Minying Enterprises and High-Technology Zones[1]

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Introduction

In *Science and Technology in Post-Mao China*, the 1989 volume that emerged from the last major international conference devoted to Chinese science and technology (S&T) development, nongovernmental technology enterprises (*minying keji qiye*) are mentioned only once. (Simon and Goldman 1989) A chapter on the utilization of scientific talent introduces the new phenomenon of scientists who establish S&T development centers or consulting companies. The Chinese Academy of Sciences is said to have over "100 technology development corporations" who have entered into joint ventures with both domestic and international companies. The chapter briefly mentions one enterprise, Huaxia Technology Development Center, speculating that as "long as the government not only tolerates but even encourages a market economy in science and technology, privately run S&T consulting and development companies will continue to function." (Orleans 1989)

Fifteen years after those words were written it is clear that *minying* enterprises have done more than simply continue to function. In 2002, there were over 100,000 nongovernmental enterprises in China, employing a staff of 6,444,300.[2] These enterprises had total income over RMB 1.84 trillion, profits of RMB 107.4 billion, and research and development (R&D) expenditures totaling RMB 48.47 billion. Growth has

been fastest in eastern China, but Shaanxi, Sichuan, and Chongqing in central China have also been leaders in nongovernmental growth. Two *minying* enterprises—Legend and Founder—produce 36% of the domestic personal computer market.[3] The CEO of Legend, Liu Chuanzhi, was pictured on the cover of the *Far Eastern Economic Review* in 2003 with the headline: "Meet China's Bill Gates."[4]

A similar story can be told about high-technology development zones. *Science and Technology in Post-Mao China* includes an in-depth discussion of China's interest in regional economies, "Silicon Valley fever," and technological clustering in the Caohejing district of Shanghai. (Rehn 1989) By 2002, the 28,338 enterprises in the 53 national-level technology development zones employed 3,490,000 and had revenues of RMB 1.53 trillion and net profits of RMB 80.11 billon.[5] High-technology zones have become critical institutional homes to *minying* firms, providing legal, regulatory, and financial support to growing enterprises as well as encouraging new sources of entrepreneurship. Enterprises with national and international reputations—like Legend—are located in and supported by the zones, and nongovernmental enterprises make up 80% of all enterprises within high-technology development zones. [6]

The rapid growth and success of both the high-technology zones and nongovernmental enterprises is the outcome of two major streams of the reform of the state S&T system during the 1980s and 1990s: decentralization and institutional innovation. Moving from a Soviet style, top-down, state-guided national innovation system to a more flexible, bottom-up, and market-oriented one, policymakers gradually devolved power over the organization of R&D and innovative activity down to lower-level actors, including municipal governments, universities and research institutes, and

scientists and other technically trained individuals. Parallel to this decentralization of authority, officials first allowed and then later encouraged the creation of new organizational and institutional forms in hope of ending the separation of technology R&D from industrial users. The first *minying* enterprises were "spun off" from the Chinese Academy of Sciences and other state research institutes, and high-technology zones were created to support and promote the establishment of new technology enterprises.

This decentralization and devolution created space for localities to experiment with different organizational structures and policy approaches. (Segal 2003) Under the broad umbrella of creating nongovernmental enterprises and building high-technology development zones, local officials implemented national policies in a manner in harmony with local conditions, but not necessarily consistent with the spirit of national policy. As a result, the development trajectories of *minying* enterprises and high-technology development zones in different localities have varied both in terms of institutional and organizational structures and technology outcomes.

Beijing, for example, has focused on a more diffuse form of development, linking small firms through personal networks and a "bottom-up" approach to zone development. As a result, Beijing led the country in software exports from 1996 to 2001 and the capital led in Internet start-ups as well. In contrast, officials in Shanghai worried less about "innovation networks" (*chuangxin wangluo*) and more about the large, state-owned, and municipally-controlled business groups (*jituan gongsi*). The six largest state-owned enterprise groups generated 87 percent of total output value in the IT sector in 2000.[7]

Shanghai has become the country's largest semiconductor producer, and leads in the manufacturing of IT machinery and hardware.

In most cases, regional decentralization aided policy innovation. Central policymakers could choose among existing policy experiments and use disparate regional outcomes to judge the ultimate feasibility of different policies. They could pick and choose among the best regional policies. But decentralization has also led to redundancy and harmful competition between regions.

Currently, nongovernmental enterprises and high-technology development zones stand at the center of the larger policy shifts that are likely to define the trajectory of the S&T system in the first decades of the twenty-first century. These include a greater reliance on enterprises for R&D and innovative behavior, and a focus on small- and medium-sized enterprises in particular; greater focus on software as well as hardware development; a continued shift from state-directed technology policy to more indirect innovation strategy; and tensions between globalization and a continued desire to create and support globally competitive Chinese firms.

At the same time, many of the challenges faced by *minying* enterprises and high-technology zones are reflective of some of the systematic weaknesses of the Chinese national innovation system, including the scarcity of capital, undefined and under-defined property rights, lack of managerial skills and shortages of trained S&T personnel, policy confusion, and continued state interference in technology markets. How China manages to resolve these problems will play a large role in determining the future trajectory of technological development.

The rest of this chapter explores the development of nongovernmental enterprises and high-technology development zones. The first part of the chapter gives a brief history of the development of these two organizational innovations. The second section concentrates on the shift to innovation strategy that occurred in the late 1990s. The next section looks at the continued challenges faced by *minying* enterprises and high-technology zones. The final and concluding section discusses the question of the relationship between economic development and political liberalization, and the increasing role of Taiwanese firms in Chinese technological development. It also addresses the challenges and opportunities presented by China's accession to the WTO and the continued globalization of R&D.

Minying Enterprises

At the beginning of the reform period in 1978, policy makers identified the separation of industrial research from industrial end users as one of the central weaknesses of China's S&T system. Reforms during the 1980s tried to build horizontal links between technology producers and users by a greater reliance on market structures as well as organizational restructuring. In particular, state S&T planners moved to merge R&D institutes with pre-existing enterprises, transform individual R&D institutions into manufacturing or engineering corporations with in-house research capabilities, and "spin-off" new non-governmental technology enterprises. (Gu 1999)

Although the first nongovernmental enterprise, Huaxia, was formed in 1980 by a research fellow from the Institute of Physics at the Chinese Academy of Sciences, the

political foundation for the growth of these enterprises was laid in a 1985 decision. The "Decision of the Central Committee of the Chinese Communist Party Concerning the Reform of the Science and Technology Management System" reformed the system of fund allocation and cut state budgets for research institutes, expanded technology markets, encouraged cooperation between research and production units, and increased the mobility of S&T personnel. (Saich 1989) The Decision encouraged universities and independent research institutes to launch their own commercial ventures as a way to compensate for reduced budgets. The Decision also reflected a growing realization among S&T policymakers that private firms were at the center of a new technology revolution that was just beginning in the West.

The State Science and Technology Commission took the lead in defining what types of firms would be considered "nongovernmental" and what types of technologies would be deemed "new" and "high". Nongovernmental firms received tax breaks as well as preferential support in the areas of import and export licensing, finance, pricing, and employment.

The Chinese Academy of Sciences (CAS) was the home of many of the most famous and successful enterprises during the 1980s.[8] New enterprises were "spun-off" CAS by entrepreneurial individuals, often with start-up capital provided by CAS. CAS typically made these enterprises loans that would be paid off once the company became commercially successful. In most instances these enterprises commercialized technologies originally developed in CAS institutes, set up offices in CAS buildings, and were staffed with CAS research personnel. Other enterprises were set up by individuals

from Beijing and Tsinghua universities, other state research institutes, and collective and state-owned enterprises (SOEs).

When these enterprises were first created, *minying* referred more to an organizational than to a property rights structure. In fact, nongovernmental firms have always spanned all the possible ownership types, including state-owned and collective. Chinese accounts of the *minying* were most clear that these enterprises were not private; "Our definition of nongovernmental is not equivalent to what they call 'private' in other countries. Our 'nongovernmental' has public ownership as the main part."[9] Nationally about 20% of all *minying* enterprises were state owned in 1997.[10] By the end of 2001, the percentage of state-owned nongovernmental firms had dropped to 6.3%; 12.5% was collectively owned, 24.2% was privately or individually owned, 48.3% had adopted a stock system of ownership, 5.35% was foreign owned, 1.2% was jointly managed, and 2.3% qualified as other.[11]

The defining elements of *minying* enterprises were that they were founded by individuals with technological backgrounds and were free from outside interference. Responsible for their own development, organization, financing, and all profits and losses, *minying* enterprises were not part of the plan and were free from government interference in personnel management.[12] While state and collective enterprises had administrative relations (*lishu guanxi*) with their supervisory agencies (*zhuguan bumen*), *minying* enterprises were not linked to bureaucratic superiors who had the presumptive right to intervene in an enterprise's business operations; nongovernmental enterprises had "none of the fetters of the administrative system."

Minying enterprises developed rapidly during the 1980s, especially in Beijing. Firms concentrated on Haidian district's Zhongguancun Avenue, which became known as "Electronics Avenue" (*dianzi tiao*). These firms benefited from "computer fever"—rising living standards and increased urban demand that sparked purchases of personal computers—as well as close ties to the education and science and technology ministries. At the same time, the Beijing local government and the central government paid increasing attention to the growth of these firms. Local officials institutionalized and reproduced a conception of technological development centered on independent and competitive *minying* enterprises. (Segal 2003)

Nongovernmental enterprises faced ideological scrutiny immediately after the Tiananmen tragedy in June of 1989 as part of a general attack on private property that occurred during the backlash against the student movement. The attacks did not last long, however. During his inspection tour of the South in 1992, Deng Xiaoping visited a number of high-tech enterprises, including several *minying* enterprises. At one, referring to the continued debate over whether *minying* were really part of the capitalist or socialist system, Deng reportedly exclaimed: "I do not want to continue this argument. From what I see here, nongovernmental are socialist."[13]

This ideologically supportive approach to *minying* enterprises was codified in a 1993 decision issued by the State Science and Technology Commission (which was renamed the Ministry of Science and Technology in 1998) and the Reform Commission: "Decision on Several Problems Facing the Enthusiastic Promotion of Nongovernmental Technology Enterprises."[14] The Decision placed nongovernmental enterprises in a larger political context, explaining that they were the desirable outcome of the reform process.

According to the Decision, nongovernmental enterprises had three main roles: 1) to introduce a new independent management style, based on scientific expertise and a responsibility for losses and gains to enterprises of all types of ownership structures, including SOEs; 2) to create a new innovation system based on enterprises that were "oriented toward the market;" and 3) to slowly change an S&T system dominated by public institutes to one that embraced organizations of various ownership structures. In addition, the Decision, by calling for more scientists to set up their own nongovernmental enterprises, for financial units to increase lending to *minying* enterprises, and for all actors to engage in property rights clarification, highlighted some of the continued difficulties faced by the sector.

Further policy support came with the 1995 "Decision on Accelerating S&T Development." While calling for the strengthening of government leadership in basic technology research, the Decision accepted that the development of applied technologies should be left to the market. Scientific research institutes were to have full autonomy in choosing R&D projects, and they should try to form joint ventures with domestic and foreign partners. Moreover, the Decision pointed out that non-state companies were an important force in the high-tech field and worthy of encouragement. This point implicitly revised the previous priority given to large state-owned enterprises, while also implicitly recognizing that policy up through 1995 had continued to favor large SOEs.

Despite the improved political and policy environment, nongovernmental enterprises would face new competition and challenges after 1993.[15] The government eliminated many of the tax breaks and tax holidays that sustained many of the first nongovernmental enterprises. The central government began to lift import quotas on

foreign personal computers and substantially reduced tariffs. Foreign enterprises like IBM, Microsoft, and Fujitsu arrived in China, set up research centers, and entered new market areas like Chinese language software that had been the exclusive domain of domestic producers, while attracting many of most talented scientists away from domestic enterprises with high salaries and opportunities to go abroad. In addition CAS ended support for many of the more established enterprises, shifting its focus and support to new ventures.

More established enterprises, especially in Beijing, faced an ever-growing array of competitors throughout China. (Table 1 about here) A key issue since the beginning stages of the reforms has been how to encourage and support individual entrepreneurship. The creation of the institutional space for non-governmental enterprises alone was not enough to encourage most scientists to set up their own enterprises. Individuals were reluctant to "jump into the sea" (xia hai)—to leave the security of their state-sector job and the social welfare benefits it provided. Moreover, as in other transitional economies, the ambiguous political protection provided to private or non-governmental property inhibited individual entrepreneurship.

Research on entrepreneurship in different countries has discovered a strong correlation between the economic and social characteristics of regions and rates of new enterprise formation. (Zapalska 2001) This has been the case in China too, as technology enterprise formation has been most robust in regions with a strong scientific base, active local government support, and a large supply of S&T personnel. But even if all these variables are present, local governments have played a key role in facilitating different types of entrepreneurs. For example, in Shanghai, entrepreneurs tended to be older

people who were at the end of their careers. In 1996, one third of all *minying* personnel in Shanghai were retired cadres. By contrast, entrepreneurs in Beijing had benefits and status to lose; only 5% of *minying* personnel in Beijing were retirees.[16] The remaining 95% either left the state sector before they reached retirement age or never entered it at all.

What explains nongovernmental growth and success?

As a separate category of firm ownership, *minying* growth in the early years was the result of several factors. First, the managers of new technology enterprises were said to be more responsive to market demand and technological change. (Gu 1999) Second, with their hybrid structure and undefined property rights, nongovernmental enterprises had access to technology and capital from both the state and the market. New firms had access to the technological capabilities that had been accumulating in the state R&D system for the first thirty years of the PRC, but had not been commercialized. Undefined property rights facilitated movement of goods into the market, at least in the early stages of development. Too strict a definition of property rights would have strangled innovation. As one journalist put it, "Knowing who owns something is not always the best. CAS from 1950 to 1978 owned all the technology, and in all that time did not sell one product. Since the reforms, 40,000 products have passed to companies, and they have put the products on the market."[17]

Third, *minying* enterprises were the first to develop new products. As Gu notes in her study of four technology zones, the majority of new enterprises—60 to 70%—

engaged in computer and information technology production. (Gu 1999) Stone dominated the Chinese word-processing market with the MS-2400 and subsequent generations of the same product, controlling over 80% of sales. Founder and Legend had significant technological leads on their competitors in Chinese language publishing software and character recognition processes respectively, and could rely on large incomes during the 1980s.

Moreover, nongovernmental enterprises entered market areas—software, bioengineering, and new materials—that were completely new and so lacked bureaucratic organs with sectoral authority. Once nongovernmental enterprises tried to enter market niches where ministries already had a strong presence, like photo-mechanical electronic integration, they faced strong competition from enterprises under the control of the Ministry of Mechanical Industry and the Ministry of Electronic Industry.[18]

Fourth, nongovernmental enterprises took advantage of direct foreign investment and trade relations with multinational corporations (MNCs). All the large enterprises had representative agreements with enterprises like IBM, Compaq, Apple, and Hewlett-Packard, and distribution agreements with MNCs provided *minying* enterprises with much needed investment capital.[19] Cooperation with foreign producers also allowed nongovernmental enterprises access to an already established global network of foreign partners to market their joint-venture products. Chinese enterprises also learned and adopted new management structures after working with foreign enterprises.

All four of these factors combined to create what Lu Qiwen has called a "top-down model of technological learning." (Lu 2000) Compared to other developing countries China's S&T base was relatively well developed. And unlike other countries in

East Asia, China did not have to rely solely on export markets; it could turn to the large domestic market, and the needs of Chinese language users allowed for the development of indigenous technologies. Institutional and organizational innovations in China's S&T system allowed China to move accumulated technological capabilities into new commercial enterprises.

More specifically, the success of individual firms is dependent on a number of entrepreneurial strategies, some specific to transitional economies. (Peng 2001) (Table 2 about here) Key for all successful nongovernmental firms has been finding the appropriate partners and building the right alliances. More likely than not, these are state agencies, powerful players who can help new firms to make sense of the complicated thicket of rules and regulations and may even help the firm land important contracts. These agencies also defend smaller firms from overzealous local officials who may be inclined to depend on technology enterprises for various "fees" or illegal taxes. At the same time, the state agency must not be predatory; it must allow the firm to choose its own development path and retain and reinvest profits into further technology development.

Second, the most successful firms have developed a long term strategy to build core competencies. Legend, for example, has moved from developing operating systems and computer resale to PC and board production, and to systems integration and Internet business. Facing restrictions on bank lending and needing new capital, there have been pressures on many enterprises to diversify into new markets in the search of quick gains. Founder moved from publishing software to computers, chemical engineering, and real estate. Stone expanded from word processors to real estate, cement, and chocolate snack

pies. In the words of one Founder manager, these changes were the reflection of the company's shift from a "product" to a "market" company: "Before we produced what we thought we could sell; now we research what the market wants to buy." Despite these moves, the most successful firms have not moved too far from the company's core technologies.[20] According to a respondent at Founder, information industries still accounted for 60 to 80% of the company's total revenue.[21]

Third, thriving nongovernmental firms have demonstrated successful managerial strategies and organizational flexibility. While almost all nongovernmental enterprises were founded by one or two individuals, the most successful have been able to move from these "patriarchal systems" based on personal authority to more professional management. Increasingly managers and directors at Stone, for example, came to believe "that one person having complete power leads to stagnation," and that the company needed to "rely on professional managers, not friends."[22] Legend is also known for its organizational skills, forming teams, setting strategy, and borrowing managerial methods from companies like IBM and Hewlett-Packard. (Hartford 2000)

High-Technology Zones

In addition to regulations directly tied to nongovernmental enterprises, officials also created new policies designed to provide more extensive financial support for R&D and the commercialization of scientific products. The most important of these was the Torch Plan, initiated in May 1988, and the most important component of the Torch Plan was the development of science parks and high-technology development zones.

Established in 1988, the Beijing Experimental Technology Zone was the first zone approved in China. The State Council approved 26 zones in 1991 and 25 additional zones in 1992. These zones, plus the original in Beijing and an agricultural technology zone established in Yangling in Shaanxi province in 1997, brought the national total to 53.[23]

The experience of Silicon Valley, Route 128, and other science parks had a strong impact on China. In the early 1980s a fellow at the Institute of Physics of CAS toured Silicon Valley and other CAS researchers made similar trips during the decade. (Tung 1988) In all of the zones, the underlying logic was the same: concentrating universities, research institutes, and production units in the same area and providing the necessary infrastructure and preferential tax and finance policies would attract technology enterprises and S&T personnel, eventually creating new clusters of regional innovation. The geographical concentration of high-tech firms and institutes of higher education was expected to generate positive externalities through information exchanges and knowledge spill-over.

Once designated a high-technology development zone, sites came under an umbrella of preferential policies that covered taxes, finance, imports and exports, pricing, and personnel policy.[24] Industries located within the technology development zones, were exempted from income taxes for the first three years after their establishment; from the fourth to sixth year tax rates were reduced by half. New technology enterprises were also exempted from construction taxes, and import licenses and duties on equipment needed for production until these policies were canceled in 1994.[25]

Zone officials were responsible for defining the criteria that distinguished enterprises as "high-technology," thus qualifying them for preferential treatment.

Zhongguancun Science Park (the new name for the Beijing Experimental Technology Zone), for example, revised the rules for technology firms in 1999 declaring that R&D must total 5% of sales, and 60% of all income must come from the sale of S&T products.[26] Local banks were directed to provide loans to new technology enterprises located within the zones. Moreover, relevant departments were permitted to establish venture capital funds, and the more mature zones to initiate venture capital companies.

The development and management of the zones have varied by region. Different zones have also increasingly focused on different industrial sectors. For example, Shanghai has focused on biotechnology and semiconductor production, Guangzhou on biotechnology, and Shenzhen serves as a link between Hong Kong capital and mainland technology. Although all zones were expected to adopt a management style known as "small government, large service"—with government agencies playing little or no role in the R&D and management decisions of individual enterprises—localities differed in how the responsibility for development and administration of the zones was distributed. Some localities developed the land used for the zone, attracted businesses to the zones, and financed zone development themselves; others established nominally independent development corporations.[27]

There has also been a move to make the policies surrounding high-technology parks more supportive of small and medium enterprises. High-tech business incubators increasingly provide management advice as well as low-cost rents to technology enterprises. (Harwit 2002) In the initial stage (1987-1994), provincial and municipal science and technology commissions and high-technology enterprises zones were the direct sponsors of the majority of incubators. After 1997, universities have become more

prominent as sponsors (and are the fastest growing segment in the industry).[28] Tenant companies are typically spin-offs from universities involved in information industries, although the number of privately owned firms has increased. There have also been "innovation parks" created to support overseas students returning to China and setting up high-technology firms.

High-technology development zones have been successful, but it is not clear whether economic gains have been driven by policy incentives or by the creation of the agglomeration effects of external economies. (Table 3 about here) From 1992 to 2000, labor productivity within zones jumped three times, new firm production increased, and the average contribution of a HTDZ to its host city's industrial output rose from 2 to 31% (Hu 2003). Between 1991 and 2002 the 53 national technology parks generated total income of $184.78 billion and exports increased from $180 million to $32.92 billion.[29]

But Albert Hu argues that that few, if any, of these gains can be explained by the creation of agglomeration effects and positive externalities that come with locating technology firms and universities together. Rather, for Hu, the convergence of labor productivity across parks over time suggests that policy incentives like tax holidays were more responsible for the return on investments made in technological parks. Foreign investment, however, does seem to have a more robust effect, creating externalities within parks.

A Focus on Innovation Strategy

During the late 1990s, Chinese decision makers began to shift their focus away from more state-directed technology policies to policies more supportive of entrepreneurship and innovative activity. The economist Wu Jinglian argues that the government "should no longer directly organize, command, and operate high-tech industries. Instead, it should concentrate on creating the right environment where qualified personnel of all types, including technical personnel and managerial personnel, can put their talents to good use."[30] Or as Richard Suttmeier puts it, China has begun to move "from S&T policy to innovation strategy." (Suttmeier 2002)

In regards to enterprises and zones, this strategy consisted of two parts. (Naughton and Segal 2003) First policymakers moved to support all types of technologically advanced enterprises—nongovernmental, private, and small spin-offs—rather than just large state-owned enterprises. This was part of a larger policy focus on small and medium enterprises (SMEs).[31] Small and medium enterprises expanded considerably under the "grasp the large, release the small" (*zhua da fang xiao*) policy for state-owned enterprises. Under this policy, SOEs changed their ownership status through corporatization, shareholding, or private management. [32]

The embrace of non-state actors also reflected important ideological changes made toward private enterprises. The 15th Party Congress openly acknowledged the private sector as an important component of the economy, and in 1999 the revised Constitution equated the non-state and state sectors. In January 2000, a minister at the State Development Planning Commission announced that the government would "eliminate all restrictive and discriminatory regulations that are not friendly toward private investment."[33] And during a speech marking the 80th anniversary of the founding

of the CCP on July 1, 2001, Jiang Zemin announced that the Party would now accept private business people as members.[34]

Second, the reduction of the mandate and manpower of state agencies has limited the government's capacity to direct resources to specific programs and develop selected technologies. Instead, policymakers seek to support broadly all domestic enterprises designated "high-technology" as "national" enterprises able to compete with foreign enterprises. Support includes access to low-interest credit lines, preference in procurement decisions, or other kinds of regulatory preference or relief.

These two strands were reflected in a late 1999 Decision.[35] The Decision created an innovation fund for SMEs with initial capital of RMB 1 billion and a mandate "to ease the capital deficiencies of small technology-based firms."[36] The Decision ensured that domestic high-tech products and equipment received preference in government and enterprise procurement and created a number of preferential tax policies including: a partial tax deduction for R&D expenditures; tax exemption for all income from the transfer or development of new technologies and related consulting and technical services; preferential 6% value-added tax rate for software products developed and produced in China; deductibility of payroll expenditures for software development and manufacturing companies; complete VAT exemption and subsidized credit for high-tech exports; and preferential tax treatment for imports of cutting-edge technologies and equipment not available in China.

Chinese policymakers have also tried to make it easier to reward technologically inventive entrepreneurs for their contributions. The Decision called for the development of venture capital companies and funds. At the end of 2001, there were approximately

150 venture capital firms with registered capital of more than $1 billion. These firms fall into four types in China: government funded, limited venture capital firms, joint venture, and science development funds.[37] In addition, domestic high-tech corporations such as Stone and Legend have established their own venture capital firms.

To further stimulate venture capital, China has changed accounting regulations on how registered capital is calculated. Policymakers have also begun to address the problem of the public sale of companies (or listing on stock markets) in order to provide an exit option for initial investors. Plans for a "growth enterprise market," like NASDAQ in the United States and GEM in Hong Kong, have been approved, but implementation has been delayed until after regulatory reforms that will restructure the existing Shanghai and Shenzhen stock markets.[38]

Continuing Challenges

While all of these reforms are necessary and suggest a policy environment that has become more attuned to the needs of innovation, high-technology zones and *minying* enterprises continue to face significant barriers to future growth. The most pressing of these challenges—the lack of investment capital, a low level of technological capability, an underdeveloped enterprise system, and inconsistent and contradictory government action—date back to the 1980s and have been constant sources of frustration to both S&T policymakers and high-technology entrepreneurs. The ability to address and resolve these issues will be critical to determining China's evolving technological capabilities and its ability to respond to the challenges of accession to the WTO.

Capital

Popular articles and scholarly analysts often cite the lack of capital as the biggest barrier to technological development in China. In a survey conducted by the State Council Development Research Center, 67% of the respondents listed "lack of funding" as the "biggest problem facing enterprise development."[39] According to Lu Kequn, chairman of the Beijing Securities Co. Ltd., Zhongguancun needs a capital inflow of roughly RMB 200 billion over the next 10 years if it is to be successful. [40]

Capital scarcity shapes the development strategies of enterprises and severely limits the competitiveness of firms. The problem, as described by Liu Chuanzhi of Legend, is we "know how to turn money into technology, but not technology into money."[41] Individual entrepreneurs have difficulty in acquiring funding through possible channels including stocks and bonds, bank lending, and government assistance. As noted above, the stock market for small technology firms has not been established yet and the threshold for listing is too high on the existent boards. High-tech companies are currently not allowed to issue bonds.

Bank lending is the most important source of funding, but *minying* enterprises, still have difficulty securing loans, even with improved policy support. In one survey of 100,000 nongovernmental firms, only 47.3% received lending from a bank.[42] The central problem is that capital allocation is driven by political concerns and official edict, not market mechanisms. Fearing the social disturbances that may accompany unemployed workers, local officials prop up moribund state-owned enterprises through bank lending. Small and medium enterprises are high risk—*minying* enterprises have a bankruptcy rate

of 20%—and lack collateral guarantees.[43] The government has recently addressed the problem of guarantees; in 2000, for example, Zhongguancun created a credit guarantee system.[44] But bank officials continue to consider small technology enterprises a risk if not a distraction, complaining that the investigation and loan process for SMEs costs five times as much as it does with large firms.[45]

Faced with these constraints, most nongovernmental firms rely on self-raised capital. The individuals who establish the companies usually contribute their own savings, as well as that of their friends and families. If they left a state research unit or university to start their own firm, sometimes that unit may also make a loan to the new company. Even if they manage to find start-up capital, firms lack the resources to further develop and market new technologies and are often forced to concentrate on selling other (foreign) companies' products.

Technological capability

Closely related to the problem of capital is the question of technological capability. Much has been made recently in the American media about rising Chinese technology exports. Office and data processing machines, telecommunications and sound equipment, electrical machinery, and other technology-intensive products now make up a greater share of Chinese exports. The American Electronics Association reports that high-tech imports to the United States from China rose from $26 billion in 2000 to $35 billion in 2002.[46] The total volume of Chinese high-tech exports reached $35.7 billion for the first five months of 2003, or 23% of total exports.

As the list of products suggests, China is a huge producer of DVDs and other consumer electronics. But China is not yet at the cutting edge of technology; 80% of truly high-technology products that China exports are produced by joint ventures or wholly foreign-owned enterprises, and Chinese firms remain mainly involved in the production of products at the low and medium end of the technology scale. Chinese analysts note foreign firms hold the majority of the patents for the products China exports; China controls 47% of the DVD market but owns none of the patents for the core technology. In order to remain competitive in the global economy, Chinese firms need to move away from simply engaging in the manufacturing of these products. Nongovernmental enterprises need to move to the design stage within the electronics trade.[47]

There have been some important changes in the role enterprises play as technology suppliers in the national innovation system. One of the main objectives of S&T reform strategy has been to increase the importance of industrial enterprises in the innovation system, and the enterprise sector in China has increased its total share from below 50% to 60% of total R&D expenditures. (Suttmeier 2002) As Suttmeier notes, SOEs are developing "in-house" capabilities for innovation, including their own R&D capabilities. (Ibid.) In 1999, for the first time, SOEs began spending more on their own R&D than they did on imported technology.

Still, questions remain about the relative role of smaller nongovernmental enterprises in the Chinese S&T system, especially in comparison to MNCs and the larger SOEs. In their survey of over 20,000 Chinese firms Jefferson et al find that "large-size" enterprises are significantly more likely to be a high R&D performer. (Jefferson et al

forthcoming) R&D intensity is closely related to firm size, profitability, and market concentration; it is also robustly associated with new product sales. In a comparison of Chinese-owned firms, small collective and private firms produce a tiny fraction of technology imports and exports; state-owned enterprises bring into the country four-fifths of all technology products imported by Chinese owned firms, and account for three-quarters of technology products exported by Chinese firms. (Rosen 2003) Looking at a list of China's top electronics firms, only two—Founder and Legend—are clearly identified as *minying* enterprises. (Table 4 about here)

Many of the nongovernmental enterprises lack the resources to undertake the major commitments to research and development that characterize high-technology firms in more developed economies. Firms in the OECD often dedicate 10% of sales to R&D; in enterprises located within technology zones, R&D expenditures make up 1.92% of sales, for enterprises outside of zones, 0.63%.[48] The national average for *minying* enterprises is 2.62% of total income. In effect, while nongovernmental firms are a dynamic part of the economy, we should not expect that they will emerge anytime soon as the primary force driving Chinese economic and technological development.

Enterprise system

In addition to technological weaknesses at the center of enterprises, relations within and between enterprises—all of the social relations that make up a modern enterprise system—are not adequately developed. Within enterprises, many nongovernmental firms have failed to develop professional and standardized management techniques. Firms were often founded by charismatic scientists who lacked management

skills. The strong personality required to battle bureaucratic opposition served small enterprises well in the initial stages of development, but as firms grew, the founders tended to "act as local despots," stifling the creativity of employees and running enterprises into the ground.[49]

Analysts also fear that China lacks many of the social organizations that support innovation. This is both a reference to specific institutions as well as an environment conducive to risk taking. One analyst, for example, notes the absence of "S&T matchmakers," individuals who unite inventors with capital. Zhongguancun produces almost 3000 "scientific achievements" a year, but without these and other intermediate institutions the commercialization and transformation rate does not exceed 10%.[50] More generally, China is seen to lack of culture that encourages risk and tolerates failure.

Policy

Despite important innovations, the policy environment continues to suffer from at least four problems. First, the shift away from direct government control over primary actors in the S&T system is incomplete. The state still relies heavily on high-profile, mission-oriented projects like the 863 Project to guide innovation efforts. (Dahlman and Aubert 2001) Moreover, state actors still control the investment process and government funds account for 80% of venture capital funds.[51]

Second, there is the question of the future implications of state attention to and support for nongovernmental enterprises. As noted above, policy makers have expanded the range of enterprises that can receive government support; technological capability is now more important than ownership structure. Government support, at least in the early

stages, can be critical to firm success, especially in regard to access to capital. As one manager of a new technology enterprise put it, "No government support, no nongovernmental enterprise success."[52]

The risk is that government support may dampen market pressures, increase the opportunities for rent seeking, and lower the long-term competitiveness of nongovernmental enterprises. In the United States, only 1 in 10 technology start-ups will provide "outstanding returns" and 4 in 10 will fail completely.[53] The firms that do survive are the most competitive, and, to some extent, local officials in Beijing adopted a similar attitude toward *minying* growth in the city, boasting that that between 1989 and 1993 200 enterprises failed a year, while 300 new ones quickly replaced them.[54] As an official at the China Non-Governmental S&T Entrepreneurs Association put it, "We [the government] are going to let the market provide signals, and if *minying* enterprises fail, well, then they fail."[55] Government investment in nongovernmental firms, of both economic and political resources, may make officials less likely to allow the market alone to provide signals and ultimately to allow state-supported firms to fail.

Third, critical work remains to be done building an adequate legal environment that protects intellectual property rights and regulates private enterprise. The incomplete system for assigning, exercising and protecting intellectual property rights impedes not only inward technology transfers, but also discourages indigenous innovation. In addition, the legal framework governing venture capital, private business, and capital market regulation is still incomplete. As Naughton and Yuan note, the government's control over who is able to list on the stock market is particularly burdensome on non-

state firms. Private enterprises only accounted for about 3% of the total 901 firms listed on the mainland stock markets at the end of June 1999. (Naughton and Yuan 2000)

Fourth, decentralization while spurring policy innovation has also created redundancy and harmful competition. The rapid expansion of technology zones has left many asking if China actually needs so many zones and whether Silicon Valley can be duplicated. As one analyst framed the problem: "In order to develop high technology, it is not necessary to have a technology zone. And having a zone does not necessarily lead to high technology."[56] Regional economies require concentration to produce agglomeration effects, but many of the zones are geographically dispersed and cut off from each other. Moreover, in an attempt to develop their own regions, local officials occasionally undercut other zones and steal their business.[57]

Tax policies within the zones are particularly problematic.[58] Tailored to individual situations and loaded down with detail, local tax policies have created confusion and weakened macroeconomic policy. Instead of offering firms two years free from corporate taxes, three years at half rate, some zones began offering breaks of two and six years, with some even offering ten years of no taxes followed by another ten of half taxes. Moreover, with career advancement frequently dependent on the growth of the numbers of firms within a zone, some officials have let the quantity of firms in the zone increase regardless of the enterprise's technological level. Others have offered preferential treatment to firms that are not truly high-tech.

Future Political and Economic Developments

Political development

There has been much theoretical and popular writing about the links between technological development and political change. Information technologies and the Internet in particular were expected to push liberalization forward in two ways. First, the diffusion of IT would facilitate a freer flow of information and the ability of opponents of the regime to organize opposition and disseminate their messages. Falungong, the Chinese Democratic Party, and other groups inside and outside of China have used the Internet, satellite broadcasts, and mobile phones to distribute restricted information and coordinate new forms of organization. But recent studies have shown the state to be extremely resourceful in its response to these new technologies, developing an effective strategy to monitor online activities at every level of Internet service and control other types of technology. (Kalathil and Boas 2001; Chace and Mulvenon 2002)

Second, economic development was expected to result in a larger middle class, who eventually would become more restless and politically assertive. Businesses would develop resources and interests separate from those of the state. *Minying* entrepreneurs in particular may have been expected to be in the vanguard of this move given the role they played in the 1989 Tiananmen tragedy and the "revolutionary" nature of their business enterprises. (Sheff 2002) The founder of Stone, Wan Runnan, was forced to flee the country for his support of the students, and Stone made a public self-criticism in July of 1989.[59]

Again, recent studies suggest that the state has been resourceful in responding to political pressures and that new economic actors are not necessarily at the forefront of democratic reform. Dickson describes a two-track strategy based on cooption and

corporatism. (Dickson 2000) Focused on economic modernization, the Party has increasingly welcomed technocrats and entrepreneurs as members. Jiang Zemin's July 1, 2001 declaration that the Party would now accept private business people as members was part of a larger strategy to incorporate productive and wealthy sections of Chinese society. The CCP has also created, and manipulated, new organizations like business associations. These associations are designed to mediate between the state and economic actors, fostering the flow of information between the two as well as allowing officials some degree of guidance over the private sector.

Moreover, both officials and private entrepreneurs have strong incentives to develop close links to each other; cadres hope to promote local growth and create ties to personal wealth, businesspeople gain access to loans and protection from competition as well as rapacious officials. Pearson argues that private businesses are more likely to "lend support [to political reform] if others take the lead." (Pearson 1998) In the end, private entrepreneurs are seen to be more interested in working within the system than promoting political reform from the outside.

For both of these issue areas—new technology and the control of information and the link between private businesses and democratization—it may be misleading to think of the contest as purely zero-sum. Focusing on whether state or economic actors might be winning or losing detracts from larger changes in the political context. In the case of IT, focusing on the lack of organized resistance to the CCP overshadows the degree to which the Party increasingly feels it must respond to the freer flow of information in Chinese society. (Wilson and Segal 2003) Zhu Rongji's public apology in March 15, 2001 for misleading the public about the cause of an explosion in a school in Jiangxi was

a remarkable example of ICT forcing greater transparency at the top. In the case of business interests and autonomous organizations, political pressure may not be focused on "democratization" *per se*, but rather on other reform measures like the development of "rule of law," transparency, and anti-corruption regulations.

WTO and Globalization

China's accession to the WTO presents significant challenges and opportunities for high-technology development zones and nongovernmental enterprises. Perhaps the most dramatic change is S&T policymakers will no longer be able to offer preferential policies to Chinese enterprises of any sort.[60] All preferential policies, in or outside of the zones, will gradually become universal and all enterprises, whether domestic or foreign, will receive the same support if the policies continue.

Chinese analysts also worry that nongovernmental enterprises will lose their comparative advantage as more foreign firms locate manufacturing and R&D facilities in China. 400 of the world's 500 largest companies have manufacturing facilities in China, and over 200 foreign R&D centers and labs were established on the mainland from 1990 to 2002. (Walsh 2003) Foreign firms will have the same access to low labor costs and a large domestic market. More importantly, foreign firms are said to be adopting a strategy of recruiting indigenous talent, attracting skilled S&T personnel away from Chinese firms. The presence of foreign firms offering high salaries to the best Chinese scientists and engineers makes it more difficult for the state to attract technical talent. Chinese officials have complained, for example, about Intel's recruitment of top engineering graduates.[61]

On the positive side, the challenges of WTO may spur further the reform of S&T policy. Critics of the zones argue for the need to adjust the industrial structure within zones since they have become saturated with manufacturing. Growth in zones was good over 2000 and 2001, but total profits are decreasing. The ratio of profits to total income was 6.5% in 2000, and fell to 5.4% in 2001. In the first quarter of 2002, the ratio fell even further to 3.9%.[62] Shifting away from extensive growth and limited by WTO regulations, zones will need to end the competition in attracting firms based on preferential policies and rather focus on "software" issues. In this context, zones will compete based on institutional innovation, government service, and policy efficiency.[63]

Nongovernmental enterprises may also benefit from two larger trends. The first is what AnnaLee Saxenian has called the "globalization of entrepreneurship"—the return of Chinese students and entrepreneurs from Silicon Valley to the mainland. (Saxenian 2002a) These individuals are increasingly investing in business in Beijing, Shanghai, and Guangzhou/Shenzhen, helping arrange business contacts, and providing advice to businesses and government. According to Chinese sources, 5000 returned students have created over 2000 IT companies in Zhongguancun, and in Shanghai returned students established 2450 enterprises with a total registered capital of US$400 million.[64]

China, although well staffed with good manufacturing engineers, lacks individuals with high technology managerial skills. As Barry Naughton argues, in China's transition to a market economy, "skills in finance, auditing, and statistics—to say nothing of entrepreneurship—are woefully underdeveloped. (Naughton 1996). Scientists and students returning from Silicon Valley may fill this critical gap. "Transnational entrepreneurs" create social networks that allow small producers to locate collaborations

and facilitate access to capital, skills, and markets. In the case of Taiwan and India, expatriate engineers played a key role in outsourcing the services of US corporations to their home countries. (Saxenian 2002b) Local governments are aggressively recruiting these entrepreneurs, offering free rent and other benefits to lure young entrepreneurs home. Beijing, for example, has announced the establishment of a Silicon Valley recruitment center in a bid to attract students to return to China.[65]

The second trend is the emerging pattern of global production of information technologies. Production is increasingly divided into discrete functions along the value chain and contracted out to producers in different national and regional economies. These constituent elements, components, subcomponents, and software, are critical to the control of the industry as a whole and become separate arenas of market competition. (Borrus and Zysman 1998) Before, large enterprises dominated the entire range of components. Today, the system has fragmented with small, independent enterprises specializing in one step of the production process, be it design, fabrication, testing, or manufacturing.

Taiwanese firms are a major driver in the globalization of IT, and the mainland is becoming increasingly central to these firms' international strategies. In 2002, more than half of IT hardware sold in Taiwan was produced on the mainland; 55.3% of laptop PCs, 60.4% of PC motherboards, 71.2% of CRT displays, and 93.1% of optical storage equipment were made on the mainland.[66]

It is still too early to discern the impact of these firms on nongovernmental enterprises. Cooperation with Taiwanese firms could bring nongovernmental enterprises much needed capital and access to well-developed international R&D and distribution

networks. Clusters of firms are emerging in areas of high Taiwanese investment; in Dongguan and Shenzhen a network of high tech suppliers have grown up around desktop computer manufacturing, in Shanghai around integrated circuits, and nongovernmental enterprises are increasingly positioned to play a role in these chains, both downstream and upstream.

Whether Chinese firms will be able to take advantage of the opportunities offered by these global production networks will depend on the types of technology Taiwan transfers to the mainland, how those technologies transfers are structured, and the capability of the national innovation system to absorb and diffuse capabilities. In the short run, nongovernmental firms are likely to benefit. But the question how they will move up the value chain to higher value-added production remains open as the majority of value added industries remain on Taiwan. The ability to leverage these new opportunities and develop new capabilities is tightly linked to the continued reform and development of the nongovernmental enterprise system and high-technology development zones.

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Segal Chapter Tables

Table 1: Minying development by region, 2002

Region	Total Income (100 million RMB)	Number of enterprises
Guangdong	3492.63	6540
Zhejiang	2875.51	4331
Jiangsu	2579.07	4232
Shanghai	2522.93	18977
Beijing	2495.74	10353

Source: Ministry of Science and Technology, 2002 Report on S&T Activities of Nongovernmental Technology Enterprises

Table 2: 2002 Annual Ranking of Member Minying Enterprises

	Minying Enterprise Name	Region	Minying Income (USD)	Type of Business
1	Lenovo (Legend Group Limited)	Beijing	4,299,217,389	Information Technology
2	Sha-Steel	Jiangsu	1,761,249,274	Steel
3	Wanxiang Group	Zhejiang	1,430,529,079	Auto Components
4	Guangsha Limited	Zhejiang	1,261,904,877	Construction, Real Estate, Tourism
5	China Orient	Heilong-jiang	1,242,558,545	Banking, Insurance, Securities
6	Fosun	Shanghai	1,223,745,645	Medicine, Real Estate
7	Hengdian Group	Zhejiang	1,132,185,020	Pharmaceuticals, Power Generation
8	Suning Appliances	Jiangsu	1,018,292,771	Home Appliance Retailer
9	Chint Group	Zhejiang	974,799,207	Electrical Power Equipment
10	Xinjiang Delong Group	Xinjiang	872,813,044	Food Stuffs, Machinery, Building Materials

Source: All-China Federation of Industry and Commerce

Table 3: 2002 Top Ten High-Tech Parks According to Total Income

	Location	Number of Enterprises	Total Income (10,000 Yuan)	Total Output Value (10,000 Yuan)	Foreign Exchange Earned by Exports (10,000 Yuan)
1	Beijing	9567	239479578	147722084	2500002
2	Shanghai	536	103593842	94420242	3009631
3	Shenzhen	156	69643275	71987474	3494154
4	Wuxi	362	62264077	47444248	2261965
5	Nanjing	170	54695574	50827919	742552
6	Tianjin	1835	49838679	41664231	1290666
7	Changchun	460	49088040	48847627	273418
8	Suzhou	364	48620885	48583098	3525124
9	Xi'an	2092	48116591	31842963	209850
10	Qingdao	142	45092378	45555805	637298

Source: China High-Tech Products Export Platform, http://kjxm.chinatorch.gov.cn/queue.asp

Table 4: Top Electronics Firms, 2003

	Name	Business Income (million yuan)
1	Haier Group Corporation	71,052.82
2	China Putian Information Industry	60,227.93
3	Legend Holding Co., Ltd.	35,542.49
4	TCL Group Stock Co., Ltd	31,885.05
5	Shanghai Video and Audio (Group) Co., Ltd.	26,869.36
6	Hisense Group Co., Ltd.	19,305.79
7	Huawei Technology Co., Ltd.	17,214.20
8	Panda Electronics Group Co., Ltd.	16,388.95
9	Beijing Peking University Founder Group Co., Ltd	14,503.72
10	Sichuan Changhong Electronics Group Co., Ltd.	14,348.92

Source:Xinhua, May 27, 2003

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