Chapter 9

FRAMEWORK CONDITIONS FOR INNOVATION

9.1. The importance of framework conditions

It is widely acknowledged that innovative capacity is determined not only by a country's research and development (R&D) system but also by the interplay of factors which enable knowledge to be converted into new products, processes and organisational forms which in turn enhance economic development and growth. Arnold *et al.* (2001) talk about "frameworks for innovations". Silberglitt *et al.* (2006) link science and technology (S&T) capacity to "institutional" capacity, which they define as including "the quality and reach of governance in a country, a banking and financial system that works, an honest and functioning judiciary, and working educational and health systems". The World Economic Forum attempts to measure countries' overall competitiveness by looking at a number of indicators: institutions, infrastructure, macroeconomy, health and primary education, higher education and training, market efficiency, technological readiness, business sophistication and innovation (World Economic Forum, 2006). Framework conditions have also been an integral part of OECD analysis of innovation systems and policy over the past decade. All recognise that the efficacy of the wider innovation system often hinges upon the quality of framework conditions and the capacity to ensure an innovation-friendly environment in both core R&D and in more peripheral parts of the economy.

It is useful to bear in mind several complicating factors when assessing innovative capacity and framework conditions in economies such as China. Many of the analytical tools and indicators for measuring innovation were originally designed for highly developed countries with sophisticated systems for gathering statistical data. Some of these indicators are not readily available for China, and the interpretation of the indicators that are available often requires taking China's social and economic context into account. For example, indicators tend to capture an average, but China has large disparities between regions and between modern and more traditional sectors. Beijing is home to the Zhongguancun High Tech Park with its information and communications technology (ICT) start-up firms, while in large parts of western and central China, farming represents a significant share of economic activity and involves very limited technology input, while locally administered state-owned enterprises (SOEs) are characterised by low productivity

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and innovative capacities (see Chapter 2). Moreover, China's rapid economic, technological and institutional development presents additional challenges for keeping the statistics on innovation and the indicators up to date for giving a more accurate, policy-relevant picture.

This chapter addresses a set of selected, rather than all, key issues that fall within the realm of framework conditions for innovation. It first looks at the general socio-economic environment which does not specifically concern innovation but has a significant impact on innovation performance. It then examines in greater detail some policy areas that are more closely related to innovation, policy such as intellectual property rights (IPR), standards and public procurement.

9.2. General framework conditions

9.2.1. Macroeconomic conditions are mixed

The Chinese economy has grown by an average of 9% a year for the past 20 years. With a 11.5% year-on-year increase, GDP grew at its fastest rate in ten years in the first half of 2006, with no sign of a slowdown. Growth has been strongly driven by investments in infrastructure, housing, industry and exports.

Macroeconomic conditions in China are generally stable and favourable for continued economic growth (*e.g.* World Bank, 2006). In spite of sustained rapid growth, there are no signs of imminent overheating. While consumer prices accelerated during 2007, largely owing to a rise in the price of pork, overall inflation remains low, the current account is in surplus and there is a large labour surplus, particularly in western China, so that, assuming sufficient mobility of labour and/or production, future economic growth should not be restrained. In the World Economic Forum's *Global Competitiveness Report 2006-2007* (2006), China ranks sixth among 125 countries in terms of macroeconomic conditions that are conducive to competitiveness and growth. Low inflation, high savings and manageable levels of public debt are among the reasons why China ranks much higher than India (88th), or Brazil (114th).

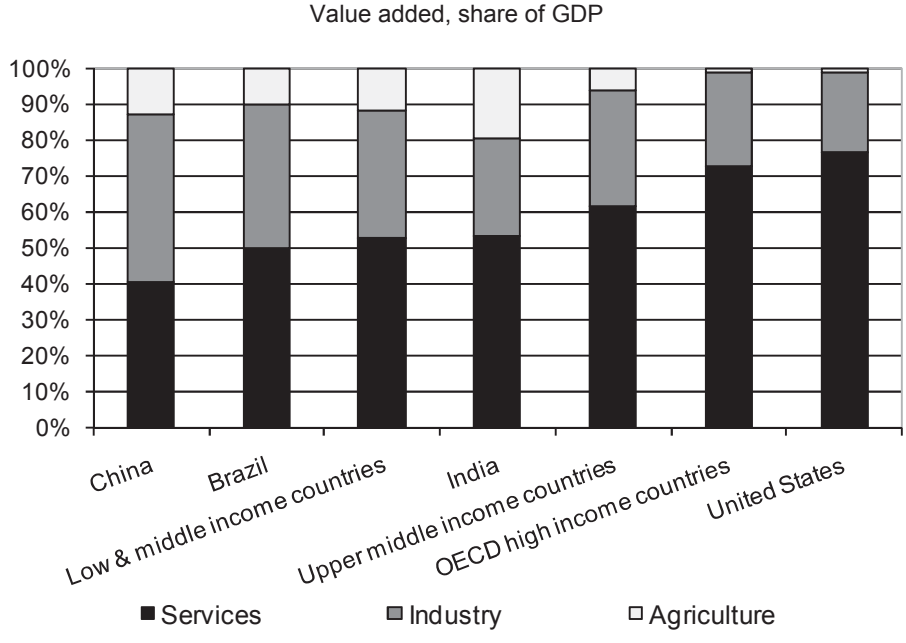
While the macroeconomic situation is generally good, there are a number of latent threats or structural weaknesses. The first is the fact that growth is strongly driven by, and some would say excessively dependent on, capital investment and exports while domestic consumption is comparatively low. Investment amounted to around 45% of GDP in 2005, compared to 30% in India and around 20% in Japan, Korea, the euro area and the United States (*The Economist*, 2006, 2 November). In fact, the share of domestic consumption in GDP has shrunk from around 62% of GDP in the 1980s to 52% in 2006 (*China Daily*, 4 November, 2006), whereas the global average is 78% (Yusuf and Nabeshima, 2006). In 2003, consumption increased by only 2.8%, while investment and exports grew by 5.4% and 9%, respectively. One explanation is that households increasingly save in order to pay for health care, education and old age (Lane and St-Maurice, 2006; World Bank, 2006; *People's Daily Online*, 27 January 2006). Lack of an adequate pension system and the privatisation and sharply rising costs of health care and education induce individuals to save rather than spend. According to the World Health Organization (2005), 90% of the rural population had no medical insurance of any sort. This suggests that fears of sickness or poverty in old age, in addition to the need to finance education, hold back private consumption.

The high level of household savings plus high enterprise and government savings explain why China's gross national savings amount to more than 40% of GDP (Kujs, 2006). It is estimated that Chinese households save up to one-third of their disposable income; this is especially high in a country where per capita income is still relatively low and prospects for continued economic growth are good (*International Herald Tribune*, "Rebalancing Economic Growth in China", 11 January 2006). A combination of traditionally high saving rates in Chinese households and general uncertainties relating to an inadequate social security net and the rising costs of medical care tend to have a negative effect on aggregate demand in the Chinese economy, thus weakening the stimulus for growth and innovation.

Another potential threat to China's future economic stability is growing income inequality. While absolute and extreme poverty has declined significantly, income inequality has increased and is now greater than in India and Russia, although still less than in Brazil and South Africa. China ranks 90th among 124 countries while India ranks 31st (UNDP, 2005). Since the late 1970s, China's GDP per capita has risen by an average of around 8% a year. However, the benefits have been unevenly distributed. A middle and upper class, estimated to consist of around 250-300 million people, has emerged (Farrell *et al*., 2006), and its purchasing power and wealth are increasing rapidly. On the other hand, despite a reduction, by one-third, in the number of the poor living with less than USD 1 a day between 2001-04, there were still 135 million people, approximately 10% of the Chinese population, living in poverty in 2004, according to the World Bank (Hianhe Zaobao, 2006). The increase in social inequality is creating social tensions and unrest.

As a further structural weakness, growth has been driven primarily by manufacturing and industry, while the services sector remains relatively underdeveloped. Figure 9.1 shows that China's services sector is small compared with that of India and Brazil, and with average low- and middle-income countries.

Figure 9.1. International comparison of China's economic structure, 2005



Source: Based on World Bank Development Indicators.

A number of factors threaten to slow down, interrupt or even derail China's continued economic development and future innovative capacity.[1] First, large and growing foreign exchange reserves may lead to international trade disputes and threaten exports, one of the pillars of China's economic growth. Second, its highly natural resource-intensive growth has resulted in a precarious environmental situation which puts future development at risk (Yusuf and Nabeshima 2006), with the additional question of how to meet its increasing demand for energy and raw materials. China already has 16 of the world's most polluted cities and 70% of the water in its rivers and lakes is not suitable for human contact. Third, China's rapidly ageing population means that China risks "getting old before it gets rich", unlike India, for example, with a much more favourable demographic pattern or the developed world which has succeeded in "getting rich before it got old". Finally, China's banking sector, discussed below, is a potential threat to macroeconomic stability.

9.2.2. Financial conditions need to be improved

China's financial system is dominated by large state-owned banks. Much of their business consists of giving loans to large state-owned enterprises (SOEs). As many of these operate at a loss, the share of non-performing loans has traditionally been very high. According to the Chinese Banking Regulatory Commission, there was RMB 1 268 billion in non-performing loans in the commercial banking sector at the end of 2007 (CBRC, 2008), down from RMB 1 917 billion at the end of 2003 (CBRC, 2004), the year when the Chinese government renewed efforts to reform the banking sector. Despite the improvements made since then, the two important challenges that remain are to reduce the level of non-performing loans and to reform the governance of the banking system so as to avoid the generation of new bad debt (Allen *et al.,* 2006, Bekier *et al.,* 2005, OECD, 2005a). The reform of the SOEs, the gradual opening of the banking system to foreign competition in connection with the country's accession to the World Trade Organization (WTO), and measures to improve banking governance and professional supervision are slowly improving conditions for reducing the level of bad debt and preventing the granting of new non-performing loans.

Currently, China's financial system is inadequate for meeting the funding needs of private firms, particularly small-and medium-sized enterprises (SMEs). Because the capital market is underdeveloped, SMEs find it difficult to secure loans and must often depend on self-funding (Allen *et al.,* 2006). More specifically, Chinese banks are not well equipped to finance innovation activities. For example, according to research by the All China Federation of Industry Commerce (ACFIC) in 2006, S&T firms in the Zhongguancun district in Beijing were only able to finance one-quarter of their RMB 120 billion working capital with bank credits; more than half was funded through informal sources. Elsewhere, many enterprises cannot get any bank loans. To address this situation, the March 2007 Congress of Chinese People's Political Consultative Conference (CPPCC) proposed creating an S&T bank to support S&T and innovation activities (CPPCC, 2007).

1. According to a survey of business executives in Asia (McKinsey, 2007), executives see potential difficulties in terms of shortages of talent and weak enforcement of commercial laws and regulations, although many respondents believe that the country can address such challenges sufficiently.

There is also a severe lack of capital for financing new ventures, which are an important source of innovation. White *et al*. (2005) found that China lacks both the expertise and the necessary legal and regulatory conditions for a functioning and adequate venture capital system. Many domestic venture capital firms are set up by the government, at national or provincial level, and run by government officials who lack the necessary technical, commercial and managerial skills (Rothman, 2006).

At the same time, many very wealthy business people and foreign venture capital firms are looking for profitable investments (*Business Week*, 16 January 2006). What appear to be missing are firms and professionals with the experience to identify and invest in high-risk ventures, as well as firms and business angels with the patience to invest in the biotechnology sector, for example, where an investment may take ten years or more to yield returns (Borrell, 2005; Nilsson *et al.*, 2006). While the number of private domestic and foreign venture capital firms has been increasing, there is still a shortage of funds – and of the type of expertise offered by business angels – available to small innovative firms (Linton, 2006).

Owing to the lack of funding for high-technology start-up firms, in 1999 the Chinese government founded the Innovation Fund for Technology-based SMEs (Innofund) under the responsibility of the Ministry of Science and Technology and the Ministry of Finance. Its mission is to fund early-stage commercialisation projects with innovative technology and good market potential. It provides grants and loans to high-technology firms in six fields: information technology (IT) and electronics, biotechnology and medicine, advanced materials, automation, new environmental resources and energy. It is considering the possibility of equity investment. Between 1999 and 2004, it gave grants worth RMB 4.3 billion to 6 400 projects.

In another effort to improve innovation funding, the government tasked the China Development Bank, one of China's so-called policy banks, to earmark RMB 50 billion for low-interest loans to high-technology SMEs (*China Daily*. 11 March 2006).

Innofund and the China Development Bank initiative show a clear determination to increase access to funding for high-technology SMEs. The fact that China Development Bank has traditionally provided loans for large physical infrastructure and construction projects and has limited expertise in financing innovative SMEs presents a challenge.

9.2.3. Education and the skills reserve

A good education system is a fundamental building block of a resilient and innovative society and economy. A Chinese proverb says: "Science and technology ensure our well-being for today; research and development ensure our well-being for tomorrow; education ensures our well-being for the day after tomorrow." It can be argued that, in the past decades, R&D and S&T have had greater priority than education. Total government appropriation for education, as a share of total government expenditure, dropped from 21.1% in 1996 to 15.7% in 2004 (National Bureau of Statistics, 2006). At around 2.8% of GDP, spending on education is comparatively low (Lv, 2007), while, as a percentage of GDP, India and Brazil spend less on R&D but more on education (UNESCO UIS Database). In its latest five-year plan, the Chinese government has targeted education as a priority area and announced its intention to increase China's budgetary expenditure on education to 4% of GDP by 2010. In addition, China is re-examining its education system, which some people think focuses too much on learning and memorising and too little on teaching people to think. Some local governments, schools and universities are

working to change their curricula and teaching methods. Overall, there are indications that China is working to improve its education system, by increasing its funding and its quality, and thus is acknowledging the key role of education in innovation and future prosperity.

Since the beginning of the open door policy, China has recognised the importance of sending students to study in advanced OECD countries. Between 1978 and 2005 around 770 000 mainland Chinese went abroad to study, mainly in the United States, Japan and the United Kingdom; approximately 180 000 are estimated to have returned (Ministry of Education website and *China Statistical Yearbook*, 2006). These returnees have been a vital component of China's innovation system, playing a key role in many of the country's scientific and technological achievements, as well as its commercial successes. Chinese returnees account for a high share of new businesses and knowledge production in terms of scientific publications, patenting and licensing. Many have been instrumental in setting up China-based R&D labs and institutes, both academic and corporate.

Overseas returnees account for a significant portion of the foreign direct investment (FDI) flowing into China, and they are key personalities in China's scientific community, including national chief scientists. This group has also founded many of the country's high-technology companies, and they have played a prominent role in prestigious scientific projects such as the space programme and human genome mapping. In 2004, they accounted for 81% of the academicians of the Chinese Academy of Sciences (*People's Daily*, 2 March 2004). More recently, they constitute a vital resource pool for foreign companies seeking to recruit at management level in China (*China Daily*, 13 March 2006). Overall, they provide unique access to networks, skills and funding sources (Saxenian, 2006).

In the past two decades, despite the impressive increases in enrolment figures (see Chapter 6), the education system has faced a number of challenges. One is the fact that numbers of students have increased while public funding has stagnated or declined, leading to concerns about quality (OECD, 2005e). A second, related challenge concerns the implications for access to and quality of higher education of the introduction of tuition fees and the partial privatisation of education.[2]

There are also various indications of a fundamental mismatch between the education provided by many Chinese universities and the skills demanded in the labour market. The number of university graduates is accelerating rapidly: 750 000 in 2006 or 22% more than the previous year. Yet, many cannot find employment despite a severe shortage of highly skilled labour (Farrell and Grant, 2005). An article in China Daily claimed that "1.24 million (out of 4.13 million) graduates can't find major-related jobs" (China Daily, 2006)

Academic corruption is another recently revealed problem affecting the education system (*Business Week*, 29 May 2006; *The Economist*, 20 May 2006). Chinese graduate students and professors are under great pressure to publish several papers each year, and this has led not only to poor quality work, but to fraud (Rothman, 2006). In addition to plagiarism, the abuse of academic power has tended to undermine not only the quality of the academic system but also, more generally, the stability of the social and economic fabric. Academic corruption – nepotism and various forms of bribery, the exchange of favours in the appointment of academic positions or the distribution of research funds,

2. For a more detailed analysis of finance and quality issues in Chinese higher education, see OECD, 2005e.

among other things – could seriously undermine the government's effort to achieve good education and research excellence, both of which are vital for China's future innovation-based economic development and prosperity.

9.2.4. Commercialisation: a recent phenomenon[3]

Until the late 1970s, research took place almost exclusively in the public domain, *i.e.* it was funded by the government and carried out at universities and government research institutes and was largely driven by, defence-oriented policy and needs (Walsh, 2003, p. 37). In recent years, the financing and performance of R&D by the business sector has increased significantly, as has patenting activity (see Chapter 2). It is important to remember that both commercialisation and science-industry collaboration or linkages are a relatively recent phenomenon in China as compared to OECD countries.

Problems of commercialisation have been highlighted recently in Chinese policy discussions and public debate. In particular, Chinese scientists' inability to provide solutions or cures during the recent SARS outbreak, in spite of increased funding for life-science research, has spurred government and university efforts to increase commercialisation and thus to ensure economic and social returns to investments in R&D.

A related question, which is starting to be addressed, concerns the incentive structure for patenting and the ownership of IPR. Traditionally, universities owned the IPR for scientific discoveries made by researchers employed by them. However, in recent years, some universities have started to offer researchers a share of the ownership of their discoveries in an attempt to encourage patenting and commercialisation. A problem in this respect is the traditional bias in favour of publishing at the expense of patenting. Scientific publications bring research funding, prestige, and private financial benefits. Patents are not regarded or rewarded in the same way and offer no other certain benefits, since they may not achieve commercial success. The publication process may also be delayed pending formal registration of the patent. Universities and policy makers have recognised that commercialisation of discoveries must be promoted more strongly. Scientists are now encouraged to establish their own companies and academics are permitted to be shareholders while retaining their academic positions. Funding organisations and universities are also encouraged to give greater recognition to patenting as a criterion for awarding grants and academic titles.

A further problem hampering commercialisation is the lack of protection of intellectual property. While the legislation for IPR protection is in place, enforcement of IPR is weak (Asakawa, 2005; DTI Global Watch, 2004; Wu, 2005; van Arnum, 2005). Fear of their ideas being stolen undermines Chinese scientists' motivation to patent discoveries; weak enforcement also deters foreign firms from transferring cutting-edge technologies to the Chinese market (OECD, 2005d).

In the 1980s, some universities, primarily in Beijing and Shanghai, began to set up university-owned technology-based spin-off companies. These were set up as a mechanism for commercialising university research and to provide a source of additional income for universities. Based predominantly in one of the national science and technology development zones, some have become important players in the Chinese high-technology industry (Sunami, 2002).

3. This section is based on Nilsson *et al.,* 2006.

In terms of the institutional landscape for commercialisation in China, it is important to understand that the innovation system is characterised by top-down, centralised decision making. The government has a view of the innovation system and its actors and decrees the creation of its vision. The venture capital system offers an example. The government identified venture capital as a fundamental weakness of China's innovation system. Its response was to create, or delegate to regional authorities, the establishment of venture capital companies which are often publicly funded and staffed by civil servants. As a result, and as opposed to the United States for example, the commercialisation process is dominated by official, or at least officially recognised, institutions, and tends to be very similar across universities (see White *et al*., 2005, for a detailed analysis of the system).

However, although this model exists, commercialisation often takes place through different channels. In theory, scientific management offices, technology transfer or licensing offices and patents and licences are important components of the commercialisation process; in practice, commercialisation often is the result of direct interaction between researchers and firms based on personal networks. Rather than patent their inventions, researchers may also sell their inventions directly to firms or start their own firms "on the side".

In the life sciences, for example, policies aimed at promoting commercialisation reveal a tendency, by national and local authorities, to focus on creating the physical infrastructure for commercialisation by establishing big buildings or state-of-the-art facilities in big science parks and setting up technology transfer offices. At the same time, they appear to focus insufficiently on the more intangible aspects of commercialisation and science-industry co-operation, such as attitudes, culture, communication and, perhaps most importantly, social capital. In fact, a low level of trust, or the absence of social capital, has been identified as one of the strongest barriers to commercialisation of academic research in the life sciences in China. Weak IPR enforcement exacerbates the problem. Overall, the challenge is to share inventions while protecting them from theft and piracy. There is, in addition, an apparent unwillingness to pay for and invest in intangible assets or ideas. According to the experts interviewed, neither researchers nor business people seem to have the long-term investment or planning horizons necessary to develop new drugs. China has achieved considerable success in commercialising research in sectors such as ICT, but it may take some time to establish a thriving, internationally competitive, life science industry based on Chinese research achievements. While the recent history of commercialisation in China partly explains some of the difficulties encountered in the life sciences, it makes the advances in scientific excellence and the success in attracting foreign R&D very impressive.

9.2.5. Knowledge spillovers and linkages

Attracting foreign direct investment has been a cornerstone of China's economic policy since the beginning of reform because it has viewed FDI as a shortcut to technology upgrading: increasing agricultural productivity, contributing to the development of the western regions, strengthening export performance, improving access to and efficient use of raw materials, to name a few (Long, 2005). However, one of the most important motivations behind China's preferential FDI policies may have been to augment domestic innovative capacity and its companies' competitiveness by "importing" knowledge, management skills and technologies from abroad.

It has long been recognised that multinational corporations (MNCs) transfer technology to affiliates not only through machinery, equipment, patent rights, expatriate managers and technicians, but also through the training of affiliates' local employees. The skills gained while working for an affiliate may spill over as employees move to other firms or set up their own businesses (Blomström and Kokko, 1998, pp. 13-14).

Foreign corporate R&D can have positive technology or knowledge spillover effects on the host country, for example through value chain linkages with domestic firms that are suppliers, customers or competitors of foreign R&D centres. In all cases, interaction with or the presence of a foreign R&D centre can lead to transfer or upgrading of knowledge or technology. R&D co-operation between foreign R&D centres and Chinese universities, institutes or other organisations is another channel for potential spillovers. Finally, people are perhaps the most, important conduit for knowledge spillovers from foreign R&D centres to the surrounding domestic environment.

Spillover effects from foreign R&D are not guaranteed, however (Blomström and Sjöholm, 1999). They require a conducive local environment, including a certain minimum level of human capital or "local capability" (Blomström and Kokko, 1998). A study of technology diffusion from foreign MNCs in 40 host countries found that in less developed countries, technology diffusion was limited because these countries lacked the human capital necessary to absorb the technology diffused by the MNCs (Xu, 2000).

Lack of human capital may partly explain why knowledge spillovers from foreign corporate R&D have been limited in China. Several studies point out that while China has a relatively high literacy rate, compared with India and many other developing countries it has a shortage of people with the skills necessary to set up, develop, manage or work in innovative companies (Farrell and Grant, 2005).

In addition, there is limited mobility of human capital between foreign and domestic companies (Schwaag Serger, 2006). Surveys indicate that university graduates clearly prefer to work for foreign firms. In 2004, 64% of students interviewed in Beijing intended to work in a foreign enterprise after graduation (Beijing Century Perspective Marketing Research). In another survey, which asked more than 4 000 students from China's top universities to rank their preferred employers, 13 out of the 20 highest-ranked employers were foreign companies, leading the authors to conclude that "[t]here is apparently a lot of working power in China and Chinese students seem to want to use this power in big multinational companies" (Universum Communications, 2005). Similarly, *China Daily* recently observed that "[w]orking at multinational companies has been the preferred choice for college graduates in China for years" (*China Business Weekly*, 18-24 September 2006).

Moreover, those working in foreign firms show little inclination so far to move to domestic firms or start their own firms. Although some Chinese employees do leave foreign firms to set up their own companies, in most cases they do so to work for another foreign firm that has offered them better pay or a better position. Thus, while turnover among Chinese employees in foreign companies appears to be high, and is identified as a significant problem by foreign employers, it seems to be due more to the circulation of Chinese employees among foreign enterprises than to movement from foreign to domestic companies which can serve as a vehicle for knowledge spillovers.

Among domestic firms, students prefer state-owned enterprises over privately owned ones. SOEs offer more job security and benefits in terms of health care and pension schemes, something which has become an important consideration for job seekers (*China through a Lens*, 15 February 2006). The limited mobility of labour between the government sector and the private sector is therefore not conducive to knowledge spillovers. The dismantling of China's public health-care, pension and education systems can thus be argued to have introduced a labour market bias against private domestic firms. The difficulties they have in attracting talent, with the best graduates preferring to work for foreign companies or SOEs, constitute an important barrier to the development of innovative, competitive private firms in China.[4]

9.2.6. Socio-cultural factors – entrepreneurship, attitudes and social capital

China's dynamic economy today may be viewed as a testament to the entrepreneurial strength of the country and its citizens. However, this is too simplistic. In fact, several authors point to weaknesses or shortages in China's entrepreneurial skills (Watkins-Mathys and Foster, 2006; Lundström and Stevenson, 2006). So far, entrepreneurship in China has been based more on necessity than on opportunity, although opportunity-based entrepreneurship appears to be increasing. The lack of, and a poorly functioning market for, venture capital and weaknesses in the education system and in the training of entrepreneurship and business skills are factors that hamper the development of entrepreneurship in China (Gao, 2006).

9.2.6.1. Belief in science and focus on technology-driven innovation

Chinese society greatly admires science and technology. This is reflected in the share of science and engineering students, one of the highest in the world. Policy making is also permeated by strong faith in technology and its ability to provide solutions to environmental, economic and social but also political challenges. The country's top leadership's decision in 1995 to revitalise the nation through science and technology epitomises this belief. It is not surprising; then, that China's innovation policy has been technology-driven, with a strong focus on R&D as the driver of innovation.

Government policy has so far been oriented primarily towards technical innovation in manufacturing, as can be seen, for example, in the orientation of the government R&D programmes and in the latest medium- and long-term plan for science and technological development. It can be argued that Chinese innovation policy follows a relatively traditional science-based model, focused primarily on technology-based innovation. . While much attention is given to scientists and engineers, with generous government funding available, both policy makers and companies traditionally neglect the importance of markets and sophisticated customers as drivers of innovation. It has been observed that while Chinese enterprises' core technologies are rapidly approaching the level of those of foreign MNCs, the gap between domestic and foreign companies results from excessive reliance on technology and a corresponding lack of market and customer orientation (*IT Manager*, 11 November 2006).

4. In a small survey carried out by the authors, job security, health care and pensions were important considerations for people in their 20s with university degrees, and one reason for them to view SOEs or the government as attractive employers.

9.2.6.2. Cultivating a social and cultural environment for creativity and interdisciplinary co-operation

A big challenge for innovation policy is that innovation, interaction and creativity cannot, or can only to a limited extent, be "decreed" or "dictated". People cannot be ordered to innovate or interact. Instead, innovation tends to thrive in societies where discretionary or interventionist policies are combined with market-driven innovation and an environment or culture which encourages critical thinking and creativity.

> *If you try to always do things in the same way everywhere, and try to ensure that everything is happening top down, you will fail. You will have to ... [grant] people freedom to try out new things through experiment. It comes not by forcing creativity but by allowing openness.* (Hans-Paul Burkner, President and Global CEO of Boston Consulting Group, interview with *China Business Weekly*, 6-12 November 2006)

Innovation requires critical thinking and willingness, and encouragement, to think "outside of the box".[5] Many successful innovations arise when people from different disciplines or backgrounds interact to find new interfaces or applications. One of the challenges to China's innovative capacity is the lack of interaction across disciplines or sectors. Chinese society is permeated by a strong respect for knowledge and science and by a very positive view of technological progress. People are therefore respected, and rewarded, for being knowledgeable specialists. While this is generally positive, it tends to give relatively little importance to inter- or cross-disciplinary work. Interdisciplinary work also requires lowering institutional barriers and rigidities and a social environment characterised by a high level of trust and social capital.

9.2.6.3. Social capital and trust

Willingness to interact is a prerequisite for absorbing, diffusing and using knowledge, and is part of the basis for innovation. Social capital is used to capture the notion that the creation of economic value depends not only on physical capital (tangible assets such as land and machinery) and human capital (knowledge and skills) but also on the value that derives from people's willingness and likelihood to share knowledge and information (Woolcock, 1998). Social capital can be defined as the shared values, norms and trust that reduce transaction costs. It is sometimes erroneously equated with networks.

Many observers point out that China has strong family ties or networks, sometimes referred to as the "bamboo networks" or the strength of *guanxi* (relationships), and to their importance in the conduct of business and other affairs in China. However, an indicator of a high level of social capital might be the willingness of people to share information or knowledge with people *outside* their immediate network. In countries with weak social capital, business interactions and knowledge transfer are often limited to family networks. Utilisation of resources can be less than optimal if knowledge and information are restricted to one's immediate network rather than channelled to others who might use them more effectively. For example, a researcher might choose to sell his or her invention to an uncle who has a company but not the know-how necessary for successful commercialisation of the invention rather than to a company or other partners which may be outside the family network but possess the relevant technical and other

5. As pointed out above, the Chinese education system is still strongly based on rote learning and unquestioning respect for authority (McGregor, 2005) and may tend to teach people to know rather than to think.

resources. An example of how lack of trust and fierce competition may prevent co-operation and thus undermine the potential for innovation is illustrated by the lack of co-operation among some research institutes during the outbreak of SARS in 2003 (Li *et al.*, 2005).

Weak social capital hinders knowledge spillovers or linkages between foreign firms' R&D activities in China and the surrounding environment. Vang and Asheim (2006), for example, examine spillovers from foreign firms' R&D activities in Shanghai and find that the absence of sufficient social capital, and particularly trust, "is still limiting the possibility of developing interactive learning environments which are a precondition for improving absorptive capacity at the firm level".

Lack of trust in people or institutions outside one's immediate network is very difficult to measure. Corruption and IPR infringements may be used as proxies, with high levels indicating a low level of general trust. Both can be seen as an indicator and a consequence of weak social capital. In the latest "Corruption Perception Index" published by *Transparency International*, China ranked 70th among a total of 163 countries, with a score of 3.0-3.6 on a scale from 0-10 (with 10 indicating "very clean" and 0 indicating "very corrupt"). While there have been widely publicised efforts to clamp down on bribery, nepotism and other abuses of power, corruption is still widespread and widely perceived by the Chinese as a serious problem (*The Economist*, 19 December 2006). The World Bank Governance Indicators confirm that control of corruption has decreased continuously since 1996 (World Bank 2007). In terms of IPR, the problem is that the laws, which are good, are rarely well enough enforced. Individuals and companies face great difficulties when they try to defend against breaches of IPR (see below).

Overall, the continued high levels of corruption and of IPR theft indicate a low level of social capital. They also undermine innovative behaviour, lead to distrust and encourage people to seek quick returns rather than invest in the longer-term interactions that are necessary to enable innovation and commercialisation in sectors such as pharmaceuticals.

9.3. Dedicated framework conditions

9.3.1. Protection of intellectual property rights

9.3.1.1. Social and economic rationale of IPR protection[6]

Intellectual property rights are commonly defined as the rights awarded by society to individuals or organisations primarily for creative works. They give the creators the right to prevent others from making unauthorised use of their property for a limited period. The main categories of intellectual property (IP) include industrial property (functional commercial innovations) and artistic and literary property (cultural creations), as well as some recently emerging hybrids of the two referred to as *sui generis* systems, such as integrated computer circuits, plant breeders' rights, database protection, etc.

6. Based on OECD (2005c).

One person's use of knowledge does not exclude another's, often at very low marginal cost and not limited by national borders. From the point of view of society, the more people use the available stock of knowledge the better off society will be, in the sense that more people gain something at little or no cost. However, if knowledge is available to everyone free of charge, there is insufficient economic incentive for private investment in the creation of knowledge; this would lead to underinvestment, with detrimental effects on society in the long run.

The economic rationale for protecting IPR is the need to ensure sufficient private investment in the creation of new knowledge. This is done by granting temporary market exclusivity to IP owners to allow them to recoup the costs of their investment and make a profit, and encourages knowledge creation and technological innovation. Thus, the protection of IPR gives individuals and institutions economic privileges in order to contribute to the greater public good; it is a means to an end, not an end in itself.

At the same time, it comes at a cost to society. One part is borne by consumers in the form of a price higher than the marginal production cost. Other costs incurred by individuals and by society as a whole include duplicate R&D and the substantial costs associated with asserting and defending IPR. Although IPR protection gives private exclusivity, it is still in the interest of the society (Cohen *et al.*, 2000; Frietsch and Schmoch, 2006; Kash and Kingston, 2001; Kingston 2001; Mazzoleni and Nelson 1998).[7] The relevant questions, therefore, are what constitutes an optimal level of IPR protection, how it should be structured, and how the optimal structure may vary depending on sectors and levels of economic development.

It is expected that as R&D investment and innovation increase in the Chinese economy, the importance of IPR protection will be better appreciated, and more effective measures will be taken. Cultural and social change, which takes place slowly, is necessary and important in this context. There are already signs of change. For instance, the State Intellectual Property Office (SIPO) has launched an annual IPR campaign aimed at enhancing public awareness (SIPO, 2005).

9.3.1.2. IPR legislation between 1949 and 1990

After its founding in 1949, the central government of the People's Republic issued in August 1950 Provisional Regulations on the Protection of Inventions Rights and Patent Rights.[8] Under these regulations, the state owned the patents and inventors were awarded certificates for inventions made in the course of employment. For inventions made outside of work, the inventors were granted ownership. The Provisional Regulations on Trademark Registration set up a new registration-based trademark system after invalidating that of the former *Guomindang* government. No comparable regulation for copyright was issued at that time, but authors were entitled to fixed basic payments and had the right to stop unauthorised alteration of their work.

7. Opponents of patenting argue instead that as the monopoly is granted on an individual level, it may be abused to gain higher royalty fees so that the social costs are higher than the social gain. They further claim that patents hinder technological progress as monopolists keep their technology from others, so that derivatives and further development are not possible. The opposition becomes most obvious in discussion of software patents (Blind, 2006; McQueen, 2005) and in the Open Source community.

8. The first patent law in China was promulgated by the Qing Dynasty in 1889. It was followed by the Republican Patent Law in 1912, and the Patent Law of Nationalists in 1944, which is still effective in Chinese Taipei (Mertha, 2005). This section draws heavily on Alford (1995) and Mertha (2005).

In the 1960s, social movements questioned the appropriateness of material incentives for creative activities and IPR regulations were amended to reduce property rights and material incentives. In 1963, the Regulations to Encourage Inventions and the Regulations to Encourage Improvements in Technology were promulgated, making inventions and improvements in technology exclusively the property of the state. The system of certificates of inventions was terminated. The Regulations Governing the Control of Trademark replaced the Provisional Regulations on Trademark Registration; its role was quality control and it made no mention of rights. In parallel, payments for publications were sharply reduced.

During the ten-year Cultural Revolution that started in 1966, the 1963 regulations were abandoned, almost all scientific work was turned down and knowledge was ignored. There was no payment and no protection for inventions or publications and no one willing to claim credit for inventive activity.

After the Cultural Revolution, China's new leadership realised the importance of science and technology and launched a series of programmes to encourage intellectuals to return to scientific work. The legal framework for IP regulations was restored, and in 1978, the 1963 regulations were reissued. In 1997, a Trial Circular Concerning Basic and Supplemental Payments for New Publications was announced and payment returned to the level of the early 1960s. It was soon replaced by the Provisional Regulations on Basic Payments for Books, which entitled authors to payment at the level of the 1950s.

Different entities took on the task of writing laws and regulations to protect intellectual work. The State Science and Technology Commission, re-established in 1978 to oversee science and technology policy, was responsible for developing policies for inventions. From 1979, the newly reconstituted State General Administration for Industry and Commerce (SAIC) was in charge of trademarks. In 1980, a special copyright committee was established.

The drafting of a patent law gave rise to hot debate. Opponents argued that the patent system, by giving a few individuals ownership of important technologies, was against socialist principles and might stifle the development of domestic industries and increase dependence on foreign technologies. In contrast, proponents believed that material incentives specified in the patent law would promote innovation activity, and that disclosure would foster information exchange among scientists. A patent system would also reassure foreign investors and encourage international technology transfer. It could enhance China's image in the world and get better protection abroad for Chinese technology. The debate continued until Deng Xiaoping decided that China should adopt a patent law. After spending five years studying patent laws in different countries, the drafting committee presented the first Patent Law, which was approved at the National People's Congress on 12 March 1984.

The first patent law made it difficult for individuals to secure rights that would allow them to extract monopoly rents but promised material rewards (Alford, 1995). For instance, individuals could not apply for patents for inventions relating to their job, using materials from work, or within one year of leaving that job, but they could receive a prize of money from their work unit. Foreign applicants faced some additional disadvantages, such as the exclusion of chemical, pharmaceutical, alimentary or process inventions from patent coverage. Because these fields were much more advanced outside China and relatively easy to reverse engineer, it was more important for them to have legal protection. Mertha (2005) suggests that the exclusion of chemical and pharmaceutical

patents from the original patent law was due to Chinese leaders' concern to avoid excessive reliance on foreign patent holders for products for maintaining public health.

These issues were addressed in revisions of the Patent Law in 1992 and 2000. In the first revision, the duration of patent protection of inventions was extended from 15 to 20 years and the duration of utility model and design patents was extended from 5 to 10 years; food, beverages, flavouring, pharmaceutical products, and substances obtained by means of chemical processes were also covered by patent protection. In the second revision, state-owned and privately owned enterprises were treated as equals for obtaining patent rights; individuals were allowed to own patents for inventions made during work time if an agreement was made between individuals and employers. In 2005, SIPO began to prepare for the third revision for the Patent Law and its implementation.[9]

In parallel, the first Trademark Law was issued in 1982 and the first Copyright Law was promulgated in 1990. Both were the subject of similar debate and concern. All these laws were based on international treaties and conventions: the Patent Law was based on the Paris Convention, the Trademark Law on the Madrid Convention, and the Copyright Law on the Universal Copyright Convention (Yang and Clarke, 2005).

9.3.1.3. Enhancement of IPR legislation: 1990s-2000s

While the intellectual property system from 1949 to 1990 can be described as being shaped by domestic political events, from the 1990s it has been under mixed pressure from internal and external forces.

The first IPR negotiations between China and the United States took place in 1979 in the context of the United States-China Bilateral Trade Agreement, in which China committed to protect foreign patents, copyright and trademarks. Since then, China has made progress in establishing IPR laws and joining international IPR conventions. However, disputes over IPR between the United States and China have been recurrent. In 1991, China was identified as a priority foreign country[10] for failing to protect US intellectual property. The United States put pressure on China to improve IPR enforcement by threatening to impose trade sanctions. After several rounds of heated bilateral negotiations, they reached an agreement in 1992, the Sino-US Memorandum of Understanding on the Protection of Intellectual Property, under which China agreed to update intellectual property protection and join major international conventions (La Croix and Konan, 2002). For example, chemical inventions were included in patent protection; and protection for foreign patents was extended from 15 to 20 years. These amendments led to the first revision of Patent Law and the promulgation of the Implementation Rules for International Copyright Treaties in 1992 (Mertha, 2005).

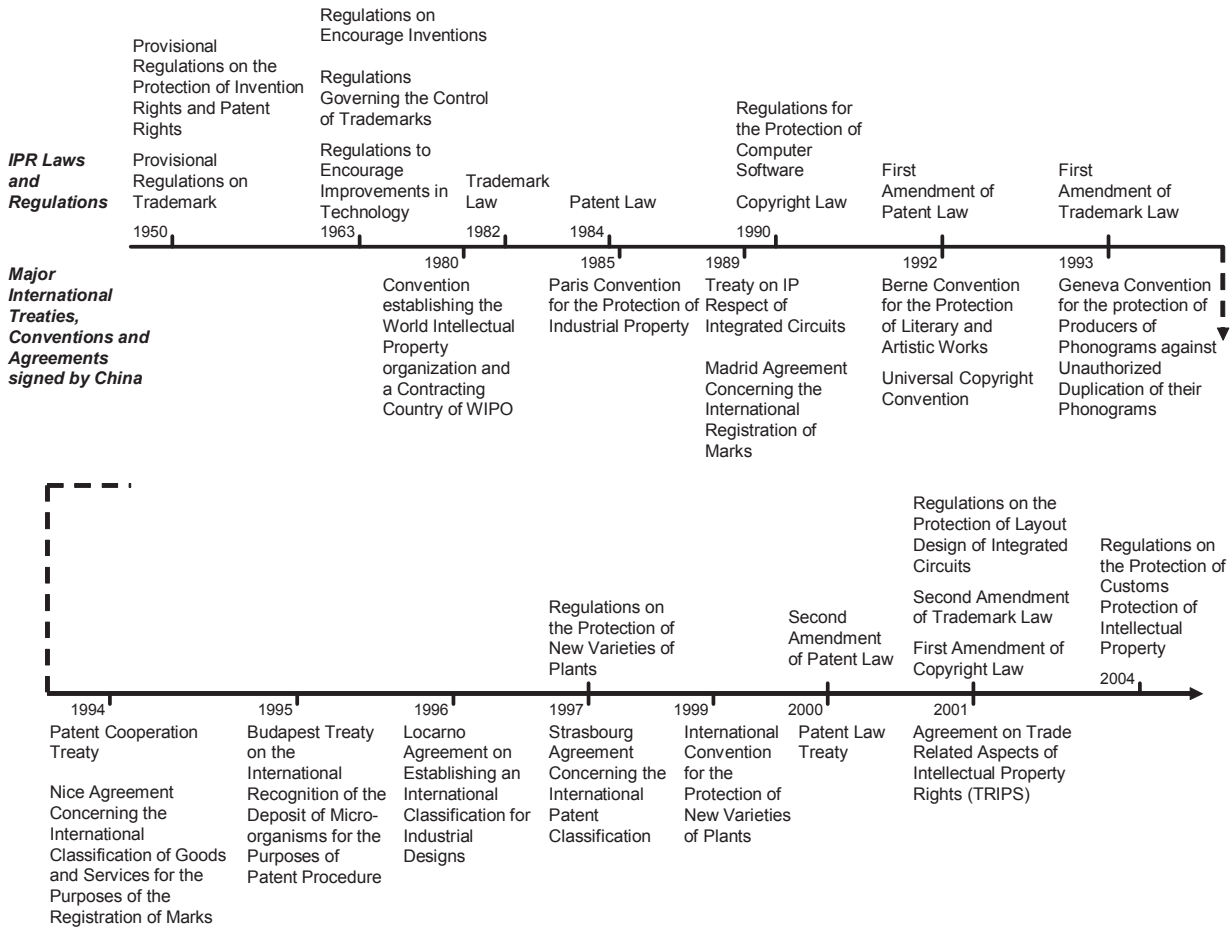
In 1993, China was accused of violating US copyright on a variety of goods such as computer software and CDs. Since then, the focus has shifted from the provision of legal measures to enforcement of IPR. New rounds of negotiations were held from 1993 to

9. See www.sipo.gov.cn/sipo_English/gjhz/zycf/t20060410_78991.htm.

10. The "Special 301" provisions of the Trade Act of 1974 require the United States Trade Representative (USTR) to identify foreign countries with inadequate IPR protection. Once these are identified, they are assessed by USTR as to whether they should be designated as priority foreign countries, *i.e.* those with the most adverse impact on US products and not making progress in addressing these problems. For details, see www.ustr.gov/assets/Document_Library/Reports_Publications/2005/2005_Special_301/asset_upload_file223_7646.pdf.

1995. An enforcement-based Action Plan strengthened the enforcement and dissemination of IPRs. In 1996, the Report on Chinese Enforcement Actions under the 1995 IPR Agreement was signed, focusing particularly on copyright issues. In 1997, Article 216, which provides for a criminal penalty for patent counterfeiting, was added to the Criminal Law. The Copyright Law and Trademark Law were amended in 2001 to comply with WTO rules (Yang and Clarke, 2005). Figure 9.2 highlights important events in the evolution of China's intellectual property regime.

Figure 9.2. Timeliness of major national and international IPR laws and regulations



Source: Alford (1995); Yang and Clarke (2005); La Croix and Konan (2002); Ministry of Commerce of PR China, Department of Treaty and Law, at: http://tfs.mofcom.gov.cn/aarticle/cj/200503/20050300029076.html; and http://tfs.mofcom.gov.cn/aarticle/cj/200503/20050300030517.html.

9.3.1.4. IPR in China – the current situation

China joined the WTO in 2001 and signed the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement).[11] Thus, the Chinese patent system reflects international standards and conventions, and Chinese officials appear to have increased efforts to protect IPR, with some success. Consequently, patent applications to the SIPO by Chinese and foreign inventors have picked up speed. The European Union Chamber of Commerce in China (2005) confirmed this in a recently published study, and some individual firms spoke of a positive development (see Annex C). Nevertheless, the situation is far from satisfactory, and IPR protection remains the subject of frequent complaints, or is criticised as inadequate, by representatives of MNCs or by innovative companies active in China. Foreign firms are therefore reluctant to transfer their latest technology to China (OECD, 2005d, and Section 5.4 of this report). For instance, for this and for strategic reasons, most foreign-owned R&D centres in China apply for patents initially in their home countries, and some do not file applications in China (Walsh, 2003).

Since 2004, the Chinese government has been working on drafting a national IPR strategy. As of September 2007, however, the strategy had not been presented. Observers believe that it extends the scope of IPR protection and is being viewed as a policy tool for strengthening domestic IPR and thus enhancing the international competitiveness of Chinese firms (Dewey Ballantine, 2006; see also *China Daily*, 28 March 2007).

9.3.1.5. IPR infringement in China

According to company reports, the patent system as such is dependable and patent infringements generally stay within acceptable limits. Patent infringements are reported and heard in court. China, like other countries, has specialised courts to which enterprises can turn according to the subject concerned. However, copyright and trademark infringements remain a serious problem. Because "pirates" generally need less technical input, infringement is easier and more frequent. As a result, product piracy, *i.e*. partly exact and partly less accurate copies of products, generally of lesser quality, still takes place in China, especially infringement of individual companies' trademark.

Re-engineering – buying single pieces to understand the technology and copy the products and achieve learning effects – is another problem. Many Chinese firms are in a position to do this and either replace the product or develop complementary technologies, thereby affecting the market position of the original innovator. However, this is true in markets throughout the world. The publication of technical properties, as in a patent application,[12] codifies the knowledge and makes it accessible to others. Given sufficiently

11. The TRIPS Agreement defines international "minimum rules", which should facilitate dealing with the international "flows" of intellectual property. The agreement states that "the agreement addresses the applicability of basic GATT principles and those of relevant international intellectual property agreements; the provision of adequate intellectual property rights; the provision of effective enforcement measures for those rights; multilateral dispute settlement; and transitional arrangements".
See www.wto.org/english/docs_e/legal_e/ursum_e.htm#nAgreement; 19 September 2006).

12. A patent application contains an exact technical description and thus enables others to comprehend the proposed technical solution and possibly replicate it. Companies accept this as the price for safeguarding an invention and extend or supplement the protection through further intellectual property rights. The reliability of the system is crucial. In addition, some applicants deliberately describe the object generally and in broad terms or make it extremely difficult for competitors to fully grasp their invention. They can also apply for further patents around the actual invention or cut the technology up into several applications. On the whole, the significance of IPR protection has increased and companies utilise it for strategic purposes (Blind *et al.*, 2006).

attractive markets, competing firms try to substitute the technology or develop further aspects of the technology and capture their own market niche. Depending on the licensing and product policy of the technology leaders, competing enterprises will be tempted to different degrees to invent alternative technologies ("patenting around"). In general, this is not a problem specific to the Chinese or Asian market, although this strategy is pursued extremely actively there.

The frequency of infringements needs to be understood in an historical context. Knowledge was transferred freely from academia to industry until the 1980s, during which period universities and research institutes were responsible for R&D, while the function of enterprises was production. In this tradition, it was taken for granted that knowledge is a public good which everyone can use. The concept of knowledge as private property embedded in IPR is thus relatively new to China.

9.3.1.6. Enforcement of IPR regulations

A second explanation for the high level of infringements can be found in the weak enforcement of IPR regulations (for an overview of IPR governance challenges in China, see OECD, 2005c). There are two parallel enforcement systems in China, judicial and administrative. Complaints of IP infringement can be filed either with the courts or with the administrative authorities.

Judicial approach

In 1992, a Special People's Court System was established to handle IPR protection cases and disputes. In 2005, courts at all levels accepted 16 583 civil IPR cases, of which 13 424 were a first instance. Among these, there were 6 096 copyright cases (an increase of 43% from 2004), 2 947 patent cases (increase of 15.6%), and 1 782 trademark cases (an increase of 34.5%). Infringement and ownership disputes accounted for the majority of all IPR-related civil cases (SIPO, 2005).

However, this approach is often not the first choice when dealing with infringements because the procedure is costly and complicated. Individuals and small firms are also concerned about the requirement that a proportion of the claimed damages has to be posted as a bond if they go to the IPR court (La Croix and Konan, 2002). Around two-thirds of patent infringement cases, 95% of trademark cases and most copyright cases are not filed in court (Bosworth and Yang, 2000).

Administrative approach

This is the approach preferred by injured companies and individuals. Before the legal system was established in the late 1970s, the government was in charge of all aspects of the country, including jurisdictions. People are strongly dependent on government and tend to seek an administrative settlement rather than go to court (Yang and Clarke, 2005). Even now that the necessary laws and regulations are in place, the administration still plays an important role in solving disputes, including IPR-related ones. Intellectual property offices (IPOs) deal with IPR-related disputes at various levels. The IPO staff conducts investigations and helps to negotiate between the two parties. If a fine is levied, the infringers are required to pay it into a special bank account. Otherwise, the enforcement units of the courts follow up.

However, because IPOs lack independent power and authority, the effectiveness of enforcement is often affected (Mertha, 2005). After the Patent Bureau was founded in the early 1980s, responsibility for the IPOs was shifted several times from one administrative authority to another, such as the State Science and Technology Commission (SSTC), the State Economics Commission (SEC) and the State Council. In 1998, the China Patent Bureau was reorganised and renamed the State Intellectual Property Office. It incorporated copyright and trademark units, although the consolidation was incomplete, since enforcement of copyright and trademark regulations remained under the control of their previous host authorities. As a result, the institutional setup makes it rather difficult for IPOs to enforce IPR across the board. At sub-national and local levels, their organisational setup and administrative effectiveness may vary, as the priority given to the protection of IPR by the local governments may affect the effectiveness of IPR protection in a given locality.

9.3.1.7. Problems with enforcement

Difficulties still exist for ensuring the enforcement of juridical and administrative decisions owing to the lack of appropriate infrastructure and mechanisms. Part of the problem is that failure to follow a court order is not regarded as a crime, and few penalties exist for non-enforcement.[13] Furthermore, to pursue an IPR infringement case in court requires the injured parties to invest a certain amount of time, effort and money. It is not worthwhile to pursue every case, as the amount of compensation relative to the damage incurred and the costs involved may not justify pursuing juridical enforcement in every case. In addition, there is a chance that even when the case is successfully pursued, the pirates may close down a "busted firm" and open a new "firm" and continue in the same vein.

Generally, MNCs do not consider themselves restricted or endangered by the infringement cases. Nonetheless, the totality of these "little pinpricks" is a problem, especially since the plagiarists or the violating parties often cannot be traced or brought to court (European Union Chamber of Commerce in China, 2005). Therefore, some Chinese and foreign firms have organised associations and networks with local authorities to undertake private enforcement and lobby the government to continue its enforcement efforts (La Croix and Konan, 2002). According to the European Union Chamber of Commerce in China and information from several representatives of western companies and institutions, criminal prosecution has improved greatly[14] and officials pursue reported cases with greater vigour. Tsinghua University – one of the largest applicants in China[15] – prosecutes each case with all possible means. This reflects the generally expressed expectation that, with the transition to China's own "genuine" innovations, the benefits of intellectual property rights will be increasingly recognised, driven by the needs of its own innovators.

13. Punishment of infringement has increased, but punishment of non-enforcement of court orders still does not receive enough attention.

14. Since 1997, counterfeiting of patented goods is subject to criminal law with up to three years' imprisonment (Article 216), which adds some deterrence.

15. A study of the largest applicants for patents in China in six technology fields revealed that in a ranking according to number of applications, Tsinghua University was among the first ten in all six fields, and frequently among the first three.

9.3.2. Standards and innovation

The priority recently given to indigenous innovation in China has reinforced a long-term trend towards enhancing technological capabilities through technological standards. Such standards serve as important tools for technological development and have often been used to support an infant industry policy or to otherwise protect domestic industries from foreign competition. However, standards have also helped to enhance competition by improving economies of scale and promoting interchangeability, compatibility and co-ordination. In addition, standards are important in the world trading system, and, with China's membership in the WTO, standards have received greater attention in Chinese technology policy.

Standards were gradually embedded in Chinese policy after 1978, and have since been adapted and developed. At an early stage they were integrated in major R&D programmes and increased in importance in 2001 when China became a member of WTO:

> *"This has now resulted in a system in which policy purposes for the standards regime – expressed through laws, administrative directives, and policy statements – are increasingly integrated with a research and development (R&D) network characterised by a strong commercial orientation, one involving a proliferation of high-technology start-up companies linked to government research institutes and universities, and a notable expansion of industrial research expenditures."* (Suttmeier and Yao, 2004, p. 4)

A key motivation behind Chinese efforts to improve its standards regime has been to better capture economic value from technological progress through R&D and innovation. Progress has been dramatic but has largely rested on technology transfer through FDI from MNCs and other sources. China has experienced fewer than hoped-for spillovers to indigenous industry and sees the technological gap *vis-à-vis* foreign players as a national challenge. It was estimated that only 15% of the value of China's electronic and IT exports is added in China (Branstetter and Lardy, 2006). In addition, reducing payments for the use of patents and other IPR represent a further motivation to increase domestic technological capabilities: between 50 and 70% of the manufacturing costs of a Chinese PC represent licence fees to Microsoft and Intel.

While strategies for standard setting vary depending on market, technology and other factors, influencing international standard setting requires the best technology, the strongest IP and the largest market (Boston Consulting Group, 2007). At this juncture, China's position is uncertain. On the one hand, given the size of the domestic market, China's increasing investments in R&D and the resulting improvement in the country's science and technology capabilities, standard setting is increasingly a strategic option for advancing China's national innovation agenda. On the other hand, in spite of the huge market potential, China has yet to acquire the technological and IP strength to pursue an international standard strategy effectively on its own. Importantly, as China has become a major arena for global competition among MNCs, the politics of standards increasingly reveals complex and cross-cutting cleavages, with substantial foreign participation in the technological development underlying the standards strategy. Also, given the growing importance of international markets for Chinese firms, they may have more interest in setting standards for global markets than for the domestic market (Table 9.1).

Table 9.1. Strategic options for standard strategies and required factors

	Participating in the normal process	Drawing strength from the market	Working with a powerful ally	Going it alone
Description / **Factors**	*Participating in normal discussions on setting a standard*	*Using the weight of China's market to set a winning standard*	*Working with a partner to build a China-favourable standard*	*Using Chinese technology and IP to set an alternate standard*
Technology and IP strength	Strong technology and IP are required to exert significant influence	Strong technology and IP are helpful but may not be necessary	An ally with strong technology and IP may be able to help secure favourable treatment	A strong technology and IP position is required
Co-ordination of the response from Chinese companies	Co-ordination among Chinese companies will increase influence	Co-ordination, perhaps led by the government, will be necessary	A co-ordinated response will be more likely to attract potential allies	A co-ordinated effort by Chinese players is more likely to succeed
Fragmentation of existing efforts in setting a standard	Fragmentation affords Chinese companies greater influence	Chinese influence may be high	Given fragmentation, it may be easier to attract an ally	Strategy is likely to work only if existing efforts are highly fragmented
Size of the relevant market	Large market size affords China a stronger voice	If China's market is large, its support may set the winning standard	A large relevant market is an attractive lure for a potential ally	A large local market is required for a go-it-alone effort to succeed
Collaboration with dominant players	High ←			→ Low

Source: Boston Consulting Group (2007).

Among the various possible standard strategies, it would be in China's long-term interest to participate actively in international standard setting in order to have its favoured standard accepted internationally. Given its domestic market and its increasingly capable technical community, China is in an attractive position to form alliances with international technological leaders and pursue this strategy. However, decisions to pursue domestic standards should take into consideration a number of other factors and possible consequences. Setting alternate domestic standards may present a less interesting option in the globalising economy than in the past when national economies were defined by national borders. Domestic standards might also have the effect of isolating China from international standards, making it more costly and difficult for Chinese firms to produce for export. It might also result in cumbersome compatibility issues between Chinese users and systems and international ones. In the longer term, the effect of a domestic standard that shelters Chinese firms from international competition may negatively affect their international competitiveness and the speed with which they improve their innovation capabilities.

The challenge for China is to develop a standards regime in line with the spirit and the letter of WTO regulations,[16] while supporting an innovation policy with specific instruments that allow Chinese enterprises and the wider national innovation system to capitalise on investments in knowledge and expand the commercial potential of innovation in both domestic and foreign markets.

9.3.3. Procurement

9.3.3.1. Growing importance of procurement for innovation

Public procurement can be a major means of eliciting innovation and accelerating the diffusion of innovative products and services throughout the economy (see Annex D for a fuller assessment of technology procurement in China). In EU economies, around 16% of GDP is spent on public procurement and it is increasingly recognised as a source of innovation dynamics at European and national levels The size of the Chinese market, the catching-up dynamic and the important roles of central and local government in the economy point towards a huge potential for innovation through public demand at various level of government.

The Chinese government has – in principle – recognised this potential in a new initiative to foster innovation. The 2006 National Medium- and Long-term S&T Plan mentions for the first time using public demand to spur innovation (Chapter 3). In parallel, since its accession to the WTO, there are pressures to comply with the WTO Agreement on Public Procurement (GPA), which China has not yet signed but negotiations are planned to start. Since 2002, China is an observer in the WTO Committee on Public Procurement.

The Chinese economy is different from that of many WTO countries, with implications for public procurement. First, key enterprises, not least in strategic sectors, are still state-owned and enjoy some technological and other advantages when competing for government procurement. Furthermore, the transition towards a fully transparent market economy, albeit under way, is not yet complete, with implications for procurement and trade regime and practices. The openness of public procurement to innovative foreign companies still seems somewhat limited, and there is an open commitment to give priority to purchasing products developed in China when possible. As China is not a party to the GPA, this does not violate the relevant WTO rules. Thus, while there is growing awareness of the potential of public procurement for innovation, severe limitations and obstacles remain. Procurement is part of the policy to foster indigenous companies and to make innovation part of the procurement rationale and puts pressure on the officials traditionally responsible for procurement who have had little concern for innovation. Innovation through public procurement cannot be ordered, however; rather, it is the result of an intelligent public agency asking, through transparent market competition, for an innovative product or service to better serve its needs, thus triggering innovation and innovation spillovers.

16. A particular concern will be the limits set by the provisions of the Agreement on Technical Barriers to Trade.

9.3.3.2. Current legislation on government procurement in China

Procurement as a part of conscious public policy was introduced in the 1990s. In 1996, the Ministry of Finance began to test a new procurement practice in the cities of Shanghai and Shenzhen, which later became a national practice. In 2002, the Law on Government Procurement was approved by the Standing Committee of the Chinese Congress. The volume of government procurement expanded from RMB 3.1 billion in 1998 to RMB 213.6 billion in 2004 and now represents 2% of GDP. This is still far lower than the 10% levels in more developed countries and the about 16% in EU countries.

The top priority of the procurement law is to reduce costs and corruption and to promote certain goals. Goals such as job creation, increasing overall demand and promoting innovation are not mentioned. For such goals, the government relies on national plans, investment and other tools. As in most OECD countries, responsibility for procurement is separate from responsibility for innovation. Procurement policy is a function of the Ministry of Finance, while promoting economic growth and job creation is a responsibility of the National Development and Reform Commission. Procurement as an instrument for promoting innovation has thus played a relatively limited role in China compared to the United States and the European Union. However, government procurement is likely to play a greater role in economic development and promoting innovation.

9.3.3.3. The National Medium- and Long-term S&T Plan

The National Medium- and Long-term S&T Plan (LMSTP) of 2006 made public procurement an instrument for promoting innovation in China. This new policy is the result of learning from best practices in OECD countries such as the United States and Korea. The LMSTP clearly seeks to promote China's indigenous innovation capability, so that the implementation of procurement policy will depend on how indigenous innovation capability is interpreted. If it is taken to mean the ability of indigenous companies to innovate, public procurement may help domestic companies competing with foreign ones to win contracts and to catch up, rather than promote leading-edge innovation. While the concept of indigenous innovation is still being debated, policies implemented since early 2006 seek to define innovative indigenous goods as those purchased from domestic companies, leaving foreign companies to provide goods and services that domestic companies still cannot deliver at similar cost-benefit ratios.[17]

However, public procurement for innovation can be viewed differently. The major goal of public procurement may be – and in fact should be – to make public services better and more cost-effective in the long run and at the same time to upgrade competition in terms of innovation and technological capabilities When seen in this light, public procurement should allow for competition that includes foreign companies in a comprehensive and non-discriminatory manner. The reason is obvious: this is the way to procure leading-edge innovation. Experience shows that even when foreign-owned companies win public contracts, spillover effects to other companies, competitors, suppliers and service and maintenance providers broaden the benefit of the public procurement, albeit indirectly and over the long term. Discrimination against foreign companies will often leave the Chinese ministry or public agency with a second-best solution rather than

17. The Ministry of Finance issued two documents, one on the management of government procurement of domestic innovation products and the other on the management of government procurement of imported products in February 2008. For more information, see SINA (2008).

a real innovation. Innovation in public procurement should be defined not as "new to the company", but new to the Chinese market. In the long run, this is beneficial for the Chinese market and the public service. However, it should be noted that restricting access to domestic suppliers for pre-commercial procurement is legally allowed in the context of the GPA, as long the pre-commercial procurement relates to R&D services.

9.4. Concluding remarks: towards a national style of innovation?

When assessing China's innovative capacity, it is important to remember that most existing frameworks were developed to measure innovative capacity in developed countries. Several aspects of China's economy, its development and its innovation system make these models unsuitable for assessing China's innovativeness and how innovative it is likely to be in the future. Some of these factors are its size, its political system, its history (with a long tradition of scholarship, science and technology, on the one hand, and the Cultural Revolution, on the other), its rapid development, and its unique access to networks, expertise and funding through its overseas Chinese population. It is also important to remember that China is still in a transitional phase. As a result, some of the challenges identified in this chapter may be temporary. For example, many weaknesses in the commercialisation process can be explained by the recent introduction of commercialisation and the resulting lack of experience, both at individual and institutional level. As China's innovation system matures, both commercialisation skills and venture capital are likely to strengthen. Other factors will require more than time for changes to occur. These include reforming the education system and increasing government funding for education. These topics have been debated for several years and progress is being made, but a lot remains to be done.

China has unique strengths and challenges. How these will affect China's future economic development is likely to be both underestimated and overestimated. Furthermore, the importance of specific framework conditions for innovation differs considerably among countries. As a result, it is difficult to assess how innovative China is today and even more so how innovative it is likely to be tomorrow. However, one thing that few may contest is that China will develop its own style of innovation.

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Table of Contents

Abbreviations and Acronyms

CAE	Chinese Academy of Engineering
CAS	Chinese Academy of Sciences
CVCF	Corporate Venture Capital Firm
FDI	Foreign Direct Investment
FVCF	Foreign Venture Capital Firm
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
GPA	Government Procurement Agreement
GVCF	Government Venture Capital Firm
HRST	Human Resources in Science and Technology
ICT	Information and Communication Technology
IPR	Intellectual Property Rights
ISR	Industry-Science Relationship
IT	Information Technology
MII	Ministry of Information Industry
MNE	Multinational Enterprise
MOA	Ministry of Agriculture
MOC	Ministry of Commerce
MOE	Ministry of Education
MOF	Ministry of Finance
MOP	Ministry of Personnel
MOST	Ministry of Science and Technology
NCSTE	National Centre for S&T Evaluation
NDRC	National Development and Reform Commission
NIS	National Innovation System
NSFC	National Natural Science Foundation of China
OECD	Organisation for Economic Co-operation and Development
PCT	Patent Cooperation Treaty

PPP	Purchasing Power Parity
P/PP	Public/Private Partnership
PRO	Public Research Organisation
R&D	Research and Development
RMB	Chinese Yuan
S&T	Science and Technology
SCI	Science Citation Index
SIPO	State Office of Intellectual Property
SIPIVT	Suzhou Industrial Park Institute of Vocational Technology
SMEs	Small and Medium-sized Enterprises
SOE	State-Owned Enterprise
STIP	Science and Technology Industrial Park
TBI	Technology Business Incubator
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UVCF	University-backed Venture Capital Firm
VC	Venture Capital
VCF	Venture Capital Firm
WTO	World Trade Organization