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SOME KEY FACTORS IN CHINA'S REMARKABLE RISE IN THE TECHNOLOGIES OF INFORMATION

I will touch on four topics today: One is the leading center of high tech companies in China, Zhongguancun Science Park. Second is the importance of international linkages in China's high tech rise. Third is the importance of domestic value-added in understanding the economic significance of China's export numbers. Fourth, is some indicators of the rise of science.

ZHONGGUANCUN SCIENCE PARK (ZGC for short). This park is located northwest of the center of Beijing, has the largest concentration of high tech companies in China. It had 12,000 of them in 2002 with over 400,000 workers and revenues of $29 billion. Sixty-four percent were in the information technology (IT) industry with the rest in advanced manufacturing, bio-medical, materials, and energy sectors. An understanding of its history and present status helps us to understand how China has made giant strides in high technology industries.

Its high tech strategy has been to train many technologists, to help scientists and engineers in research institutes and universities form companies, to make state-owned one more market-focused, and to encourage foreign firms to bring technologies via direct investments. Taiwanese companies and foreign MNCs are responsible for a large proportion of China's IT exports. Large investments in telecommunications have been a core part of the strategy. The ZGC cluster in Beijing has made a remarkable transition from a set of government research institutes, state companies, and universities in a non-market system to a more dynamic, market-driven place with many new companies.

Shortly after China's reform movement started, in 1980, a researcher, Chen Chunxian, left the nuclear laboratory of the Academy of Sciences to set up the first privately funded research and technology institute in Beijing. He was followed by other entrepreneurial scientists and technicians. According to Adam Segal (in *Digital Dragon; High Technology Enterprises in China*), from 1950 to 1978 the Chinese Academy of Sciences "which owned the all the technology … in all that time did not sell one product. Since the reforms, 40,000 products have been passed to companies and have been put on the market."

By the end of 1987, the Academy had spun out several dozen hi-tech enterprises, including the computer companies Legend (now called the Lenovo Group) and China Daheng Information Technology. Most were PC-related. By the end of 1987, hundreds of enterprises were crowded along a ten-kilometer long street called Zhongguancun Electronics Street.

During this period, Tsinghua University and Peking University also established their own hi-tech enterprises. There were two main motives: one was to supplement low salaries and enable them to keep the best people; the other was to move technology from laboratories to the market. University-funded enterprises have played an important role in Zhongguancun's development.

In 1988, the Beijing Experimental Zone for Development of High and New Technological Industries was set up with the power to try new rules and institutions on a small scale before moving them nationwide. It became known as the Zhongguancun Science Park. It was small, with only 10,000 workers in 1989, but about to take off. Waves of start-ups in ZGC coincided with, and depended on, the rapid growth of China's IT industry. The domestic market was greatly aided by large government investments in telecommunications while paralleling this was China's rapidly growing participation in the global IT market. Essential to this strategy has been an openness to foreign goods and direct investments.

At the beginning the region had important assets and daunting liabilities. The main assets were many scientific and academic institutions, a well-educated and talented group of scientists, and a willingness to experiment, and supportive governments, both at the national level and locally. The liabilities, also substantial, included poorly defined laws, including those for intellectual property rights, an array of state-owned companies, bureaucrats micro-managing state-owned enterprises, weak managerial skills, isolation from world markets, and an underdeveloped financial system, especially for risk capital.

Essential to the successes that followed were networks of relations that connected families, the new entrepreneurs, the institutes from which they had come, universities, local governments, and national ministries. The institutes supported their spun-off entrepreneurs in several ways, including financially; local officials for the most part worked to reduce regulations, arranged for finance usually in the form of loans, and did not interfere excessively in the inner workings of enterprises; universities set up enterprises and maintained close ties to their graduates; and national ministries kept research money flowing to institutes and universities.

From 1988 to 2002, the number of its companies grew from 527 to over 12,000 (of which perhaps 4,000 are not really viable) with total employment going from 10,000 to 420,000. In 2002, fifty-five of these companies were listed on an exchange and thirty-three had sales of over US $12 million per year. ZGC firms have 40 percent of the market for software applications and 50 percent of the PC hardware market. It has the No.1 Chinese portal, Sina.com, and the top online game firm in China, ourgame.com. It is the leading place in biotechnology, new medicines and new materials, but these industries are still small.

At the small end of company sizes, 4,300 had sales of less than $120,000. This is far from an equilibrium situation. For example, 82 percent of the 4,300 small companies lost money in 2002. The number of firms in ZGC is likely soon to shrink.

Today, China gets most of its technology from overseas with multinational companies as the main source. In ZGC, they account for 43 percent of the Park's total revenues and 78 percent of its exports. Actually, what is being transferred is not only technology in a narrow sense but also design techniques, know-how and managerial skills, including knowledge about how to solve problems and how technologies are related to each other. Investments made by multinationals are a kind of package that combines money, products, technology, talent, managerial skill and ideas. Many are establishing research centers; for example, Intel, Microsoft and Novozymes (a Danish enzyme company), have set up such centers there. China's poor protection of intellectual property discourages the transfer of advanced technologies but it has not prevented a large and sustained flow of direct investment by foreign firms.

Another major source of "capital" is the human kind embodied in returnees from overseas. It is remarkable that the total of 4,900 such people (3,500 since 1999) had started 1,800 companies in ZGC by 2002. In two years they had started two companies each working day on the average.

ZGC has both advantages from being in the capital city and disadvantages. On the advantages, there is a large flow of money from government ministries both directly for procurement and indirectly through support of institutes and universities and it benefits from the idea incorporated in the Beijing Experimental Technology Zone, "What is not forbidden by the law is not against the law." Two examples: one is that a venture capital limited partnership can be established; the other is that the scope of a business need not be clearly defined. On the disadvantages, from the vantage point of Silicon Valley – or Shanghai or Shenzhen – there are benefits in being far from the Emperor, whether he is seen as being in Washington or Beijing.

On ZGCs human resources, about half the work force has at least bachelors degrees. There are over 30 online job service web sites and 42 percent of workers find jobs through them. The job market is a classical free market one: employment at will by both the employee and the employer; those who don't measure up are dismissed, an especially effective measure in the early development stage when other enterprises had lifetime employment. Worker mobility is high; two-thirds of employees working for less than three years have changed jobs. (A rate this high may be dysfunctional.)

The ZGC system has changed. Tax advantages were reduced in 1993 and the Academy of Sciences ended its support for many successful firms in order to support new ones. Competition has been encouraged among domestic firms and has intensified with the arrival of foreign ones. Corporate forms were adopted with ownership being expressed though stock issuance, appointment of general managers and boards of directors.

Close university links to business are also under pressure to change. Universities and research institutes within ZGC run their own ventures, often holding 100 percent of their equity. Problems inherent in these connections have become evident. Legal unclarity in ownership makes it impossible to share it with other investors, a barrier to raising capital. Efforts are underway to clear up enterprise ownership, to enable university-founded enterprises to operate independently, and to set rules so that teaching, research and operation of university-founded enterprises can be mutually beneficial and not in conflict. This requires a separation of the teaching and research missions of universities from commercial activities that may be socially useful but that can detract from their core missions.

China’s financial system, especially for risk capital, remains underdeveloped. Despite the fact that the Beijing Municipal People’s Congress enacted the first local law allowing limited partnership venture capital firms, this organizational form has yet to be adopted and a mergers and acquisition market has yet to emerge. High tech companies are listed in Hong Kong or, ideally, on NASDAQ. (A recently established NASDAQ-like second board at the Shenzhen exchange might provide a domestic market listing for young firms in a few years.) In 2002, 21 ZGC startups received RMB 830 million (US $100 million) of venture investments. Foreign investors are still dominant; 12 local institutions supplied 29 percent and 7 foreign ones supplied 71 percent.

In little over 20 years ZGC has come a long way. It future depends on that of China, which faces challenges in building institutions, including those of law, finance and those for the creation of technology. Given its record, it will overcome them.

It is hard to miss the high proportion of scientific and technical papers published in the leading scientific and technical journals that have Chinese authors, many of them at American universities. Increasing numbers are returning home. This was a major source of talent for Taiwan in the 1980s and 1990s and now there is a growing flow back to China. They return not only with scientific and technical skills but also know-how on organizing and conducting research projects and building companies. It is remarkable that the total of 4,900 such returnees (3,500 since 1999) had started 1,800 companies in ZGC by 2002 and that by 2003, 4,300 returnees to Hsinchu had created 119 companies. Foreign nationalities constituted over one-fourth of Singapore’s professional IT manpower in 1995-97 and is likely to have increased since then.

Whether among Silicon Valley, Hsinchu, ZGC, or Bangalore, linkages have been critical. Some of these places have become hubs, such as Silicon Valley, linked through flows of goods, people, capital and technology into a global network.

INTERNATIONAL LINKAGES. The story of ZGC reveals many important foreign connections: People, direct investment, technology, markets. Martin Kenney and Kyonghee Han (in “The Venture Capital Industries in Five Asian Nations”) describe three types of people links between Silicon Valley and Asia. The first was the human linkage provided by Asian students who stayed in the United States and worked in Valley firms and elsewhere in the U.S. such as Bell Labs. They soon began launching their own start-ups while they kept close relationships with friends and families in Asia. Second was Asian students and seasoned managers who returned to their various nations, either joining the Asian operations of Silicon Valley firms or setting up companies that contracted with Silicon Valley ones. The third link was Asians trained at home who then joined the overseas operations of Silicon Valley firms. Each link was a conduit for information transfer and learning. The repeated interactions that occurred on many levels created awareness of what was occurring in Silicon Valley, not only in terms of the technical and managerial skills but also of its entrepreneurial character.

According to Marguerite Gong Hancock, Jen-Chang Chou and Ming Gu, a new and prominent international network example is the Semiconductor Manufacturing International Corporation (SMIC), a silicon foundry whose headquarters are in Shanghai. It has three fabs in Shanghai, one in Tianjin, and three being built in Beijing. Ninety percent of its output is exported. Almost all of its early management team were veterans of the semiconductor industry and had spent most of their professional careers in leading semiconductor companies worldwide before they joined SMIC. Chief Operating Officer Marco Mora, for example, had more than 18 years of management experience at STMicroelectronics N.V., Texas Instrument Italia S.p.A, Micron Technology Italia S.p.A and WSMC (a Taiwanese foundry). Of its 4,400 workers, 500 came from Taiwan, 300 from the U.S. and 200 from other places outside of China. Significantly, all but one of its initial management team started out in Shanghai.

Its funding was also global: from H&Q Asia Pacific, Walden International, New Enterprise Associates, Oak Investment Partners, Vertex, Goldman Sachs, and four Chinese state banks.

In short, it is hard to imagine anything like the present global IT industry without these many kinds of connections. In the present post-bubble era, it is common, almost a rule enforced by venture capitalists, that Silicon Valley startups establish a part of their operations from the outset in some place in Asia. Costs are lower and able people can be recruited.

PUTTING CHINA'S EXPORT NUMBERS IN PERSPECTIVE. The common practice of reporting gross revenues from exports can lead to a misinterpretation of their economic significance. Almost always missing in such reporting is the value created domestically associated with these exports. This is often modest. Thus, according to Wong Poh Kam, in Singapore, 25 percent of the value of its exports of disk drives in the mid-1990s was added domestically and, according to Chen, Cheng, Fung and Lau, China's domestic value added to its electronics and telecommunications exports to the U.S. in 1996 was about 20 percent. These numbers imply that for every dollar of exports, goods costing 75 cents or 80 cents had to be imported. So, if China exported, say, $50 billion of high tech products to the United States, it had to import around $40 billion of goods (although not necessarily from the U.S.) for that to be possible.

Doubtless, the value being added domestically in China to its high tech exports is growing but it is growing from a modest level.

SOME INDICATORS OF PROGRESS IN SCIENCE. There is a growing belief in scientific and technical circles worldwide that Asia, and especially China, will become not only a place for making things but also – perhaps soon – become a creator of technology. They have able, well-trained people, have or are developing needed institutions, and are connected to the world of ideas.

One indicator is the large and growing numbers of well-educated scientists and engineers. According to Diana Hicks, the number of PhD's granted in China from 1986-1999 increased by about 50 times (from 100-200 to over 7,000). Others are increased spending on research and development; the growth in scientific publications and in their quality measured by citations. Still another is the setting up by high tech foreign firms of R&D centers in China – about 200 in number. Today, these centers seem to be doing more "D" than "R" but that mix will surely shift towards doing more research.

China has great ambitions in science and technology and given its accomplishments they are likely to be realized – although the timing is uncertain. Between 1995 and 2000, its spending on R&D more than doubled. It was still only one percent of GDP but it was growing at ten percent a year and the government says it want to increase that share.[1]

[1] Kathleen Walsh, "Foreign High-Tech R&D in China: Risks, Rewards and Implications for U.S.-China Relations, The Henry L. Stimson Center, 2003.

According to Kathleen Walsh, by the year 2000 China ranked eighth in the world in scientific papers contributed by Chinese authors (three percent of the world total) compared with it being 15th in the world five years earlier. This is not to assert that China's capacities are up to those of the industrialized countries.   This will not likely happen soon but it is on the move.

The rise of China in innovativeness will have mixed impacts on others. The generation of new ideas can benefit everyone. It also gives their creator an advantage – as Silicon Valley has demonstrated. What should not be in doubt is that the U.S. and every else will face a large challenge coping with the rise of an innovative China.