing has a strong information technology industry and Shenzhen a strong manufacturing base, Shanghai focuses on further exploiting an advanced biotechnology base and building the Pudong Bio Science and Technology Park.
2. Preferential tax regime and financial assistance help high technology startups invest in R&D
3. Public resources establish new basic research institutions focused on Shanghai’s strengths and interests, to encourage cooperation between universities and corporations, and to reorganize old research institutes.

### **Shenzhen – The Cradle of Coastal Industrialization**

Hong Kong and Shenzhen just across the border to China have in very recent times become twin cities and are closely linked together in all economic aspects. The recent and very rapid modernization and industrialization in modern China got off to a dynamic start in the late 1970s when a first batch of special economic zones was established along the coastline. Early on Shenzhen in Guangdong province immediately north of Hong Kong took on a prominent role for which several factors contributed and gave the impetus to a heady start. First, Shenzhen was virgin land for industrialists and

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<sup>18</sup> Shanghai Science and Technology Committee, Formation of Shanghai Knowledge Strategies, Shanghai 1999, translated in Dahlman, Carl J. & Aubert Jean-Eric, China and the Knowledge Economy – Seizing the 21<sup>st</sup> Century, World Bank Institute, Washington. D.C. 2001

entrepreneurs with no tradition in planned economy solutions. Second, Hong Kong that had hitherto been a significant manufacturing centre for toys, garments, electronics products and many other light industrial goods was experiencing rapidly rising wages for workers in its industries that were in the main labor-intensive activities and thus became less competitive. Third, entrepreneurs in the Hong Kong environment of dominantly private business quickly sensed immediate prospects of doing good business on the Mainland when the central authorities started to grant special status and privileges to the zones.

The government in Beijing offered two important provisions. First, Shenzhen as well as other special economic zones were provided an almost full liberty in establishing new ventures, a panacea when comparing with earlier very troublesome procedures. Second, China offered labor that was relatively well skilled, disciplined and most important at the time at wages that were only a fraction of those in Hong Kong. With hardly any migration across the border and with wages only slowly raising Shenzhen provided a golden opportunity for the industrialists in Hong Kong. China on the other hand was in the Guangdong province given a dynamic injection of industrial entrepreneurship, good management, employment and industrial upgrading of worker skills. Thus, an exceptional synergetic relationship between China and Hong Kong occurred. Within little more than a decade the industrialists in Hong Kong had created more than three million jobs across the border, all of which were more or less directly serving their direct interests. The manufacturing base in Hong Kong that had earlier been quite substantial almost completely disappeared. In the transformation process the economy of Hong Kong became geared to providing services among which finance, logistics and transportation are most prominent. The early success of Shenzhen as a springboard for injecting a new spirit of modernization set the precedent for dynamic change.

This transformation has by now encompassed the complete coastline of China, although Guangdong province, where Shenzhen is located, set the stage for what would happen in many parts of China<sup>19</sup>. Xiamen, further to the north, also experienced good effects from one of the next special economic zones. The city which is located just across from Taiwan initially attracted a number of investors from oversea. Investors from Taiwan were mostly channeling their capital through other countries. However, Xiamen and Fuzhou, the capital of Fujian province, still further to the north did not provide the same dynamic conditions that had favored the economic relationship between Hong Kong and Shenzhen. Second and possibly more important was the complete lack of political understanding between Taiwan and China in how to foster their economic relations.

From an early start in the south the political leadership and planners in Beijing quickly expanded the scope of industrialization. This was based on an almost unlimited acceptance of foreign direct investment followed by access to the country's pool of low-cost labor. After completing a first stage, namely providing special economic zones the central government went on to create special zones for high-tech development. The purpose was to wean away the localities from depending on labor-intensive activities when they accepted foreign investors. A later stage has seen a rapid proliferation of

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<sup>19</sup> Vogel, Ezra, *One Step Ahead*, 1980?

incubators for exploitation of research and high-technology innovations. They are usually connected to universities, which underwent a major reform and a very rapid expansion of enrolment since the late 1990s, or to government research institutes. Both have simultaneously come to play a very important role in establishing spin-off companies and some of the most well-known high-technology companies in China owe their origin to this phenomenon.

The industrial strength in Shenzhen lies in the following five areas. First, the majority of the industrial high-tech companies are private ones, with strong participation from abroad. Second, R&D is carried out within companies. Third, incubators play an important role, with presently more than 1,000 enterprises in incubators. Fourth, all required support services for the electronics sector are available. Fifth, Shenzhen gives strong support to IPR, with many companies having their own IPR sections. Shenzhen is number three in China in terms of IPR. Furthermore Shenzhen organizes annually, since 1999, a High-Tech Fair, held in mid-October.

## **Shenzhen's Industrial and Technological Advances<sup>20</sup>**

**Shenzhen Special Economic Zone** was established in 1980 after the City came into being the preceding year<sup>21</sup>. The official investment guide<sup>22</sup> says that “in a short 23 years, Shenzhen has developed from a frontier town into a garden city with solid economic strength, complete urban functions, good ecological environment, civilized society, sound legal system and rich vitality.”

Shenzhen's characteristics include prominence in IT, finance and logistics. IT products constitute 90% of industrial output with an expected increasing share for biotechnology. Shenzhen companies have established a strong position in telecom switching equipment and in magnetic and optical reading heads. Leading companies such as Huawei Technologies has become very strong in optical communications, with ZTE having established a strong position in CDMA technology for mobile telecom networks. The expansion of technological competence in new materials originates in a rapid development of production technology for new types of advanced high-tech batteries. A very large share of global production of electronic watch mechanisms is based in Shenzhen, although design is mainly done outside China.

Foreign companies have located in Shenzhen because of labor which is not only attractive for cost reasons but also for its increasing competence levels. Another reason for the increasing attractiveness of Shenzhen lies in its dominance of private companies.

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<sup>20</sup> The information and views in this section on Shenzhen are based on interviews that were jointly carried by the author and Ms Vicky Long in June 2003.

<sup>21</sup> Reflection: One day when passing from Hong Kong into China at Lowu there were only four passengers in the international group and only some tens among the rest – against an hourly passage of 4,000 at Huang Kang.

<sup>22</sup> Shenzhen Investment Guide, Shenzhen Municipal Government, Shenzhen, February 2003

As a consequence, more than 90 per cent of all R&D carried out in Shenzhen is carried out inside companies. This is very different from other major cities in China.

Government revenues (taxes) from Shenzhen reached RMB26 billion (2002) and exceeds those of Beijing and Shanghai. The GDP of Shenzhen has taken the fourth position among China's major cities. Exports from Shenzhen have expanded rapidly during the past ten years and today about one third of China's high-tech exports originate in Shenzhen and in this respect Shenzhen is becoming more important than Beijing.

The GDP of Shenzhen in 2002 reached RMB 223 billion, to be compared with 313 billion for Beijing and 540 billion for Shanghai. Its exports in 2002 amounted to US\$46 billion compared with 32 billion from Shanghai. Shenzhen in the same year attracted foreign investment at the level US\$4.9 billion which is basically the same figure as for each of other three major cities in China – Beijing, Shanghai and Suzhou.

Beijing High-Tech Industrial Park is most important for science and technology and its activities are strongly supported by the government to become best in China, and best in the World. The High-Tech Industrial Parks in Shanghai, Xian and Shenzhen have important responsibilities for regional development which must be based on scientific research. Shanghai is already strong in its development of semiconductors, while Shenzhen has established a very strong position in IT. Shenzhen sees itself in competition with other major cities in China which has fostered a number of initiatives which for which the following provides a few examples.

### **A Multitude of Technology Development Structures**

Established in 1996, **Shenzhen High-Tech Industrial Park (SHIP)** is one of the five national science parks. SHIP serves as the base for high-tech industrialization, R&D, incubator and high-tech talents training. 22% total industry output comes from this park. Altogether there are 53 designated science parks in China of which five have been designated as High-Technology Industrial Parks, with particular support from the central government: Zhongguanzun in Beijing, Zhanjiang High Technology Park in Shanghai, Xian Science Park and Yangling Agricultural Park in Shaanxi that was the latest of such parks - established in 1997. These five parks have very different character as Beijing and Shanghai are dominated by state-owned companies and government agencies while the private sector completely dominates in Shenzhen, a fact that owes very much to its very close relations with neighboring Hong Kong. Shenzhen has in a very short period grown from almost nothing to a city with a population of more than five million, compared with about six million in Hong Kong.

Shenzhen High-Tech Industrial Park, for which the original concept was established in 1985, was upgraded to special national status in September 1996 as a consequence of Deng Xiaoping's visit to South China in 1992. By taking advantage of the environment and resources of Shenzhen Special Economic Zone SHIP have formed a number of professional and interactive incubator groups which combine activities of government, venture capitalists, scientific research institutes and overseas Chinese students and

enterprises. They include Virtual University Incubator, Overseas Chinese High-Tech Venture Park, Software Park and Bio-Engineering Gene Incubator – located inside the Shenzhen Special Economic Zone. The SHIP incubators also include an IC Design Park.

The park has 80,000 staff employed in some 1,500 firms and more than half have university or college degrees. More than 10,000 have master degrees and more than 1,000 have doctoral degrees. There are more than 40 research centers in the Park with Huawei and ZTE taking the top positions with R&D spending of more than RMB2.7 billion and 1.8 billion respectively (2003) which means that they are spending more than 10 per cent of their revenues on R&D. Other companies with substantial R&D in the Park include Legend (Lianxiang), now named LENOVO, having established activities in March 2003

**Shenzhen Software Park (SZSP)**, located inside Shenzhen High-Tech Industrial Park, is the national base for the Torch Plan Software Industry that has been designated by the Ministry of Science and Technology. The Software Park with a total of 225 registered firms and 11 firms among the top 100 software firms in China. SZSP is dependent on SHIP for resources and interaction with companies. The software companies employ more than 6,000 and generated software with a value of RMB 2.5 billion in 2001.

Shenzhen City expects that SZSP will become an internationally well-known centre for software development, technology cooperation and enterprises in incubation. A set of policy measures were formulated in 2001, based on “The Policies for Encouraging the Development of Shenzhen software Industry based on National Program.” The policies include measures on funding, taxation, export and personnel. Some 20 national, provincial and municipal engineering development centers and laboratories are now present in the Software Park. The SZSP brochure states that by 2005 the number of companies in the Shenzhen Software Park will reach 800 with annual software revenues of RMB30 billion.<sup>23</sup>

SHIP is one integral part of the **Shenzhen High-Tech Industrial Belt (SHIB)** that comprises 11 parks including 9 high-tech industrial parks, a university town and one ecological agriculture park. SHIB includes the Virtual University with some 8,000 postgraduates and 6,000 undergraduates (2003). SHIB has 40 IT centers, and a number of R&D centers that are operated by companies. Incubators have in recent years taken on a prominent role although private firms also play a significant role. The government policy is focused on providing finance for incubators. The main functions of SHIB are the development of Shenzhen high-tech industry which provides a concentration in China’s southeast coastal areas. This includes Shenzhen Software Park which is a software colony of enterprises that develop embedded software, system software applications and IC design software.

Shenzhen will soon have seven million people and is today the most multicultural city in China, developing at high speed with great flexibility. Forty per cent of the present inhabitants come from Guangdong. The rest comes from Hong Kong, Taiwan other parts

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<sup>23</sup> Shenzhen Software Park, Shenzhen Software Park Management Centre, Shenzhen 2002 (?) – [www.szsoftwarepark.com](http://www.szsoftwarepark.com)

of China. Route 128 and Silicon Valley in the US are often referred to as models for Shenzhen, although they were not planned but developed and expanded because of favorable environment.

The industrial output of Shenzhen is predicted by 2020 have increased from RMB350 billion to RMB2,000 billion. SHIB only will by 2010 have an industrial output of RMB500 billion, also according to expectations. By 2020 semiconductor manufacture is expected to have become a very important part among the IT industries in Shenzhen. New materials and biotechnology are also expected become prominent from today's very low levels of activity. These national ambitions can clearly be seen in Shenzhen but are more evident in cities like Shanghai and Beijing. Here the central government has more leverage through government research institutes and a large number of state-owned enterprises.

Shenzhen is looking into the future and has to consider is development of human resources and R&D. Shenzhen should become more international which will require attention to improved infrastructure, environment and city management. The Shenzhen Investment Guide states that Shenzhen focuses on developing computer and parts industries, very large-scale integrated circuits, networks and communications software, digital electrical household appliances, biological engineering and new materials. Although the last two have been singled out for future development ICT is today completely dominating the industrial development in Shenzhen.

Naturally, the foreign investors are unwilling to give up control of their valued positions in China and are better protected after China joined WTO. At the same time China has the ambition to regain at least partial control of the high-tech sector that is now so dominant in its foreign trade. This is being done through national programs, through state-owned enterprises that at the national level represent the pillar industry of the country, and through advanced technological development that is done within the defense sector. In this endeavor regions and the national government at times have identical interests while on other occasions they may be radically conflicting.

### **Higher Education in Shenzhen**

Shenzhen is not yet very well endowed with institutions of higher learning and government research institutes. The Shenzhen University has 12,000 students and Shenzhen also has a Normal College. Furthermore, the national government has established a Medical Instrument Research Institute and local government has set altogether some 20 laboratories. In addition Beijing University has established its presence in Shenzhen and Tsinghua University has set up the Shenzhen Institute of Tsinghua University, with the former having established in 1999 the Beijing University Medical Hospital. Another related activity is the Shenzhen Institute of International Technology Innovation and Shenzhen-Hong Kong Institute of Industry-Education Research – PKU-HKUST.

To improve higher education, Shenzhen is partly relying on its Shenzhen Virtual University (SVU), established in 1999, which is a novel approach. A University Town was inaugurated in December 2003 with 10,000 students of which 70% will be all-day students while the rest are “local” part-time students who will study in the evening and on weekends. The University Town will in particular draw on resources from Tsinghua University in Beijing, Beijing University, Harbin Engineering University and Nankai University in Tianjin.

The Shenzhen Virtual University offers member universities, enterprises and venture capitalists an opportunity to communicate and cooperate to commercialize technical research. Including the year 2001 more than 4,000 students with Master or Doctor Degrees have graduated from the Virtual University. Shenzhen is part of China’s 211 Project whereby China will have the 100 best universities in the 21<sup>st</sup> Century.

SVU is located inside the Science Park. Almost all the well recognized universities in China, also some from Hong Kong are members in SVU. Beijing University and Tsinghua University have initially together with Harbin University of Engineering played an important role, the presence of the last one is explained by the fact that one of the earlier mayors of Shenzhen City came from Harbin.

### **Budding Clusters**

It is apparent that the emergence of a knowledge society is creating a very unequal distribution in the geographical space of a country or a region. Obviously relatively small territories – cities and their close surroundings –are becoming the key production areas in an emerging knowledge economy. This also means that there is a shift away from the national perspective to the regional perspective in understanding the welfare of a nation. It is possible to identify three types of regional agglomeration.

- First, in a number of locations there already exists a strong industrial base which naturally provides good conditions. This corresponds to what could be termed “traditional clusters”.
- A second category is locations where high-tech activities have started to agglomerate and where policies support frontier research.
- A third category is locations, which have a weak industrial and technological base. In some cases the attempt to establish R&D agglomerations run counter to major trends in the process of ongoing restructuring of R&D and industrial activities.

In China the second category prevails. There is an inherent conflict between regional or localised development on one hand and the rapid concentration of industrial and technological activities on the other. In the second category industrial and technological stimulation on a region will require a multitude of resources and cannot rely only on local companies. The science and technology industrial parks are not evenly distributed in China, and do not represent the actual distribution of population or economic activity. They will no doubt advance technopole-led growth that by necessity requires precedence in obtaining scarce resources such as capital, engineers and scientists in research institutions and land which is attractive for foreign MNCs. This development also favours

businessmen and professionals over the agricultural population that still provide the labour for the many process and assembly enterprises that presently play a dominant role in China's modernization.

## Regional Clusters - Examples

A successful development of clusters requires capabilities and facilities to meet a number of demands. One is the physical infrastructure such as water and power supplies, physical transportation and telecommunications, and must also include easy access to ports and airports. Equally important is institutional development which must facilitate investment measures and offer transparent tax rules.

### BoHai Rim (BHR)

Availability of human resources is another critical dimension for successful development of clusters that will require three kinds of labor: unskilled, skilled and professionals, with the last category also including researchers. Tianjin and other cities in the Bohai region provide an almost unlimited supply of cheap labor and Tianjin is well endowed with universities and colleges.

Most of the development zones in Hebei are located in the areas around the Bohai Sea or around Beijing and Tianjin or areas with main railway lines and trunk highways running through. After the Qinhuangdao Economic and Technical Development Zone was established in October 1984 with an approval of the State Council, more than 20 development zones at or above the provincial level were set up in Hebei Province<sup>24</sup>. Among them the Qinhuangdao Economic and Technical Development Zone, the Shijiazhuang New High-tech Industrial Development Zone and Baoding New High-tech Industrial Development are state-level ones and those development zones located in Langfang, Tangshan, Tangshan Seaport, Zhuozhou, Cangzhou, Huanghua, Huanghua Seaport, Shanhaiguan, Beidaihe, Yanjiao, Nanpu, Bazhou, Anping, Shijiazhuang, Renqiu, Wuqiao and Baiyangdian are all at the provincial level.

Let us look at the budding car industry cluster in **Tianjin Economic Development Area (TEDA)** which belongs the BoHai Rim region. The administration of this area has, following Toyota's investment in car manufacture, decided to attract small and medium-scale enterprises to support the development of the car industry. Thus, TEDA has recommended that a number of companies making automobile components should locate with this budding cluster – with the expectation that they supply components to assembly firms in Beijing, Tianjin and other cities in the region<sup>25</sup>.

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<sup>24</sup> Hebei Online, The Construction of Development Zones in Hebei, July 15 2004, (China Daily)

<sup>25</sup> Kuchiki, Akifumi, A Flowchart Approach to Asia's Cluster Policy

One result of Tianjin's development is the emergence of a car industry cluster at a time when the car industry in China has reached the stage of take-off to meet the rising expectations and buying-power of a rapidly growing middle-class.

Toyota in 2002 started to operate an assembly firm in Tianjin and will in 2005 together with its partner, FAW, launch four models, including Corolla, Land Cruiser Prado and Crown and is expected to reach a very high local contents ratio. Toyota has for two decades been distributing its cars in China and in 1995 established the Toyota China Technology Center in Tianjin to train parts and component suppliers and to support service facilities in other parts of the country. During the following years Toyota made a major investment in a joint venture engine plant with Tianjin Automotive Group (TAG) that was already a producer of mini cars and trucks. Furthermore, Toyota established its own facility to manufacture a certain engine, and also particular key components such as universal joints and steering components. After completing this phase Toyota in 2003 formed a joint venture with Tianjin Automotive Xiali Company to produce one of Toyota small-car models, the Vios. Toyota had during the years supported TAG in upgrading its production both in quality and quantity. The FAW Group in 2002 acquired a majority stake in TAG and the following year Toyota and FAW announced its ambitious plans to launch a number of Toyota models by 2005.

Tianjin is, together with Beijing, Shanghai and Chongqing, one of the four municipalities directly under the central government. It is the biggest coastal city in northern China, and has become an economic center of the Bohai Rim Area (Bohai Sea Encircling Zone<sup>26</sup>) with a wide range of industries and sophisticated high-technology firms. Total population is 9.5 million of which only one third resides in the city proper. Its industrial strength is primarily based in four areas: automobile, electronics, petrochemical products and metallurgy.

TEDA<sup>27</sup> has also played an important role in the establishment of a State Base for Nanotechnology Industries (SBNI) which became one of the first of its kind in China under the guidance of the Ministry of Science and Technology (MOST), after the Ministry made an on-site inspection. Within the boundaries of TEDA SBNI has basically brought together the top-class nanotechnology research institutions and experts of Beijing and Tianjin, including experts from Chinese Academy of Sciences, Tsinghua University, Beijing University, Nankai University, Tianjin University. The mission of SBNI is to drive technological innovations and to become a world-class nanotechnology center within five to ten years. By capitalizing on the existing advantages of TEDA, SBNI is

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<sup>26</sup> The "Bohai Sea Encircling Zone" is an important player in the economy of China. The Zone contains 17 of the country's 450 cities. It has respectively 5.7% and 8.7% of the country's land area and total population. However, its GDP accounts for 11.56% of the country's total. Tianjin ranks first in economic strength in the "Bohai Sea Encircling Zone". The Zone was jointly established by Tianjin and other 16 cities in provinces of Liaoning, Hebei and Shandong in May of 1986. The joint meeting of the 17 mayors is held in Tianjin on a regular basis. <http://www.teda.gov.cn/englishnew/local/overview.htm> (June 16 2004)

<sup>27</sup> Another important initiative is The Science and Technology Garden of Tianjin University (STGTU) which was jointly funded with TEDA in 1999 with a total investment of RMB 500 million to become a rallying point for high and new tech enterprises

intended to provide a platform that facilitates the development of new and high technologies.

The ambitions and way of operation can be understood from the following statement that clearly indicates that construction of professional parks and transformation centers in Hebei has three major objectives<sup>28</sup>.

The **first** is to further perfect the construction of information industry parks in Hengshui, Shijiazhuang, Baoding, Langfang, Tangshan and Qinhuangdao. The **second** is that key focus should be given to the construction of Sanheyanjiao, Shijiazhuang, Baoding and Qinhuangdao 4 provincial level software parks to drive forward the development of relating industries and middle and small software enterprises in the surrounding regions and to strive to establish a national level software industry base in about three years. And the **third** is to build information technology transformation centers in development zones in Shijiazhuang, Langfang, Sanheyanjiao and Qinhuangdao, and through the construction of industrial parks and transformation centers, to form an information industrial belt and establish an electronic and information industry processing and production base with industrial complementation among Beijing, Tianjin and Hebei so as to build an excellent platform for the development of information industry in priority.

### Yangtze River Delta (YRD)

Although Shanghai remains the centre of the region the surrounding provinces have also made great efforts to promote their development zones. For example here are eight national development zones and 54 provincial economic development zones in Zhejiang<sup>29</sup>. They have total investment of RMB 55 billion for infrastructure and cover area of 492 square kilometers. These development zones have become hot spots for domestic and foreign investors. In 2002, US\$1.8 billion worth of overseas investment which amounted to 58 percent of the total figure in the province was actually used in these development zones. The industrial structure in the development zones has gradually changed to include agriculture and services.

Shanghai is developing into another cluster of China's budding car industry and Shanghai Automotive Industry Chinese largest automaker has announced an annual group production capacity to 1.5 million vehicles by the end of 2007. However, the leadership in Guangzhou has indicated that production value of car components there could surpass that in the Shanghai area in the near future. See in the following.

<sup>28</sup> (Hebei Online)Information industry, July 13 2004 (China Daily)

<sup>29</sup> zjol.com.cn, Economic and Technological Development Zone (China Daily)

Economies of scale have been created through the accumulation of numerous auto-related companies. A further industrial expansion of car component makers belonging to different industrial groups will increase competition and reduce procurement costs for automakers. A likely outcome is that trade will expand with neighboring Asian countries and Europe. Honda's factory in Hueijou, close to Guangzhou, is exporting crank shafts to Thailand, while importing other components.

The rapid development of the car industry in China and the involvement of many Japanese car component manufacturers are forcing some of them to establish product development centers in China to create parts that meet local need<sup>30</sup>. By early 2005 Nifco will set up a site in Shanghai to develop interior-use fasteners. A few engineers will initially be sent from Japan to staff the facility, which will take orders from a Chinese joint venture of General Motors Corp. Calsonic Kansei plans to establish product development centre in early 2005 with a staff of about 50 to develop parts for a local joint venture of Nissan Motor. Nissin Kogyo began developing brake systems in China in mid-2004 at a wholly owned subsidiary in Guangzhou. Similarly, Keihin Corporation has begun researching electronic control technology for fuel injection systems at a wholly owned subsidiary in Shanghai.

China will soon become the world's third largest producer of cars.<sup>31</sup> A likely outcome is that enterprises based in China will in the intermediate future become dominant suppliers for many components used in cars assembled only in China but also in Europe, Japan and the US. Chinese cars from domestic companies will also be exported and a first market entry in the US is planned for late 2004. The significance of this lies not only in manufacturing capabilities. As the Toyota example shows other substantial inputs are also required such as training local producers, service staff and investments into the manufacture of more and more sophisticated parts and components.

## **Pearl River Delta Region (PRD)**

### ***Car Industry Cluster in Guangdong***

Rivalry among China's region is prevalent in many sectors and automobile production is no exception. Honda started its operations Guangzhou in 1998 with an aggregation of makers of car<sup>32</sup>. Today all three largest Japanese automakers - Toyota, Honda and Nissan, have announced major investment in the Pearl River Delta region which may rapidly become the hub of the local automotive industry. In early January 2004 JFE Holdings from Japan started construction of a joint venture factory in Guangzhou to produce high-quality galvanized steel sheets for supply to local Japanese automakers like Toyota and Honda, with deliveries to start in 2006. Another company from Japan, Zeon, is building a

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<sup>30</sup> Autoparts Firms Establishing R&D Sites In China, Nihon Keizai Shimbun, June 6 2004 (Nikkei Interactive)

<sup>31</sup> Car policy document

<sup>32</sup> China's Pearl River Delta Emerging As Major Auto Production Hub, Nihon Keizai Shimbun, January 16 2004 (Nikkei Interactive)

plant in Guangzhou to produce intermediate materials of synthetic rubber used in autos and started delivery in mid-2004. Kurabo Industries, also from Japan, is expanding its existing plant in the city to boost the output of urethane forms for automobile seats. Honda will in 2004 double its annual vehicle output to 240,000. To handle this expansion Honda has dispatched over 200 engineers from Japan to Guangzhou Honda Automotive Company and is bringing a number of assembly line workers from its plant in Taiwan.

The municipal government in Guangzhou envisages that about 500,000 passenger cars will be produced in PRD in 2005, with a total value of finished vehicle and car components production in the area of around RMB100 billion which would account for some 20% of regional total gross economic output. Thus, the Pearl River Delta is almost certain to become the biggest production base in China for Japanese-affiliated auto and related industries. Passenger car production in the region could reach 1.5 million units, with a value of RMB120 billion, with additional car components in the region of RMB204 billion. Currently, about 70 Japanese-affiliated auto parts makers, including auto door sash and brake makers, operate in the region. If very small Chinese related firms are also included, the total number of auto industry firms there apparently stands at some 200.

### *Dongguan City Clusters*

Advantages such as industrial agglomeration, growth of domestic firms, improved infrastructure, and expansion of the domestic market has made several cities in the Pearl River Delta into major centers for a variety of clusters and Dongguan provides an illuminating icon. Dongguan in southern Guangdong province has in the past been described as “the lower end of technology-related clustered activity”.<sup>33</sup> Furniture is one of the clusters where Dongguan has established and maintained cost leadership and a high level of competence. This success is based on globally imported raw materials, a skilled workforce, international fashion designs and state-of-the-art equipment and workmanship which foreign enterprises have brought to Dongguan. Thus, the city today has the largest furniture industrial cluster found anywhere in China. There are more than 2,000 producers of furniture in Dongguan that has established itself as an important production base for the world furniture market.

Dongguan is China's third leading exporting city behind Shenzhen and Shanghai. And is in many sectors a leading centre for export processing in labor-intensive, light manufacturing industries. FDI has been an important driver of Dongguan's development, with the majority of Dongguan's industrial output supplied for foreign invested firms.

In the early days of the Open-Door-Policy large amounts of FDI advanced to Guangdong province where Dongguan City, aside from Shenzhen has greatly benefited with a major share coming from Hong Kong and Taiwan. Initially in the early 1980s enterprises in Dongguan were primarily manufacturing garment and shoes on orders from Hong Kong,

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<sup>33</sup> Walcott, Susan M., *Chinese Science and Technology Industrial Parks*, Ashgate Publishing Company, Burlington, 2003

Macao and Taiwan. Investment patterns changed dramatically from the mid-1990s and onwards as Taiwanese companies identified Dongguan as an ideal location for much of their electronics products. Today one out ten of Taiwan's enterprises on the Mainland is located in Dongguan<sup>34</sup>.

In the late 1990s, the computer and information industry developed rapidly and transformed Dongguan into China's leading desktop and computer parts manufacturing center. The industrial chain in Dongguan is so complete that the city is able to supply 95 percent of all component parts needed to assemble a computer. The Dongguan phenomenon attracted worldwide attention, and Dongguan-produced information and computer products have carved an important niche in the world market. The city finds itself among the front ranks in the manufacturing of computer magnet heads, mainboards, monitors, scanners, drivers, and so on, and is the purchasing center for the world's top ten computer companies including IBM, Compaq, and Hewlett Packard.

FDI from some 15,000 enterprises have resulted in close to US\$20 billion in investment in Dongguan. Companies from Hong Kong and Taiwan still account for more than 80 per cent of FDI in Dongguan. Companies active in Dongguan also include Phillips, Samsung and Nokia. The latter company has one of its largest production bases in Dongguan. The vast majority of Taiwan's major computer and computer components manufacturers have facilities in the city. Global computer companies, such as IBM and Dell, use Dongguan as a base for sourcing computer parts and components.

A stream of foreign direct investment has fueled sustained economic development and industrial reorganization in Dongguan and has continued to rank highly in export performance. The reason for success lies in its favorable transportation and location between Guangzhou and Hong Kong, its close relations with investors from Hong Kong and Taiwan, and the willingness and ability of the local government to plan and implement the construction of all required infrastructure. However, the prominence of Dongguan has come within only two decades. Thus the education level of the local residents is relatively low and a large share of employees in industrial enterprises comes from the hinterland and their wages are low. Until recently there was no single college in Dongguan and it was difficult for the city to provide well-educated professionals when needed.

A special characteristic of Dongguan is evident from its structure of population and share of permanent residents. The city has only 1.5 million residents, according to official statistics, but they are outnumbered by more than three to one by migrant workers from other parts of China as the total population is reported to be 6.5 million.<sup>35</sup> A majority of factory workers in Dongguan are female – 72 per cent – and mostly between the age of

<sup>34</sup> Jiang, Xiaojuan, Geographical Distribution of Foreign Investment in China: Industrial Clusters and Their Significance, *China & World Economy*, No 1, 2003, pp. 16-24

<sup>35</sup> McMillan, Alex Frew, Dongguan joins China's assembly line, CNN November 28 2002 (<http://edition.cnn.com/2002/BUSINESS/asia/11/28/china.dongguan>)

18 and 22.<sup>36</sup> Almost all stay for a period of five years and save most of their wages. Migrant workers in Dongguan sent back RMB 13 billion to their homes in 2001.<sup>37</sup> Major advantages in Dongguan include an excellent location, good transportation, eager FDI investors from Hong Kong and Taiwan, local government support and almost unlimited availability of migrant workers

Dongguan has a number of industrial and technology parks which include:

1. Xin An Industrial Park specializing in electronics, computer parts, and related products
2. Zhen An Industrial Park is base for a number of capital-intensive facilities
3. Dongguan High-Tech Development Zone is compound for producers of fine chemicals, high-tech materials, and related products
4. Anli Science and Technology Compound is home to capital-intensive facilities in plastics among other industries

The important new addition for future development is Dongguan Songshan Lake Science and Technology Park project that was inaugurated in January 2002. This park will become focal point for future development in advanced equipment, photo-electricity industries and bio-medical sectors.

This might eventually reduce the character of satellite-type manufacturing that is prevalent in China today, as many foreign-controlled companies lack durable relations with local suppliers. The satellite companies, controlled from headquarters outside China, generally do little design and product development and key technologies have been created outside China. However, recent years have seen the establishment of FDI in R&D centers in China, and several MNCs have started to manufacture increasingly sophisticated components in China. These changes indicate that industrial cluster, presently dominated by FDI, could evolve into innovate industrial clusters through an expanding exchange of knowledge, and some clusters could become global centers for design and R&D.

With the increasing sophistication of electronics products manufactured in China, clusters started to shift. Dongguan and other cities in the South were no longer able to meet demands in human resources and more sophisticated infrastructure needed for cellular phones, PDAs and laptop computers. From the late 1990s Suzhou has seen a concentration of high-technology FDI that required managers and technicians and higher level an also needed easy access to supplementary industries. A news report from late 2002 mentions that "(A) business park that hypes itself as the Yue Yuen Hi-Tech Optoelectron Estate mainly produces soles for Nike and Adidas sneakers"<sup>38</sup>.

Dongguan is possibly one of the best examples of industrial development in the Pearl River Delta region, with a very dense concentration of light-manufacturing firms and

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<sup>36</sup> *ibid.*

<sup>37</sup> *ibid.*

<sup>38</sup> McMillan, Alex Frew, Dongguan joins China's assembly line, CNN November 28 2002 (<http://edition.cnn.com/2002/BUSINESS/asia/11/28/china.dongguan>)

suppliers, and its very large pool of migrant factory workers from other regions in China. Dongguan needs to deepen and upgrade its traditional industries and expand in high technology industries. The electronics and information technology equipment industries are to be focal points of development. Retaining its position as a cost-competitive manufacturing platform for local and international companies the city emphasizes cooperation with Hong Kong and Taiwan in finance, trade, technology, and manufacturing.

## **Economic Integration with Neighboring Countries**

FDI in Chinese industrial sectors has brought about a swift resolution to the international division of labour with its constantly shifting comparative advantage and contributed to expansion of bilateral trade between China and the nearby countries from which FDI originated. However, the challenge for these countries is to develop new areas of comparative advantage if they wish to maintain economic growth as China will itself become a source for increasingly sophisticated products and services. The expansion of internal trade in Northeast Asia clearly indicates that industrial sectors and the economies of the region are entering a phase of close integration. This process involves not only the Chinese Economic Area (CEA) but also an economic relation with South Korea and Japan. One may assume that close relations with neighboring countries was a significant factor in developing the three major regions that have been discussed in this section.

### **Korea – Its Influence on China’s Regional Development**

Similar to Taiwan that in 2003 saw its exports to China surpass exports to the U.S. South Korea, another of the world's main production bases for IT components, also experienced a change in its trade pattern. Since the 1980s Korea has made major investment in China that has become Korea’s third largest trade partner<sup>39</sup>. As a result of China’s rapid transformation its exports have in many cases replaced of Korea’s exports to the US and Japan, which is partly a reflection on an expanding movement in intra-industry trade between the two countries. It has now become apparent that Korea must succeed in gaining a comparative advantage in technologically more advanced industrial sectors to maintain its economic growth. The changes in China’s export structure are concurrent with its mounting ability to manufacture technologically more advance products. Since the turn of the century the structure of China’s exports have changed dramatically with an amazing increase in medium and high-technology products. This is particularly evident in engineering and electronics products for which the combined share of exports increased from less than two per cent in 1986 to more than 35 per cent in 2001.

China is for the time being only able to achieve this level of exports in high-technology products with the support of foreign investors. The results depend on foreign technology, capital and management but may increasingly originate from technological improvements that are based in genuine domestic capabilities, which could replicate similar developments in Korea and Taiwan at an earlier stage. When looking at the revealed

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<sup>39</sup> Kim, Joon-Kyung & Kim, Yangseon & Lee, Chung H., Trade and investment between Chin and South Koirea: Toward a Long-Term Partnership

comparative advantage (RCA) it is very clear that China in the period 1986-2001 quickly dropped its RCA in primary products, keeping it in textiles while also gaining in other labour-intensive products. At the same time China's increase in the revealed comparative advantage in electronics and engineering products is very remarkable. The effects have been extraordinary in major export markets like Japan and the US where a comparison between exports from Korea and Japan shows an enlightening picture.

China's share in Japan's import of telecommunications, sound recording and reproducing equipment increased from 1.5 per cent in 1987 to 28,8 per cent in 2001, while Korea's share fell from 27.4 to 7.5 per cent. China's export achieved an almost equal success in the US market during the same time while Korea's export share for these categories remained at basically the same level. These developments indicate that engineering and electronics industries in China are catching up with its counterparts in Korea. A KDI investigation shows that China's export intensity with Korea increased significantly during the period which indicates that bilateral trade between the two countries expanded quicker than trade with the rest of the world<sup>40</sup>. However, intra-industry with the world as a whole is more important than that with Korea. An Intra-industry trade is generally understood as a consequence of product differentiation and economies of scale and has increasingly become related to an escalating international fragmentation of many manufacturing processes.

A substantial share of exports from China's high-technology industries come from companies that are foreign-owned or are joint ventures with Chinese partners, where assembly operations are of a significant magnitude in order to take advantage of low labour costs. Between Korea and China there is an increase in the trade of parts, which clearly indicates a growing division of production processes and growth of production networks. Thus, it is quite possible that a loss of market in Japan or the US for companies from Korea and other nations is at least partly a displacement of exports that are now coming directly from affiliates in China.

Foreign investment in production facilities in China are done in order to gain access to the huge market, benefit from low cost labour or a combination of both. For example textiles and footwear industries had been major export industries in Korea until they lost comparative advantage in the 1980s because of high wage increases. With established international marketing networks many Korean firms were able to shift production to affiliates in China. Companies from Korea have in the past concentrated their investments in Shandong, Hebei and Liaoning all of which are close to China. The importance of closeness is further supported by the development of airlinks between Seoul and nearby Chinese cities

However, low labour costs in China have also been a significant factor for firms to invest in capital-intensive industries. This is explained by the progressively widespread practise of manufacturing based on intra-firm, inter-process structures which have become prevalent in the era of international fragmentation. The reason is that heavy industries contain a large number of sub-processes which can be separated and have very different

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<sup>40</sup> *ibid.*

requirements inputs of labour, capital and technology. Thus, China as a developing country has become a natural site for manufacturing parts in a process for advanced and heavy machinery that would previously have been totally integrated, thereby acquiring skills and technology by participating in the production process.

### **The Chinese Economic Area – CEA**

The Chinese Economic Area CEA has since the early 1990s become a concept now widely used by economic commentators, IMF and the World Bank. The concept refers to the economic integration of a geographic area, which encompasses China Mainland, Hong Kong, Macao and Taiwan. The economic exchanges between the two sides of the Taiwan Strait have been growing rapidly and have become a dynamic core of CEA. This agglomeration of economies has since the mid-1980s become a new agglomeration of industry, trade and finance although lacking intergovernmental coordination. CEA has substantial technology resources and an enormous manufacturing capability, marketing and service skills and extensive business networks. It also has very large foreign exchange reserves, an abundant supply of natural resources and an unparalleled market potential. This influential network is based on shared culture and language and in many cases the extensions of family and other ties.

Despite the lack of formal political relations between China and Taiwan, Taiwan has in a short period of time become the third largest external investor on the Mainland, next to Hong Kong and the US. There are several conditions, which determine continued development of Taiwan-China economic relations. First, high-tech industry is reaching a critical mass with high-level sophistication in many sectors, which is attracting new investment from high-tech companies in Taiwan. Second, the investment from Taiwan has shifted from neighbouring provinces like Fujian and Guangdong to Shanghai, which has become China's economic centre and the surrounding Yangtze River Delta. Third, investors from Taiwan are now focusing on a combination of labour-intensive and capital-intensive industries. Fourth, an increasing number of large companies from Taiwan are also investing in China. Fifth, the business community in Taiwan is exerting pressure on the government to force its policy of restricting investment into China and also lift its ban on the "three direct links"<sup>41</sup>.

The integration of CEA differs significantly from other regions such as EU and NAFTA, where integration has in a major way been shaped by political initiatives and intergovernmental coordination. The economic integration of Taiwan and China is an informal process with the following three characteristics. First, it has primarily been driven by the entrepreneurship and self-interest of businessmen and other actors, and politicians and grand designs have hardly played any role. The integration has been driven from below as the process has lacked inter-governmental coordination and has had to deal with prolonged mistrust and political hostility between the two sides.

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<sup>41</sup> Embedded into WTO is the assumption of free trade in goods and services and direct trade between all WTO members. After joining WTO China and Taiwan will have to establish direct trade relations, direct postal services and direct transport services by sea and air.

Second, there is no necessity for mutual recognition as a prior condition for cooperation. This has implied a tacit understanding on both sides that the other side has a de-facto administrative power over the territory under its jurisdiction.

Third, the economic integration of CEA has been greatly facilitated by mutually reinforcing comparative advantages, and shared culture and language. In sum, the informal integration between the two sides seems to have gained its own momentum despite the lack of intergovernmental cooperation and coordination. However, such an informal integration is likely to encounter difficulties, which need to be resolved through government-to-government contacts through institutionalised channels of dialogue.

For Beijing, enhanced institutionalised dialogue and cooperation could facilitate an eventual peaceful reunification with Taiwan. An integrated economy within a well-institutionalised structure might be the best guarantee of a successful reunification. Intertwined economic and non-economic cooperation is more likely to create a vested interest in Beijing to peacefully resolve disputes in order to ensure continued prosperity, and could lessen the nationalistic outlook on both sides.

### **Taiwan-China Technological Integration**

A network of global industrial and technological relations is today the conduit for an integration of human resources across the Taiwan Strait for which US relationships also play a very important role. Networks of IT industries connect high-tech centres in Taiwan, China and the US which constitute integral parts of global production networks (GPN). They have a control over cooperation and managing as division of labour in R&D, design, production and logistics. The division of labour in such networks is constantly undergoing changes as conditions in terms of costs and/or sophistication of production are becoming more favourable in one or another location. The networks are borderless and an essential ingredient in this process is skilled manpower which by its very nature has become highly mobile.

Globalization of the electronics industry over the past couple of decades has facilitated the interaction and cooperation between Taiwan and China despite a lack of political understanding and the result is a high-tech network in which capital, technology and human resources are flooding onto the Mainland. However, both Taiwan and China are facing a serious challenge from the attraction of high-calibre universities in the US and subsequent job opportunities in American companies. The result is that an outflow of some of the brightest students constitutes a potentially serious brain drain which could at some time in the future turn into a brain gain. In the 1999-2000 academic year China's students made up more than 10 per cent of all international enrolment in US universities<sup>42</sup>.

With manufacturing moving to China Mainland, Taiwan is increasingly transformed from a production base to a knowledge center. This meets the expectations of the global IT companies because they believe they can design and develop products faster and at lower

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<sup>42</sup> Leng, Tse-Kang, Economic Globalization and IT talent Flows Across the Taiwan Strait: The Taipei/Shanghai/Silicon Valley Triangle, Asian Survey, Vol. 42 No. 2 (March/April 2002), pp 230/250

cost by setting up R&D bases in Taiwan and partnering with local companies with experience in production technologies

Taiwan, based on its strength in design, development and distribution, has become the IT hub for the network of foreign production bases in China.<sup>43</sup> Taiwanese IT firms are relatively unknown because their core business is producing notebook personal computers on an OEM basis. But in terms of production volume they hold 65% of the world market. Last year, they made two-thirds of their computers in China, increasing the ratio of production there by a factor of 13 over the 2001 level. While their Chinese operations produce goods at low cost, the Taiwanese parent firms handle design, development, parts purchasing and distribution. The main beneficiaries of this division of labor are IT companies in Japan and the U.S. Taiwan worried about deindustrialization when its plants first moved to China, but soon found its niche as a design and IT distribution hub connecting Chinese production bases. Quanta in Taiwan is setting up a 7,000-strong R&D team in northern Taiwan, scheduled to start work in 2005. Taiwan will likely continue to produce core electronic parts and be the IT hub.

Drastic changes have taken place in Taiwan's trade structure. Exports to China have grown bigger than exports to the U.S. and are still increasing, above all for goods like liquid-crystal display panels and other electronic components<sup>44</sup>. Simultaneously China has become a major exporter of goods to the U.S., but it depends on Taiwan and other nations in the region for parts and materials. A horizontal industry structure has been created in the IT sector, and affects not only Taiwan but the entire East Asia region, including South Korea and Japan. Increasing demand from the U.S. for finished goods is the engine to growth of China's assembly industries, and they in turn have increased their demand for imported parts and materials.

Since the early 2000s the IT industry in China has developed by leaps and bounds which covers basically all sectors and stages of the industry although still in major way dominated by foreign companies<sup>45</sup>. In the process a strong symbiotic relationship has developed between the IT industries in Taiwan and China. Although the rapport was initially focused on assembly operations it now involves Taiwan companies establishing advanced production facilities for semiconductors.

To understand the evolving relations between Taiwan and China in the IT sector to is essential to understand the character of the global semiconductor industry which consists of three distinct sectors. First, central processor units (CPUs) make up the largest segment with more than 40 per cent of a global production value of around US\$200 billion. This segment is highly design-intensive as well as capital-intensive. Intel is the absolute leader in this segment. Second, the next largest

<sup>43</sup> ANALYSIS: Taiwan's IT Hub Status May Help Improve China Relations, The Nikkei Business Daily, May 20 2004 (Nikkei Interactive)

<sup>44</sup> Murayama, Hiroshi, Taiwan atop East Asia trade triangle, March 15 (Nikkei Interactive)

<sup>45</sup> An insightful presentation has been prepared by Naughton, Barry, The Information Technology Industry and Economic Interactions between China and Taiwan, conference paper to appear as chapter in volume edited by Mengin, Françoise, China in the Age of Information, Palgrave MacMillan 2004

sector is made up of memories where DRAM dominates. This sector constitutes roughly 30 per cent of global production of semiconductors. Samsung is the absolute leader in this segment which is highly capital-intensive but less design-intensive.

Third, application-specific integrated circuits (ASICs) constitute little less than 30 per cent of semiconductor global production. This segment is highly design-intensive. The production of ASICs can be separated in two distinct stages – the design and the manufacture which need only to be loosely coupled. Thus it is actually possible to see a parallel in publication of journals where the editorial offices are responsible for all design and can freely choose the printing companies. Similarly the design of ASICs is done by software companies (like editorial offices) which can choose freely from different IC-fabs where they can have their designs printed into silicon.

China today has only a limited interest and possibility to enter into the first two segments as they require huge investments where the Chinese banking system may have difficulty to bankroll such extensive projects. Furthermore, there exists hardly any industrial group in China that has the acumen of Intel and Samsung. However, there was at one time a Chinese industrial group wanted to acquire the ailing Hynix Electronics Company in Korea, although only a minor deal was accomplished with the acquisition of Hynix flat screen division by a Beijing-based company.

China is actively pursuing a sophisticated strategy in its development of ASICs where Taiwan have highly development manufacturing competence in a number of companies that are now setting of IC production plants on the Mainland. The dynamic development of the electronics industry in China has fuelled the major changes in its software industry and IC design capability. Thus, the superiority of Taiwan in supporting China's electronic industry with advanced software and IC design is now being gradually eroded – at a time when ASIC manufacturing capability is being transferred to the Mainland.

Furthermore, a substantial number of Taiwan-based IT firms have already give R&D mandates to their subsidiaries in China. A recent survey<sup>46</sup> suggests that these relations include five different types of having R&D performed in China. First, engineering and manufacturing-related R&D is undertaken in China for products where production lines are concentrated on the Mainland, with major product development maintained in Taiwan. Second, many IT companies outsource their software development to China. Third, Taiwanese companies have started collaboration with universities and research institutes to perform basic research, Fourth, there is also a shift towards China of R&D activities for mature products while core development for new products is maintained in Taiwan. Fifth, some firms have relocated system R&D to the Mainland for products where final product consists of several modules.

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<sup>46</sup> Chen, Shin-Horng, Taiwanese IT firms' offshore R&D in China and the connection with the global innovation network, *Research Policy*, 33 (2004), pp 227-349

Taiwan's IT companies have in recent years concentrated their investment in the Yangze River Delta region with a strong agglomeration in Shanghai. Tentative conclusions suggest that this flow of investment is become both more capital-intensive and more technology-intensive, with 40 per cent Taiwan's FDI in China going into the electronics and electrical appliances industry<sup>47</sup>. Locating R&D in China has been prompted by an increasing demand of R&D personnel with their higher costs in Taiwan, and the increasing availability of R&D personnel on the Mainland at considerably lower costs.

Taiwan during the 1990s ceded its low-technology and labor-intensive IT industries to China while keeping a comparative advantage in high-technology manufacturing. A recent study suggests that this advantage may not be lasting, and Barry Naughton provides the following comments<sup>48</sup>. "The comparative advantage can be transferred to the Mainland, and Taiwan companies have in fact developed a high stake in the emerging mainland industry, currently concentrated in Guangdong and the Shanghai region. This means that as expertise develops in Shanghai and Beijing, Taiwan's share of the business may not necessarily decline. Instead, Taiwan could be pulled into increasingly close involvement with mainland industries. This will have significant implications for economics, politics, and the development of new information technologies."

### **The Future of Regional Innovation Systems in China**

Industrialization leads to concentration. However, intelligent and learning regions develop outside early industrialization concentrations, which happened both in Europe and the US. The primary industrial concentration in Europe has in recent decades undergone major changes and new technology and knowledge centers have emerged in new locations.

The dimension of regional concentration with respect to population, higher education, research-intensive industry, small and medium enterprises, and diversified services are important factors to generate regional development. This alters the conditions for traditional industries and also demands new roles to be played by universities and other learning institutions.

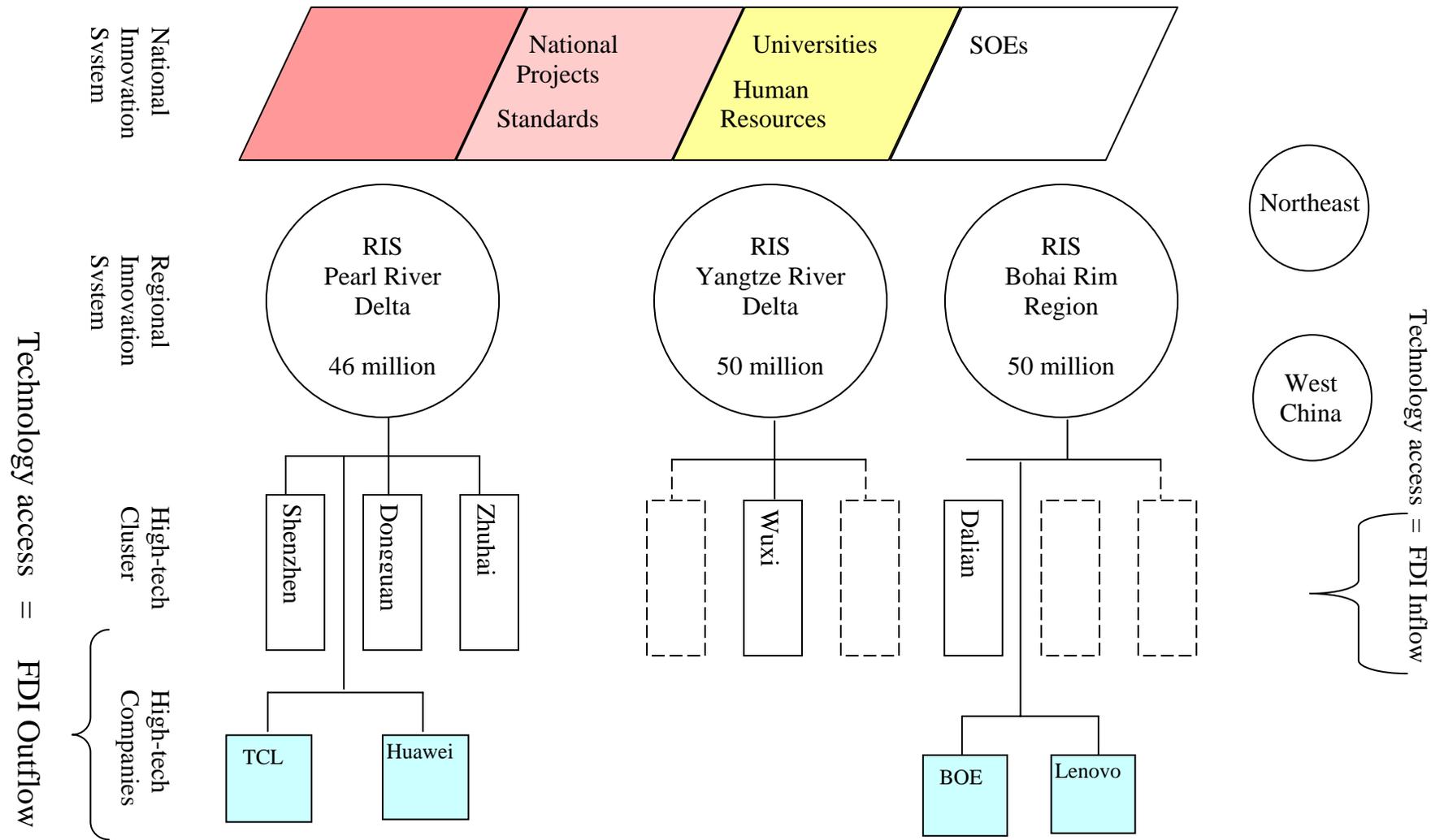
Planners and policy makers in all countries are today eager to promote regional development. In both Europe and North America we can observe a development pattern that shows increased concentration of knowledge, capital and people. In recent decades similar changes have taken place in China, although still on a much more modest scale. The following provides a crude presentation of various important actors and factors in China's regional innovation systems. See figure.

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<sup>47</sup> *ibid.*

<sup>48</sup> Naughton, Barry, *The Information Technology Industry and Economic Interactions between China and Taiwan*, conference paper to appear as chapter in volume edited by Mengin, Françoise, *China in the Age of Information*, Palgrave MacMillan 2004

# INNOVATION SYSTEM STRUCTURE IN CHINA 2004



It is obvious that the modern-age society is creating a very unequal distribution in the geographical space of a country or a region. Apparently relatively small territories – cities and their close surroundings – are becoming the key production areas in an emerging knowledge economy. This also means that there is a shift away from the national perspective to the regional perspective in understanding the welfare of a nation.

Looking back into earlier stages of industrial development it is important to understand that industrial plants as such are no longer in focus. It is rather the enabling structures and information flows that determines the efficiency of a system. Thus, knowledge flows and linkages have become key elements in knowledge-based production. The following characteristics define production of advanced knowledge today.

1. Rise in the number of locations and environments where new knowledge can be generated. The traditional universities and colleges are increasingly complemented by centers or research and knowledge institutes, as growing share of new knowledge is being generated in corporate laboratories. Basically all organizations, both public organizations and private companies, are progressively using highly trained experts and consultants.
2. Locations and environments are connected through well-functioning communication networks, which are electronic, organizational as well as social.
3. Knowledge becomes increasingly differentiated to suit various needs and conditions. Traditional specialties are redefined and combined into new knowledge areas, which indicates a move away from traditional disciplines.

In the light of these changes it is occasionally argued that the modern state today might be vulnerable because it is too small or too big. Certain states are too small to incorporate all networks and linkages that are required for successful development of domestic industry and research. This profound change reflects the disappearing territorial symmetry between industrial, scientific and political interests. Fully developed democracy requires trust and commonality, which can only exist in tight social networks.

Viewing China's extraordinary rapid economic development many observers have emphasized that China remains a fragmented federal system, although unified by a single political party<sup>49</sup>. A corollary is that domestic companies are not able to fully exploit the huge Chinese market as they are too reliant of local structures and local officials. This drastically reduces their capability to develop unique and proprietary technologies, which has the following two consequences. First, by allowing major inflow of foreign direct investment China's high-tech exports are dominated by foreign companies. Second, their Chinese counterparts are highly dependent on designs crucial components and manufacturing equipment that is imported in major quantities. Thus, it has recently been argued that China "has joined the global economy on terms that reinforce its dependence

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<sup>49</sup> See for example Gilboy, George J. The Myth Behind China's Miracle, Foreign Affairs, July/August 2004

on foreign technology and investment and restrict its ability to become an industrial and technological threat to advanced industrial democracies<sup>50</sup>.

China needs to continue its reform of economic and political structures and considerably improve its corporate governance in order to fully reap its fruits of modernization. Today the car industry provides an example of such changes where until recently a foreign company – Volkswagen – was the dominant car manufacturer with some 50 per cent of the market. Until recently the local manufacturers, often in partnerships with foreign makers, were scattered all over the country. Their scale of production was small and they were dependent on foreign technology a situation that has gradually changed as more and more foreign component makers have been lured to set up shop in China.

Let us look at the relation between territory and networks by considering three important characteristics social and cultural networks, physical networks and institutional networks. A territory is perceived as an interconnected part of the globe while networks relate to individual geographical point by their ability to link those points (nodes) into a structure that has economic, social and other functions.

Social and cultural networks are connecting individuals, which are the smallest units in a nodal network. These networks are essential for transmitting new ideas and approaches and exist, in ways that are similar to nervous systems, in all social life.

## **Social and Cultural Networks**

**Physical networks** include structures such roads, railways, electricity and telecommunication lines which provide the means for transportation of materials, people and messages. The character of physical networks becomes obvious when comparing networks, which have sparse nodes such air communications with road networks where nodes are more amply distributed. Cities are often major nodal points for physical networks.

**Institutional networks** are connecting units and structures that are involved in all types of societal activities – whether they produce goods, are responsible for administration or other services. There is important distinction between internal and external institutional networks. The former exists only with a preferred organization and facilitates control of internal flows of resources, and can be both hierarchical and flat. The external institutional networks link various environments that exist in different organizations. Given the dominance of networks it is increasingly argued that a networked society is taking shape in our new world.

China's regional development that can presently be observed poses one very important question that can only be tentatively answered. Does the fragmented and federated nature

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<sup>50</sup> *ibid.*

of China's economy delay the restructuring of the corporate sector and makes it more dependent on foreign technology?

In 1949 the population in China's cities and towns had only reached 57 million or 10.6 per cent of the country's total population. This is actually three percentage points lower than the world average level of urbanization in 1900. Since 1949 the urbanization process has passed through four stages.

1. The first stage was characterized by the rehabilitation of the economy and the construction of a number of large industrial projects. Some cities expanded during this period that ended in 1957, with urbanization level of 15.4 per cent.
2. During a second stage, from 1958 to 1966 the economy experienced great fluctuations, which directly affected the level of urbanization. Initially, during the Great Leap Forward moved into the cities and the urbanization level reached 19.7 per cent before a reversal took place – to be slightly modified before the Cultural Revolution started.
3. The third stage covered the period from 1966-1978, which almost brought economic development to a standstill. In order to reduce the pressure on cities a large number of young students, cadres and intellectuals were transferred to the countryside and urbanization remained at a low level.
4. The fourth stage, since 1978, has seen a stable and rapid economic development with a gradual transformation of the planned economy system. A number of new cities were established and urbanization level reached some 30 per cent. See table.

Table  
Urbanization level in China, 1949-1998

	1949	1957	1965	1978	1984	1990	1994	1998
Urbanization (%)	10.6	15.4	18.0	17.9	23.0	26.4	28.6	30.4

Source: Liu, He, Qin, Hai and Yu, Shiyang, Urbanization in China: History Retrospection and Policy Choosing, Paper presented at *Reforming China's Economy—Data Analysis and a Quantitative Assessment* Conference, Beijing 9-10 May 2000 International Statistical Information Centre of NBS China and the Stockholm School of Economics

Considering that there is direct correlation between level of economic development and urbanisation it has been calculated that the level of urbanisation should have reached 40 per cent in 1996. The existing gap is primarily due to the fact that the natural connection between industrialisation and urbanisation has been severed on many occasions, as indicated above. The highly centralised planned economy relied on administrative directives and basically all economic activities were organised in strict plans. This actually enabled industrial development without the services and infrastructure that exists in a market economy, and the expansion of service industry was severely contained. It should also be observed that the delayed urbanisation made it possible to allocate more investment to industrialisation as such.

Furthermore, the residence control system that started in 1958, was able to secure a separation of the cities from the rural areas. Thus, the expansion of urban areas only relied on the natural growth of the urban population. The priority in economic development for a long period of time remained in fostering heavy industry while at the

same ignoring the service industry. As a consequence, the efficiency of industrial investment was far below then optimal level due to lacking services that also had created greater flexibility in industrial production. In sum urban centres were not able to provide its full contribution to industrial and economic growth.

The existing industrial structure poses two serious problems – both within town and village enterprises and within the large state-owned enterprises. The former have allowed surplus rural labour force to become employed in industrial development, which also played an important role in increasing peasant incomes. However, this dispersed industrialisation, today involving more than 100 million rural people, suffers from a number of shortcomings. One serious problem is the small-scale operations of many types of industries that actually require economies of scale. The other is the lacking linkages to needed services that could improve the efficiency of rural enterprises.

An equally serious problem lies in the still existing “kombinat” character of many state-owned enterprises. In many cases they still maintain service functions and provide infrastructure facilities that could more efficiently be provided by separate entities. Thus corporate governance is a major policy issue. This problem has partly been solved through combining state-owned enterprises into a substantial number of large group companies, while at the same time shedding many of their peripheral activities like printing, transportation and canteen facilities.

## Education and Innovation in the Regions

From various Chinese statistics it becomes apparent that a relatively small number of locations control un-proportionally large shares of resources which are critical for further economic development. The three cities Beijing, Tianjin and Shanghai together with the Jiangsu province in 2002 provide approximately 15 per cent on the national enrolment into institutions of higher learning. Their share for enrolment in specialized secondary schools was equally large, although their population constitutes only little more than 5 per cent of the country’s population. See table.

Table  
Enrollment of Institutions of Higher Education and Specialized Secondary Schools by Region (2002)

	Institutions of Higher Education			Specialized Secondary Schools		
	Number of Graduates	New Student Enrollment	Student Enrollment	Number of Graduates	New Students	Student Enrollment
<b>National Total</b>	<b>1337309</b>	<b>3204976</b>	<b>9033631</b>	<b>1441539</b>	<b>1553062</b>	<b>4563511</b>
Beijing	67958	127597	395713	31645	32893	113870
Tianjin	27295	69453	196892	26397	20743	74690
Shanghai	55198	109184	331649	29418	39331	126883
Jiangsu	104079	222880	700210	117444	160058	451377

A similar pattern appears when examining the geographical location of patent activity. The two cities of Beijing and Shanghai together with the three provinces of Jiangsu, Zhejiang and Guangdong are responsible for almost 50 per cent of patent applications as well as granted patents, although populations share is less than 15 per cent.

Table  
Three Types of Patent Applications Examined and Granted by Region (2002)

	Number of Patents Applications Examined	Inventions	Utility Models	Designs	Number of Patent Applications Granted	Inventions	Utility Models	Designs
<b>National Total</b>	<b>205544</b>	<b>39806</b>	<b>92166</b>	<b>73572</b>	<b>112103</b>	<b>5868</b>	<b>57092</b>	<b>49143</b>
Beijing	13842	5785	5920	2137	6345	1061	3721	1563
Shanghai	19970	3968	4952	11050	6695	341	2805	3549
Jiangsu	13075	1940	7002	4133	7595	334	4304	2957
Zhejiang	17265	1843	6390	9032	10479	188	3860	6431
Guangdong	34352	3819	9972	20561	22761	352	6395	16014

## Conclusions

There are several likely effects of China's extremely rapid development of coastal areas which are the most advanced regions in the country. First, China will in the future have a number of mega-cities located in its coastal areas where vigorous industrialization started and they will not only remain centres of continued development but also constitute captivating magnets for people and activities from the inland. Second, partly as a consequence people who are now referred to floaters will become residents in coastal areas and will be joined by many more from the inland. Third, also as a consequence a substantial shift of China's population will take place away from the inland. Thus, the emerging industrial and economic structure in the inland provinces is more difficult to predict. However, it is not unlikely that the economic and industrial structures of the three major coastal regions – Pearl River Delta, Yangtze River Delta, and Bo Hai Rim – will eventually evolve along different lines, linked strongly to the global economy. There is apparent competition among them. The question is whether this will fuel efficiency and faster development.

The Minister of MOST has argued strongly that domestic firms should step up their innovations to earn advantages of intellectual property, while integrating themselves with advanced technologies and overseas capital. He has also called on domestic high-tech firms to intensify the integration of financing and science and technology, and to improve

the environment of investment and financing. "For this purpose we should set up multiple capital markets, encourage the development of venture investment, and make it a means to drive the industrialization of high technology," Xu has said.<sup>51</sup> China has set up high-tech parks in Britain and the United States with the purpose of playing an active role in giving Chinese enterprises experience of developed countries to promote their high-tech products in world markets<sup>52</sup>.

The initial success of regional innovation systems along the coastal areas of China is based on having created favorable conditions for a large number of clusters coming into being. Many of them, possibly most of them, are clusters that require functional proximity for which FDI has offered great possibilities by linking local clusters into Global Production Networks. This special characteristic poses immense challenges in bringing a similar approach in the Western parts of China and making it successful there. This further challenges politicians and policy makers in the already successful coastal areas to provide the necessary conditions for transforming operational clusters into technological clusters.

Given the diversity and size of China it is not surprising that a regional development policy framework has rapidly evolved. The planners have seen the creation of development zones and parks as one of their major objectives. The result has been that there existed in 2004 6,741 development zones of various kinds in the country<sup>53</sup>. The number of diverse programs, each one usually having a distinct focus, may occasionally have squandered scarce resources in the huge number of industrial development zones, high-tech development zones, science parks, incubator structures to serve industry and universities<sup>54</sup>. They are supported and financed both by the central government and by the localities, with varying concepts and objectives to develop regional economies. This has provided an infrastructure to innovate, discover and manage knowledge and contributes to its transfer where needed. Knowledge creation and its efficient use is a central issue with a focus on acquisition of knowledge, innovation and management of brainpower.

The ability of accepting and employing new ideas is a determining factor in success and competition for resources will under many circumstances be contributing to improving efficiency. The role of universities and other institutions of higher or specialized training

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<sup>51</sup> XIAO CAO, Plugging into high-tech, China Daily. September 20 2003

<sup>52</sup> CUI NING, High-tech industries become new money-spinners, China Daily, September 17 2003  
2003-09-17 07:46:39

<sup>53</sup> Qin, Chuan, Illegal land development zones cut, China Daily, July 26 2004

<sup>54</sup> Soufun.com Academy, the research department of China's largest property portal, will soon release its recent research on the competitiveness of China's development zones. The research was conducted in early 2004 by Soufun.com Academy, the Real Estate Institute of Tsinghua University and the Institute of Enterprises under the Development Research Centre of the State Council (DRCSC). The study covered 53 State-level high-tech development zones and 54 economic and technological development zones. The report was to be released during the China Development Zone Competitiveness Forum, planned for June 10-12 in Beijing's Diaoyutai Guest House Hotel. Source: (China Business Weekly)Development zone research to be released, May 24 2004

have taken on an increasingly important role. When embedded in local partnership they will serve industrial development and further technological upgrading.

The explosive growth of development zones and parks has also created a number of serious problems. One is the indiscriminate use of land which has recently led to strong countermeasures. Thus, the central government in April 2004 announced serious control measures on land to be used for development zones and parks. The Ministry of Land Resources reported that the government had suspended the establishment of new economic development zones and invalidated 3,763 of the total 6,015 already-built economic development zones in 2003, a remarkable progress made in the country's land market regulation work<sup>55</sup>.

There are great differences between the three major regions and also a number of important and striking similarities. Shanghai is dominated by state-owned companies and government agencies and has in recent years seen a great influx of companies from Taiwan.

The private sector completely dominates in Shenzhen, a fact that owes very much to its very close relations with neighboring Hong Kong. IT dominates in Shenzhen's high technology with 91 per cent trailed by new materials with 4.2 and biotechnology with a paltry 1.4 per cent. Attention is given to optical, space, ocean and new energy technologies. Although industry plays a dominant role in Shenzhen it constitutes only 39% of the economy with only one per cent for agriculture and 50 per cent in services, where financial services play a very important role. While undergoing structural changes Shenzhen will continuously update its IT industry, support for development of new materials and biotechnology. Special attention will be given to a future semi-conductor park, thus challenging the dominance of Shanghai in this field.

The Bo Hai Rim region that covers parts of Hebei Shandong and Liaoning provinces has good physical infrastructure which includes good transportation and telecommunications and easy access to ports and airports. Tianjin and other cities in the region provide an almost unlimited supply of low-cost labor and is well endowed with universities, colleges, and research institutes.

The success of regional innovation systems in China has its roots in the following three factors. First, the central government has strongly support the regions by providing a framework and resources for the various types of zones, industrial parks, science parks and incubators where national science and technology programs have often been involved. Second, foreign direct investment and the increasingly closer industrial and technological links with the neighboring countries have given strong impetus to regional development through technology transfer, management skills and extensive links to global markets. Third, the directed but also spontaneous development of technological and industrial

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<sup>55</sup> Xinhua, 3,763 economic development zones canceled, April 10 2004

clusters has provided the bases for further development. The justification comes from the following.

Successful and innovative firms are seldom alone, and networking and clustering has become more important in recent years as the character of competition in market-based innovation systems has undergone fundamental changes. The approach to clusters has changed from direct intervention to indirect stimulus for which supporting infrastructure remains important, and many clusters are now increasingly market-led. An early narrow sectoral approach has been replaced by support for knowledge flows within wide production networks.

**HighTech Parks in China**

Location	Year	Province	Region	Size
1. Zhongguancun	1988	Beijing	East	
2. Tianjin	1991	Tianjin	East PHR	
3. Shanghai	1991	Shanghai	East YRD	
4. Shenyang	1991	Liaoning	East PHR	
5. Dalian	1991	Lianing	East PHR	
6. Shihjiazhuang	1991	Hebei	East	
7. Jinan	1991	Shandong	East PHR	
8. Weihai	1991	Shandong	East PHR	
9. Nanjing	1991	Jiangsu	East YRP	
10. Hangzhou	1991	Zhejiang	East YRP	
11. Guangzhou	1991	Guangdong	East PRD	
12. Zhongshan	1991	Guangdong	East PRD	
13. Shenzhen	1991	Guangdong	East PRD	
14. Fuzhou	1991	Fujian	East	
15. Xiamen	1991	Fujian	East	
16. Guilin	1991	Guanxi	East	
17. Hainan	1991	Hainan	East	
18. Harbin	1991	Heilongqiang	Middle	
19. Changchun	1991	Jilin	Middle	
20. Zhengzhou	1991	Henan	Middle	
21. Changsha	1991	Hunan	Middle	
22. Hefei	1991	Anhui	Middle	
23. Xian	1991	Shanxi	West	
24. Chongqing	1991	Chongqing	West	
25. Chengdu	1991	Sichuan	West	
26. Anshan	1993	Liaoning	East PHR	
27. Baoding	1993	Hebei	East	
28. Qingdao	1993	Shandong	East PHR	
29. Weifang	1993	Shandong	East PHR	
30. Zibo	1993	Shandong	East PHR	
31. Suzhou	1993	Jiangsu	East YRD	
32. Wuxi	1993	Jiangsu	East YRD	
33. Changzhou	1993	Jiangsu	East PRD	
34. Foshan	1993	Guangdong	East PRD	
35. Huizhou	1993	Guangdong	East PRD	
36. Zhuhai	1993	Guangdong	East PRD	
37. Nanning	1993	Guanxi	East	
38. Daqing	1993	Heilongqiang	Middle	
39. Jilin	1993	Jilin	Middle	
40. Baotou	1993	Neimenggu	Middle	
41. Taiyuan	1993	Shanxi	Middle	
42. Luoyang	1993	Henan	Middle	
43. Wuhan Donghu	1993	Hubei	Middle	
44. Xiangfan	1993	Hubei	Middle	
45. Zhuzhou	1993	Hunan	Middle	
46. Nanchang	1993	Jiangxi	Middle	
47. Baoji	1993	Shananxi	West	
48. Lanzhou	1993	Gansu	West	
49. Urumqqi	1993	Xinjiang	West	
50. Mianyang	1993	Sichuan	West	
51. Kunming	1993	Yuannan	West	
52. Guiyang	1993	Guizhou	West	
53. Yangling	1997	Shaanxi		Agriculture

Source: Cong, Cao, China's High-Tech Parks in Transition, EAI Background Brief No. 153, April 24 2003

The term research park generally refers to a concentration of activities, which are carried out in the facilities of universities, public institutions and private company laboratories.