The new great leap:

The rise of China's ICT industry*

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INTRODUCTION

A dramatic revolution in information and communications technology at the end of the last century has changed the industrial landscape of China. The information and communication technology industry (ICT industry) is one of the fastest growing industries and recently ear-marked as a pillar industry (Meng and Li, 2002; IFC, 2005), surpassing even some traditional industries such as oil and steel in sales growth (Liang, 2004). The industry ranks first among all national industries in output, gross sales scale, as well as the contribution to national economic growth (United Nations, 2002; China Statistical Yearbook, 2005). The total amount of ICT sales doubled in the past five years and accounts for 18% of the world total. China has even surpassed Japan in 2003 and became the second largest producer of electronics and ICT products in the world, a surprising feature of an otherwise under-developed economy. Which factors can explain this remarkable development? Did the global ICT revolution boost China's ICT industry? And is China gaining the benefits of being a close follower? Is it directly related to China's economic growth of approximately 10% annually for the past decade? Or is it the strong hand of the government which facilitated the growth of the ICT industry?

What makes the ICT industry rather unique is that it became the recipient of state intervention of a special kind. Usually state intervention refers to regulation, taxation or resource control, all of which serve the purpose to either set hard (budget or regulatory) constraints or formulate negative incentives. In the case of the ICT industry state intervention refers to the opposite: deregulation of the sector, liberalization, or positive incentives in form of tax exemptions, if not subsidizations of

firms or activities. Some of the so-called state interventions are not sector-specific but refer to general programmes such as reforms in the educational system (indirect state intervention). Some forms of state intervention, however, are sector-specific such as tax rebates (direct state intervention). The overall effect of these policies cannot be assessed by looking at one set of interventions only. The question therefore is: did the state succeed in speeding up the development of the ICT industry via the chosen interventions? Likewise, the competing assumption, namely that foreign direct investment (FDI) is behind China's success in the ICT industry, deserves empirical scrutiny. Here too, one has to distinguish two effects. First, is the overall effect of FDI on economic growth, average income, workplace generation and revenues of central and local governments. Second, is the direct involvement of foreign companies in the ICT industry, as producers and "gates" to international value chains.

This chapter will show, using qualitative analyses of policy and statistics, that state intervention has been a major attempt to mobilise more and new resources in the ICT industry, using both direct intervening measures – such as providing investment incentives and promoting entrepreneurship – and indirect, non-sector specific measures – such as reforming the educational system, encouraging private investment and attracting foreign investment by deregulation. I will show which factors give rise to what kinds of incentives and constraints that shape the operations of firms in China's ICT industry and illustrate this with a case study of a local software firm in Hangzhou that managed specific incentives and constraints.

The first section starts with an introduction of the *ICT industry* in China, in terms of composition, performance, and players. The second section provides an overview of *previous research* with respect to the factors that have influenced the operations of firms in the ICT industry: state intervention, foreign investment and other factors. Section three deals with China's *dynamic economic environment*. The importance of this relatively straightforward factor is often underestimated. The subsequent sections deal with the general argument: the state attempted to mobilise more and new resources using direct and indirect intervening measures to provide incentives and pose constraints to firms in the ICT industry. Section four, introduces the argument and goes into detail with respect to direct *state intervention*. In section five, I discuss the deregulation of *foreign investment* and the inflow, source, mode and effects of foreign investment and, in particular, the role of Hong Kong and Taiwan. Section six

discusses the upgrading of the *human capital* base in terms of reforming the formal educational system and on-the-job training programmes. Section seven analyses the accumulation of *private capital* and private investment and how it is still hindered by an uncertain regulatory system. In section eight, a study of a local firm shows how various incentives and constraints affected the operations of the firm. The chapter concludes with a discussion and directions for further research.

THE ICT INDUSTRY

In this chapter the ICT industry refers to those firms that produce products or provide services related to the input, process or output of information. There are three sectors in the industry: telecommunications, computer software and hardware (Dedrick and Kreamer, 2001; Liang, 2004; Yuntin, 2004; IFC, 2005).

Impact

Of all science and technology intensive industries, the ICT industry is the most telling in terms of impact and rate of development[1]. Over the period 1997-2002, the computer hardware sector had an average annual growth rate in gross industrial output value (current prices) of almost 35%. In the same period, the electronic and telecommunications equipment sector had an average annual growth rate in gross industrial output value (current prices) of almost 20% and the software sector grew with a steady 30%. The High-Technology industries growth of gross industrial output value including the ICT sectors is 20%, excluding these sectors only 12%. Thus, showing the relatively fast growth of the ICT sectors, even compared to other fast-growing high-technology sectors. If we compare the growth rates to the overall growth of the manufacturing industries in China, which is approximately 10%, we can see that the growth of the ICT industry is truly remarkable.

Geographic concentration

The geographic distribution of firms in the ICT industry over China is unequal: most of the best performing firms in the industry are located in the following regions: the

Yangtze River Delta; the Pearl River Delta; the Bohai Sea Rim; and areas along the Shenyang - Dalian expressway. Beijing, Shanghai, Shenzhen and Xian are the country's four best-known high-tech cities. Of them, Beijing has - by far - the largest high-tech area with approximately 8,000 enterprises and 280,000 employees generating 17% of all high-tech enterprises' gross output value and 13% of all high-tech exports in 2002.

Telecommunications: operators and equipment producers

In the early 1950s, China's telecommunications sector was relatively advanced, mainly because of the strong foreign presence in the coastal areas (Harwitt, 2004). For instance, Shanghai had the largest manual exchange station in Asia. In later years the government wanted to expand its network over the whole of China. During the Great Leap Forward era, network expansion plans failed and led to few low-quality connections. In the Cultural Revolution era, the network did expand modestly, even though the quality of the connections remained poor. As Harwitt (2004) mentioned, the goal of the government was not to get a telephone in every house but to get one in every political station around the country as a new way of political control. Many of the lines were later removed because of their poor quality. It was in the early 1980s, starting with Deng Xiaoping's economic reforms, that the telecommunications system really started to take off. In the late 1980s and 1990s telephone access expanded into the homes of the Chinese and the 1990s are characterized by phenomenal growth and revenues in the telecommunications sector (DeWoskin, 2001), which is still under the control of the Ministry of Information Industries (formerly the Ministry of Post and Telecommunications).

Currently, China has the world's second largest telecom network and world's largest paging network. The overall market penetration, however, remains very low: 25% for fixed lines and 26% for mobile services (IFC, 2005). In total six telecom operators are in business, i.e. China Telecom, China Netcom (fixed line network operators), China Mobile, China Unicom (mobile carriers), China Railcom, and China Satellite (of minor importance). Most of them are listed in Hong Kong and New York but are still under the control of the state. With respect to the services and network providers, the Chinese enterprises are in control. The six companies provide the basic services and 4,400 companies deliver value added services. Internet access is provided

by China Telecom, China Netcom, China Unicom and China Mobile, Ministry of Education and the Chinese Academy of Science operating seven data communication networks: ChinaNet, GBNet/China 169, CERNet, CSTNet, CNCNet, UNINet, CMNet (IFC, 2005).

Market leaders in production of equipment are foreign producers like Nokia, Motorola and Siemens[2]. Moreover, these firms are among the largest foreign investors in China (IFC, 2005). However, domestic manufacturers are closing in. For instance, in mobile handsets they have almost 50% of the market coming from almost nothing several years earlier (IFC, 2005). Some of the major domestic producers are: Huawei, Shenzhen Zhongxin Technology Corporation (ZTE), Datang Telecom Technology (DTT), Great Dragon Information Technology (GDT), TCL, Bird, Keijan, Haier and Shouxin. With the 3G technology being introduced to the market in 2006, the market will become even more competitive. Many domestic firms, like Huawei, have developed 3G equipment and can become very competitive for foreign producers.

Although there is foreign investment in China's telecommunications market, it is only in manufacturing equipment to supply the operating companies. The operations side is exclusively domestic: China Telecom and China Netcom operate the fixed lines; China Mobile and China Unicom operate the mobile carriers (with the 3G technology standards in place, China Telecom will also enter these operations and become a competitor); and China Satcom and China Railcom as minor actors (IFC, 2005). So, the role of foreign investment in this sector is limited to the operations side. The role of the state is substantial in the telecommunications industry as both a 'guard', promoter and owner/investor (Mu and Lee, 2005). Although attempts are made to open up specific sectors within the telecommunication market, many crucial services and operations remain under state supervision.

Computer hardware

The computer hardware industry in China has its roots in the late 1950s. The first Chinese-made computer was completed in 1958. In the 1970s and early 1980s, policy aimed at developing a self-sufficient industry. In the 1980s, China increased its imports of large and mid-range computers from the US and Japan (IBM, DEC, Unisys, Fujitsu, Hitachi and NEC). The main activity was the assembly of imported kits. In the mid-1980s the growth of the sector was driven by a strong market demand

for consumer electronics in China. In the 1990s, policy shifted to a more pragmatic approach. With the opening-up after 1992, China's computer industry entered a period of growth and intensified competition; the personal computer dominated the market. It is also in this period that the state's promotion of entrepreneurship allowed firms such as Lenovo to develop competences within a supportive institutional environment (Lu, 2000; Gu, 1999).

The late 1990s are characterized by a change in composition of the computer market (Liang, 2004). Whereas the foreign[3] PC makers had 60% of the market in the early 1990s, domestic companies had 80% of the market by the late 1990s (Chung, 1999; Kreamer and Dedrick, 2001). In recent years, the largest shares belong to Chinese firms and most new players are Chinese. The domestic vendors have two-thirds of the PC market, since the high tariffs on imported PCs and peripherals drive foreign competitors to build production facilities in China (as, for instance, IBM, Dell, HP and Acer did).

Taiwan and Hong Kong firms continue to play a leading role in the industry (Kreamer and Dedrick, 2001). Hong Kong's computer industry is a mixture of SME local firms and foreign multinationals. The major products are PCs, motherboards, printers and more. Most of the companies are small, labour-intensive assembly or subcontractor operations, relying on imports from Japan and the US (Dedrick and Kreamer, 1998). Hong Kong is China's second largest trading partner after Japan and China provides the Hong Kong electronics industry with abundant supply of cheap land, subsidized factory leases and low-cost labour. Hong Kong has been a major investor in China in large-scale production and its manufacturing firms provide support services, such as packaging, promotion, design, technical assistance and technology and management transfer. Especially the transfer of skills and knowledge was crucial for the mainland Chinese firms, since the development of human capital was insufficient.

Taiwan, on the other hand, is specialized in the production of electronic data processing and components and depends heavily on technologies, components and equipment from US, Japan and Europe (Kreamer and Dedrick, 2001). In the early 1990s, Taiwanese PC makers entered China with low-end operations. The main purpose was the use of low-cost production. Since 1995, the competition from US firms grew and Taiwan increased its investments. Most investment is directed to Jiangsu Province, Shanghai and nearby cities. Between 1999 and 2001, Acer,

Twinhead, Inventec, Compal, Quanta, FIC and Arima invested in China. The level of technology is increasing, with notebooks, LCD monitors, scanners and motherboard production. Besides producing for foreign multinationals in China, the Taiwanese firms also manufacture for China's domestic companies (Kreamer and Dedrick, 2001). Half of Taiwan's IT production is now outside Taiwan, mostly in China.

Foreign investment played a significant role in the early years of the computer sector. Foreign firms dominated the sector in the early 1990s, partly driven by strong market demand and liberalization of foreign policy. Throughout the 1990s, Taiwan and Hong Kong were responsible for a large part of the investments made in the coastal regions and in the process enhanced the technology level and management skills. Furthermore, the shift of attention to the promotion of entrepreneurship to high-tech industries facilitated the development of indigenous technology.

Software

As a relatively new industry, the software sector started to develop only in the 1990s. In the 1980s most software products were sold together with computer hardware and were very specific (Zhang and Wang, 1995). There were some software projects scattered around various institutions but hardly any commercial software development existed. The global internet hype and an increasingly strong national economy brought resources to the software industry and the industry started to expand. Especially foreign investors, like Microsoft, IBM and Oracle, and private domestic investors were attracted and still dominate the market. For instance, in Shenzhen 95% of all software firms are either private or foreign. From 1992 to 2000 there was an average annual growth rate of over 30% (Saxenian, 2003;Tschang and Xue, 2003). However, as Saxenian (2003) and Brizendine (2002) observe, the software sector remains the 'weakest link' in the ICT industry. For instance, only 1.4% of the total ICT industry exports come from software. However, it must be noted that software development in China primarily started with developing Chinese language software and serving the growing domestic market. So, even though the export rates are very low compared to, for instance, India, it does not necessarily mean that the industry is ill-performing. Still, the state introduced many preferential policies, most notably tax cuts, to increase domestic companies share and software exports.

Currently the focus clearly is on the domestic market, with an increasing focus on software production. In 2003, there are over 8700 registered software firms, of which 2000 were newly founded in 2003. In total 51% of the revenues come from software products, 33% comes from systems integration and 16% from software services. Even though the preferential treatment of domestic firms over foreign firms has helped the domestic producers to gain momentum, foreign firms still dominate the market (IFC, 2005). Domestic software producers are specialized in financial software and supply chain management software. The market is fragmented with thousands of small enterprises producing niche applications and adapting software to the Chinese language. In addition, many hardware producers, such as the Lenovo Group, developed software arms. The Lenovo Group separated its software arm and renamed it Digital China. Many of the largest software developers are diversified firms, since it is difficult to be a specialized software producer in China (Saxenian, 2003). The reason for this is that more than half of China's total software output is in software services (primarily systems integration). Due to the weak property rights regime, many companies choose for integrated services, to reduce the risk of piracy. The lack of a supporting institutional environment is clearly a constraint for software firms and strongly influenced the type of operations they perform.

To sum up, the development of the ICT industry in China rests on three components:

(1) a redirection of resources and production to the effect that inherited SOEs become major players in the industry
(2) the establishment of foreign firms in this industry which produce for the international markets thereby contributing to the county's export earnings. The increasing production for the domestic market whereby they help to satisfy increasing demand for ICT products, and assist to change the capital stock of China's industrial base, to the effect that more "modern" technology is employed
(3) Domestic entrepreneurship leading to an increasing number of new firms

This begs the question whether the state through intervening aims to maintain a segregated market where SOEs play a key role in the telecommunications sector and become major players in the computer hardware market, FDI dominates in computer

hardware manufacturing, while new Chinese firms concentrate on software development - and whether this segregation can be kept by state regulation.

LITERATURE

The growth of China's economy and its industries has received much attention in the economic literature. Most of the studies that deal with aggregate explanations such as productivity gains or capital accumulation (see for instance: Chow, 1993; Borensztein and Ostry, 1996; Hu and Khan, 1997; Wu, 2003) see the similarities with the development of the economies of the "East Asian Tigers"[4] (Stiglitz, 2003; Krugman, 1994; Young, 1994) but remain too general to be able to explain the development of a specific industry[5], in this case the ICT industry. There is no comprehensive study of the ICT industry as such[6]. On the one hand, one finds studies focused on sub sectors, such as the software industry (for example Yang, Ghauri and Sonmez, 2005). On the other hand, one finds studies that focus on single cases, such as Lu's (2000) in-depth investigation of computer firms. The following tries to fill the gap and provide a more comprehensive study of the ICT industry. The existing literature is organised around two topics: studies that highlight the role of the state in the development of the ICT industry; and studies which concentrate on the role of FDI. This is done in order to review the two most frequently mentioned factors and identify several shortcomings. Subsequently, studies which mention other – missing – factors such as human capital development, private capital accumulation and the proximity to Hong Kong and Taiwan are discussed and summarised in a third paragraph.

State intervention

The role of the state in the development of the ICT industry is particularly large as other authors suggested (see for instance: Tschang and Xue, 2005; Jici and Wang, 2002; Saxenian, 2003; Lu, 2000). However, it remains unclear how the state plays a role or, more precisely, which incentives and constraints arise from the state's involvement and how these find their effect on firms in the ICT industry. It is common knowledge that China's economy, but also its political, legal and social systems, is under reform since December 1978. Not going into detail with respect to

the general reform program of China's central state, the main consequence of the reforms is that the incentives and constraints to firms continuously change. As Smith (1995) acknowledges in the context of the development of the East Asian Tigers, it is very hard to draw conclusions about the general effect of such state interventions. Garnaut (1990) argues that this depends on the specific type of intervention and the context of the intervention. Since the state – be it the central or the local state – is the driver of reform, the state's policy with respect to the ICT industry is a crucial factor in the industry's development (Kreamer and Dedrick, 2001; Yuntin, 2004).

The intervention by China's central state in the ICT industry is highly selective, that is, the intervention is a policy measure to change the allocation of resources, thereby favouring individual or groups of activities (Lall, 1994). The ICT industry has received many forms of preferential treatment and re-allocation and distribution of resources, often in the form of subsidization rather than mere regulation or taxation measures, in contrast to other industries. For instance, Gu (1996) investigated new technology enterprises. Encouraged and supported by the state, R&D institutes started to commercialize their technology via establishing a profit-oriented enterprise or joint venture with private investor. These enterprises are usually collective or collective-private enterprise subordinated to the specific R&D institute and often referred to as New Technology Enterprises (NTEs). He identified the important role of state support and the availability of resources from existing institutions. Studying the software sector, Saxenian (2003) stresses the widespread institutional changes and the persistent role of the government and *guanxi* in the development of the software sector. In the same sector, Yang, Ghauri and Sonmez (2005) conducted a competitive analysis – identifying strengths, weaknesses, opportunities and threats – of the software industry in China and paying particular attention to the role of government policies in shaping the competitiveness of the industry[7].

Even though *direct* state intervention is an important factor in the development of the various sectors in the ICT industry, we need a more detailed analysis of the mechanism by which state intervention plays a role. This kind of explanation still stays at a very general level and does not allow the identification of specific incentives and/or constraints that firms are faced with. It is also *indirect* state intervention in, for instance, the development of the educational system or the liberalization of investment rules and regulations that provides incentives and poses

constraints to firms. It is this mechanism of incentives and constraints that helps us to understand how state intervention influenced the growth of Chinese ICT firms. In short, a more detailed account of incentives and constraints that arise from both direct and indirect intervention is necessary to understand the effect of state intervention.

Foreign investment

Foreign investment is usually viewed as contributing to economic growth by facilitating technology transfer and marginal productivity improvement. This occurs through the externalities technology transfer may engender - technology transfer in this context means the flow of technology from developed to developing countries (Berthelemy and Demurger, 2000). Numerous studies find that increased foreign investment and international trade had positive effects on economic growth (Berthelemy and Demurger, 2000; Chuang and Hsu, 2004; Hobday, 1994) and industrial upgrading (Gereffi, 1999). Gereffi (1999) for instance, argues that better positions in international trade networks allowed East-Asia's apparel manufacturers to upgrade from labour-intensive assembly to skill-intensive full-package supply of new goods and services. However, it remains to be seen whether such upgrading actually takes place in the case of China. As several interesting studies on the role of foreign trade and investment in China suggest, the strong reliance on foreign investment may not be so forthcoming to China's domestic private entrepreneurs (Huang, 2001; Lardy, 1995). Huang (2001) argues quite convincingly that FDI came to China because of the opportunities posed by the state's preferential treatment and the large involvement of FDI in state-owned enterprises (SOEs) because of the political capital necessary to invest. Subsequently, China has had rapid export growth rates but this has depended highly on foreign invested firms. As Lardy (1995) and Huang (2001) conclude, this high reliance on FDI for maintaining export rates and aiding the privatization of SOEs, actually inhibited the growth of the private sector, mainly by missing backward linkages and low domestic content of exports.

These studies, however, are on a national economic level. Many other studies – on an industrial or firm level – suggest the positive effects of foreign investment in the ICT industry, indicating that the preferential treatment of this sector in combination with large foreign investments directed to this industry, might actually have had a positive impact on this industry. Zhao (1995) finds that the foreign

investment boom aided many firms in the ICT industry to accumulate capital, acquire new technology, imitate and learn from foreign firms and develop skills. This finding is supported by a World Bank study (1996) and Liang's (2004) investigation of FDI and industrial development in China's ICT industry (among other industries in his analysis). In short, a more comprehensive assessment of the specific incentives and constraints arising from foreign investment is necessary to be able to draw more precise conclusions about the effect of foreign investment on firms in the ICT industry.

Other factors: economic growth, human and private capital, governance and the proximity to Hong Kong and Taiwan

Several studies direct our attention to a combination of explanations for the success of (firms in) China's ICT industry: overall economic growth, human capital development, private capital accumulation and investment, the role of SOEs and the proximity to Hong Kong and Taiwan. Studying the software industry, Tschang and Xue (2005) identify state intervention as the main factor in software industry growth. However, they also stress that the overall economic growth played an important role in the growth of the software industry by providing investments and increasing demand. Furthermore, they identified the low quality and quantity of human resources as inhibiting growth, a conclusion shared by the earlier study of Wang (2003) on the role of human capital in the economic growth of China. Jici and Wang (2002) try to explain the growth of the personal computer industry in China. State intervention and the accumulation of private capital, which spurs demand and investment, are the two main reasons found by them for the growth of the PC industry. The latter explanation finds support by studies of Rodrik (1995), Huang (2001) and Lardy (1995) which point at the important role of state intervention in the promotion of private investment and saving. China witnessed a large increase in private capital and private investments. Furthermore, Jici and Wang's research suggests two other reasons: (1) the evolution of many successful firms out of older state enterprises and (2) the interaction with Hong Kong and Taiwan.

The first reason is in line with Lu's (2000) findings in his study on how and why 'indigenous Chinese companies [were] able to catch up in a high-tech industrial sector such as computers' (Lu, 2000; p.2). The in-depth study of four Chinese

computer companies leads him to stress the importance of innovative learning. Moreover, the specific institutional structure of corporate governance in these companies was conducive to such learning and innovation. Basically, firms evolved out of state-owned organizations with access to science and technology resources and a market. Having a socialist past, the Chinese economy has both the disadvantages and advantages of a socialist legacy. On the one hand, many former state-owned enterprises have the burden of complex bureaucratic structures and the uncertainty of the outcomes of economic reforms. On the other hand, organizations – such as the computer enterprises investigated by Lu (2000) – had the advantages of a secure customer base and access to state developed technology.

The second reason, the proximity of the southern coastal provinces to Hong Kong and Taiwan, is strongly related to the foreign investment thesis, but the influence of Hong Kong and Taiwan is especially significant in the ICT industry. Taiwan started the electronics development in the 1950s (Hobday, 1995) and has many small firm innovation clusters. Technological development in Hong Kong, on the other hand, is characterized by *laissez-faire*, market-led industrialization. In the early 1990s, large numbers of firms relocated into China, as wages rose. Hong Kong and Taiwan became the largest investors in China (Sun, Tong, and Yu, 2002). Both Hong Kong and Taiwan provided domestic Chinese ICT firms access to the international market, although it is unclear whether this actually led to better positions in international trade that helped upgrading the operations, as Gereffi (1999) would argue. It is clear, however, that the economies in the region – Hong Kong, Taiwan and China – have become more intertwined. Adams and Davis (1994) and Elek (1994) argue that this might reduce the significance of government policies. In short, there is a range of other factors that influence the firms in the ICT industry, beyond direct state intervention and foreign direct investment.

The review highlights the state intervention and foreign investment theses as dominant explanations for the growth of the ICT industry but also identified several shortcomings in the sense that it remains an incomplete explanation. On the one hand, state intervention is both direct and indirect and an exploration of both is necessary to understand which incentives and constraints ICT firms have to manage. On the other hand, the effects of foreign investment are inconclusive, meaning that it can lead to both incentives and constraints. In the following I propose an exploration of direct and

indirect state intervention and foreign investment and identify several incentives and constraints arising from both factors. Furthermore, I will include other factors that some of the studies point at to make a more comprehensive assessment of incentives and constraints: human capital development, accumulation of private capital and investment, proximity to Hong Kong and Taiwan. The analysis starts with an assessment of the overall economic environment, a factor often mentioned but underestimated in impact.

ECONOMIC GROWTH: BETWEEN INCREASING DEMAND AND UNCERTAINTY

The fact that China's economic growth is unsurpassed in the last decades can hardly be doubted. With an average annual growth in GDP of 10%, China is growing harder than any other country in the region (**Figure 1**). Except for some pessimistic authors (for example Chang, 2001), the overall image is one of growth and opportunities. Viewing it as a window of opportunities, economic growth boosts investment and increases consumption (i.e. GDP per capita increased from RMB 2000 in 1992 to RMB 4000 in 2003). Investment in information infrastructure, for instance, is an important factor, considering the relatively underdeveloped state of the art compared to other developing and advanced economies in Asia in terms of internet use, personal computers installed and ICT expenditures (Dahlman and Aubert, 2001; China Statistical Yearbook, 2004). It does not only help firms, institutions and entrepreneurs to reduce costs, increase market coverage and achieve economies of scale, it also increases awareness and understanding of new technologies among (future) customers.

[insert Figure 1]

The expansion of the market not only creates business opportunities for domestic firms. At the same time it attracts foreign (see the case study at the end of the chapter) producers to the effect that domestic companies need to learn how to compete. The competitive pressures force underperforming firms out of the market, save for those still protected by state preferential treatment. Furthermore, with more competition and

a faster pace of development, the rules of the game change. The Chinese economic environment has often been characterised as adverse (Nee, 1992; Redding, 1990; Xin and Pearce, 1996; Hendrischke, 2004). This translates into uncertainty and risks that pose firms with severe resource, management and other challenges. This is especially so for firms in newly emerging industries such as the ICT industry (Aldrich and Fiol, 1994; Feeser and Willard, 1990; Shan, 1990; Zahra and Covin, 1993). They lack technical and social requirements such as managerial and technical skills and there is no past experience or a template for success or failure.

In fact, the market – the firms – are demanding more market-oriented institutions. As a result of the co-existence of socialist institutions and newly created, market-based institutions (Krug and Polos, 2004), the economic environment has weak economic institutions. The institutions are not weak because they have a socialist hue, which traditionally is unsupportive of private capitalists, but because there are institutions in place coming from both the socialist era and more market-oriented institutions. Both of them are not complete in the sense that they do not provide a stable institutional frame (Qian, 2000), which would reduce the uncertainty emanating from external shocks, value changes, or innovation (Krug and Polos, 2004). Thus, even though rapid economic growth creates opportunities, it also poses constraints to the development of firms in the ICT industry.

ICT INDUSTRY: DIRECT AND INDIRECT STATE INTERVENTION

Both the literature and development patterns in the ICT industry suggest that state intervention has both a direct and indirect influence on firms in the ICT industry. This section will analyse the general regulatory frame, ICT industry specific incentives and regulation, the promotion of entrepreneurship and the role of SOEs – the direct factors – and introduce several factors related to the reform of China's wider economic environment – the indirect factors.

The general regulatory frame

The central state initiated reforms and programs to restructure and reform technology development within China since 1978. There are basically four phases of reforms. The

first phase (1978-1984) is a period of restoration, in which the central government tried to restore the level of technology to pre-Cultural Revolution level and commercialize results from the state S&T system. The second phase (1985-1986) started with the idea that collaboration between state research and enterprises would facilitate the commercialization of technologies from the state S&T system (Lu, 2000). However, most of the resources went to state-owned institutes rather than the potentially more innovative non-governmental enterprises (Saxenian, 2003) and not many new products were brought to market. The third phase (1987-1992) is characterized by the intention to further merge industrial research and development (R&D) institutes into enterprises; though enterprises found it harder than. The Torch Plan of 1988 aimed at creating a supportive institutional environment for the development of new technology enterprises. Entrepreneurship was promoted and actually lead to the creation of several High-Tech Industrial Development Zones and many new technology ventures. The most recent phase started in 1992 with Deng Xiaoping's famous Southern Tour. Government policy offered for the first time significant domestic market access to firms that brought in advanced technology. The policy reforms led to a massive flow of foreign (direct) investment into China. Furthermore, (private) entrepreneurship was promoted by the adoption of the Company Law (December 1993, amended in 1999) and the important constitutional change in 1999, which established the status of private and non-state sector enterprises (Sole Proprietorship Enterprise Law in 1999). The WTO membership in 2001 clearly has many consequences for trade and foreign investment, mainly increasing foreign presence and influence in the Chinese markets.

Incentives in the ICT industry: knowledge sharing and arm's length regulation

The state has been – and still is – very active in promoting and regulating the high-technology industry and the development of science and technology in general. The Ministry of Science and Technology (MOST) is responsible for many promotion programs. The 'Key Technologies R&D Program', the '863 Program' and the 'Torch Program' are all initiatives of the MOST. The programs funded S&T projects in institutes of higher education, R&D institutes, enterprises and companies. The Chinese Academy of Sciences (CAS) is China's science and technology (S&T)

research organization. It has 123 research institutes, employing over 60 000 scientific and technical personnel. Research focuses on mathematics and physics, chemistry, earth sciences, biology and technology.

The CAS has been very active in commercializing R&D from CAS research. At the end of 2001, 13 CAS institutions had been transformed (CAS, 2006) into enterprises: 12 became limited-liability firms and one merged into a state-run company. The firms reached a total turnover of 81 billion RMB (USD 9.7 billion) in 2001. The Chinese Academy of Engineering (CAE) and the state Natural Science Foundation Committee (NSFC) are two other important institutions in the technology sector. The CAE was established in 1994 and is a key advisory institution for the engineering community. The NSFC was established in 1986 to promote and finance S&T research. All in all, the central government and associated institutions are very active in the provision of incentives for the development of technology in general and ICT specifically.

Overall, state intervention often takes the form of subsidization. The rules and regulations for the ICT industry are relatively broad and focused on the promotion of sectors or technologies. The overall ICT development and commercialization facilitating environment is illustrated by the case of an ERP software firm in Hangzhou, at the end of the chapter. However, there is no clear set of rules and regulations (yet) that regulate the ICT industry. The newness of the industry and the rate of development make it difficult for policy makers to keep up. As DeWoskin (2001) observed, sometimes the changes in technology are one step ahead of policy, eventually forcing policy to fit the technology. In this kind of regulatory environment entrepreneurship can also be promoted by the lack of specific institutional requirements. Entrepreneurs are not burdened by complex sets of rules and regulations that characterize the traditional industries. Of course, the lack of a straightforward institutional system is a burden, especially in the case of piracy-sensitive software development, but it also means less rules and regulations that need to be obeyed and thus less interference of the state. So, it is not possible to single out positive or negative effects conclusively, which adds uncertainty to the institutional environment.

Stimulating entrepreneurship: carving out a hospitable niche

Many programs promoted the establishment of new technology enterprises and entrepreneurship at large. One of the most striking endeavours is the Torch Plan (Gu, 1996; 1999; Wang, Wu, and Li, 1998; Sigurdson, 2004; White, Gao, and Zhang, 2002) and the subsequent development of technology development zones and the creation of new enterprises with a special legal status (Gu, 1999; Lu, 2000)[8], which led to strong concentration of ICT firms. The Zones facilitate the operations of the ventures and provide preferential treatments (for example tax cuts), infrastructure and access to capital (from state, banks and foreign investors), including venture capital. In return, the government obliged the enterprises to meet certain requirements. Firms have to meet the following criteria (Lu, 2000): (1) operate in the area of new and high technology as indicated by the Ministry of Science and Technology; (2) have appropriate capital and physical resources, market potential and acceptable organizational and managerial abilities; and (3) the chief manager should be a scientific or technical professional. These Zones are different from the Special Economic Zones that had been established earlier. The technology zones are more geographically distributed over China, there is preferential treatment for both foreign and domestic investors but the preferential treatment is less favourable than in the Special Economic Zones.

The promotion of entrepreneurship in the ICT industry has been – and still is – one of the main goals of state intervention in high-technology industries. The reforms in enterprise policy have been substantial and created opportunities for entrepreneurship. The adoption of the Company Law in December 1993 (amended in 1999) and the Sole Proprietorship Enterprise Law in 1999 paved the way and allowed private enterprises as an organizational form and this opened up possibilities for technology entrepreneurs, especially in enterprise development zones[9].

The emergence of new SOEs

Strongly influenced by state intervention and clearly a result of reform policies and industrial experimentation is the governance mechanism of many (former) state-owned enterprises or organizations (Lu, 2000). Ever since the reforms started, the central government tried to commercialize state R&D; first by reforming the state R&D system to its pre-Cultural Revolution level, later by trying to create a technology market. Both attempts proved to be harder to realize than expected, as

argued by Gu (1999), because there were many uncertainties with respect to technological innovation, inexperience of users in general and underdeveloped market institutions. In the late 1980s – early 1990s, the attempts were more successful. Several decisions and policies supported the integration of R&D assets with commercial production within newly-created enterprises, which were basically spin-offs of state R&D institutions (for example universities). The state as a partner enabled these enterprises to use resources and customers from the state sector. Support was given through financial incentives, preferential stipulations and basic intellectual property rights (Gu, 1996). The institutional environment provided ways to tap into networks of finance: R&D institutions (some venture capital), banks (expansion funds) and Technology Zones (infrastructure). The arrangement combined state ownership with market-oriented, enterprise management enabling a 'collective rationality of building strong organizational capabilities with the strong financial commitment within the institutional framework' (Lu, 2000: p. 187). Examples of such successfully created enterprises are Lenovo and Founder.

Not only incentives

State intervention also poses constraints to the population of ICT firms at large. The most straightforward constraint is that preferential treatment of sectors or even individual firms hinders the market process. Only the firms that fall in the categories chosen by the central or local governments are supported but this does not mean that firms that do not fit the categories are not potentially innovative or successful. An example is that in many cases large funds for creating innovative new enterprises actually go to state-owned or controlled firms (Saxenian, 2003). It also inhibits risky investments with potential higher returns and the development of a venture capital market. Another example is the high-tech zones. In principal these prove to be very beneficial for the enterprises within them, but they are also an institutional device of the government to control resources and influence decisions. The enterprises were obliged to meet certain requirements, such as the number of technical personnel, the allocation of retained earnings and the percentage of sales spent on innovation (Lu, 2000). Such preferential treatment also meant direct control over several sectors – such as the telecom sector – prohibiting foreign investment and any other

'interference'. The main reason of the state was to keep an eye on the Internet and telecommunications. This limited the possibilities for firms in this sector severely.

Besides many successful interventions, many plans, such as the technology auction and forced merging of organizations, did not work as well as the central state had hoped. Experimentation – in technology and policy – has lead to the failure of firms and inhibited firms' own initiatives. Only after the initial experimentation, the main bottlenecks came to light: lack of trained engineers, scientists and managers, inexperienced users, a general lack of a technical basis for economic and social development. A related result of continuous change of policies and regulations is a dynamic but also very uncertain institutional environment. Weak institutions do not contribute to the problem of reducing high uncertainty caused by the technology, competition or the market (Krug and Polos, 2004) because – for instance – property rights are not clearly defined (Lau, Lu, Makino, Chen, and Yeh, 2002), which particularly is a problem for software firms (Saxenian, 2003). Another example is the telecommunications market in which a lot of uncertainty exists about issues such as the 3G standards (which will be assigned by the central state), the opening of the market, and the control and censorship of content.

Indirect intervention

Basically, as the next sections will show, there are other factors important in the development of the ICT industry that are more or less influenced by state intervening measures: foreign investment regulation, private capital policy and the educational system. Some of the reforms were supporting the development of the ICT industry, others were inhibiting it. First, state intervention in *foreign investment* promoted and attracted many foreign investors. In the early 1990s, the central government changed its foreign policy by offering market access to firms that brought in advanced technology. In 1992, the management of technology import was transferred to the State Economic and Trade Commission and changed from a system of 'technology import control' to 'scale of funds control'. The central government set the macro-targets – focusing more on electronics, motors and machinery – but responsibility with respect to the management and control of imports was given to enterprises. Second, *human capital* is one of the key assets in high-technology industries such as the ICT industry (Becker, 1962). The relative weakness – in terms of skilled labour -

of China's human capital base has been the reason for many reforms and other types of state intervention. For instance, the State Council's Decision on accelerating scientific and technological progress (1995) also aimed at promoting and developing high technology and the training of workers. Several reforms of the educational system were enacted and directed at enhancing human capital development. Third, state intervention also increased market demand by promoting the use of IT. The Golden Projects in the early 1990s are good examples of how the central government promoted the adoption of IT in banking, furthered the development of telecom and promoted computer networking for foreign trade. Furthermore, the reforms in the *private capital* market slowly allowed private equity and venture capital to develop, which are crucial incentives for the ICT industry.

FOREIGN DIRECT INVESTMENT: BRINGING THE NEIGHBOURS IN

The development of China's ICT industry is characterized by the strong presence of Hong Kong and Taiwan firms, as well as multinationals, demonstrating the dramatic change in China's foreign trade policy. Indeed, the statistics show that:

(1) FDI increased in response to deregulation of markets
(2) FDI is predominantly of Asian origin, with Hong Kong and Taiwan playing the leading roles
(3) Foreign firms tend to establish subsidiaries rather than joint-ventures when this became an option
(4) FDI became a new channel for technology transfer
(5) FDI might not be 'really' foreign, leading one to question the extent of technology transfer and learning of new capabilities

First, foreign direct investment increased sharply in response to the deregulation of foreign investment policy. The total inflow of foreign capital increased from USD 4.5 billion in 1985 to USD 64 billion in 2004. From the early 1990s onwards, the composition of total foreign investment changed. Even though some foreign capital is still from loans or other foreign investments, it has become predominantly direct investment (FDI) (China Statistical Yearbook, 2005). There has been an increase in

investment from USD 1.7 billion in 1985 to USD 60.63 billion in 2004. There are basically two phases of FDI inflows (Sun, Tong, and Yu, 2002; Yi, Zhang, Men and Huang 2004). The first phase is between 1979 and 1991. In the first half of this phase, FDI is concentrated on particular state-owned traditional industries in the coastal regions. In the second half, access was extended to a limited amount of other industries and some central regions. During this phase, the Open Door policy was predominantly restricted to the coastal region, foreign investors had limited access to the Chinese domestic market and the range of industries in which foreigners could invest was restricted. In the second phase opening up was extended to all regions, the pace was accelerated, the domestic market has been further opened, and the direction shifted from a regional to an industry based orientation. China maintained a strong specialization in traditional industries (for example clothing), but also started to build up new, technologically advanced industries (for example computer equipment).

[insert Figure 2]

Second, foreign direct investment is predominantly coming from within the Asian region (**Figure 2**). Within the Asian region, Hong Kong, Japan, Taiwan, Korea and Singapore, invest approximately 95% of total Asian FDI (China Statistical Yearbook, 2005). Hong Kong and Taiwan have been particularly important as foreign players in the Chinese ICT industry. Given the inequality in population, size and resources they play a remarkable role in the development of Chinese ICT. As shown in the discussion of the computer industry, the role of Taiwan and Hong Kong firms in terms of investment, learning new technologies and getting managerial assistance is substantial. China received almost USD 60.63 billion of foreign direct investment in 2003. The share of Hong Kong and Taiwan of the total amount is 36% (China Statistical Yearbook, 2005); thus indicating the dominance of two single, small, territories. Furthermore, the amount of trade with Hong Kong and Taiwan is substantial. In 2004, China traded almost 29% of its Asian trade with Hong Kong and Taiwan; culminating to almost 17% of the world total. It must be noted that Japan remains the largest trading partner with 27% of China's Asian trade and 16% of China's world total trade. Hong Kong and Taiwan provide China with a large amount of investment and, especially in the case of Hong Kong, support services and technical and management transfers. The proximity to both economies enabled

mainland Chinese firms to tap into international markets and imitate and learn new capabilities.

Third, the entry mode changed from cooperative enterprises to subsidiaries with a considerably stronger commitment when this became an option. Yi, Zhang, Men and Huang (2004) identified four ways in which FDI enters China: joint-venture enterprises (JVEs), cooperative operation enterprises (COEs), foreign investment enterprises (FIEs) and cooperation development (CD). Until 1992, the total amount of FDI was small and the COE and CD entry modes were dominant. The turning-point is in the early 1990s. From this point onwards the share of foreign investment enterprises increases to almost 50% of total FDI. The share of COE and CD declined when more structural investments were allowed and foreign investors were allowed to make stronger commitments. The development of FDI and types of FDI entry modes is strongly linked to the regulatory reforms regarding foreign firms and national-level political events (**Table 1**). The more rights and opportunities were given to foreign enterprises, the larger the inflow of investment.

[insert Table 1]

Fourth, foreign investment - FDI - became a *new* channel for technology import besides capital accumulation and importing management skills (Wang, Wu, and Li, 1998; Zhao, 1995). During the process, localities got more authority and enterprises were given more responsibility through various policy reforms. As Piek (1998, p. 35) observed ‘decentralisation of institutions and lifting of state’s monopoly in the foreign sector stimulates domestic enterprises to enter the world market’ or many ICT firms, the increase of foreign investment had positive effects by increasing investments, transfer of knowledge and larger markets.

Fifth, although a very large stock of FDI has entered China, the story is perhaps not as rosy as the figures suggest. The FDI per capita is not large, compared to other Asian countries. For example, stock per capita in China is USD 160, in Thailand USD 320 and in Malaysia USD 2000 (Lemoine, 2000). The distribution of FDI is very uneven with a concentration in the coastal provinces (China Statistical Yearbook, 2005). Furthermore, it is unclear to what extent FDI is actually really ‘foreign’ and,

subsequently, to what extent transfer of technology takes place through foreign investment. Graham & Wada (2001) argue that (unspecified) parts of Hong Kong FDI, the largest source of FDI, is in fact of domestic Chinese origin, which is 'round-tripped' through Hong Kong, or Western nations and Taiwan that enters China through Hong Kong intermediaries. Huang (2001) argues that round-tripping of foreign capital was actually promoted by the foreign investment policies of the government which favoured foreign enterprises over domestic enterprises. Furthermore, he finds, as Lardy (1995) did, that China's high reliance on FDI is not healthy because it inhibits the private sector by creating more competition and giving more preferential treatment to such foreign invested firms and protection of SOEs, thereby inhibiting productivity growth. The main problem of round tripped foreign capital is that it does not involve technology transfers and learning of new capabilities, which questions the benefits from the sharp increase in FDI.

HUMAN CAPITAL DEVELOPMENT

Human capital is a crucial factor in the development of the ICT industry but seems insufficiently developed for the demands of an emerging ICT industry in China. On the one hand, 'qualified personnel, who can monitor technological and other trends, assess their relevance to the prospects for the country and individual firms, and help to develop strategy for reacting to and taking advantage of trends' are needed (Dahlman and Nelson 1995, p. 97; see also Mytelka, 2001). On the other hand, strong education is also necessary at the primary and secondary level '… to speed the diffusion and adoption of new technologies, to make local adaptations and improvements on the shop floor, and more generally to increase the awareness and ability to take advantage of technological opportunities.' (Dahlman and Nelson 1995, p. 97). However, the pre-reform period had left its scars on the educational system. Several observers typified it as not sufficient for the development of the necessary human capital (Cheng and DeLany, 1999) and as 'over-centralized' (Mok, 2002). A World Bank study has shown that regulation of the labour market and the skills of employees were the major constraints of the investment climate in China over the past years (Table 5.2, World Development Indicators, World Bank, 2005; also affirmed by another recent study done by IFC, 2005).

Formal education: redefining the talent pool for the ICT industry

In order to expand the ICT industry, more and better qualified academics and skilled workers were needed. While the latter can be trained in-house, the former have to pass the state controlled university system. The challenge was therefore to reform formal education so that it produced more academics, upgraded technical university programmes and opened new programmes, such as management studies. The results so far are mixed, as the statistics show that:

(1) basic education is well-developed but access to higher education remains rather limited
(2) technical education is well-developed whereas management education remains problematic
(3) the low ratio of students returning from abroad indicates a potential brain drain
(4) the management and finance of the formal educational system has improved substantially as a result of deregulation

Firstly, the actual rate of growth of human capital in terms of average years of schooling in the population aged 15-64 has declined in the reform period, as compared to the pre-reform period (Wang, 2003). It seems that access to secondary and tertiary education is problematic, as indicated by the gross enrolment ratios (**Table 2**). This is a ratio of total enrolment, regardless of age, to the population of that age group that officially corresponds to the level of education shown (World Development Indicators, 2005). A figure over 100% indicates that there are people enrolled at a certain level that are older than the age group that corresponds to that level. All countries (European, North-American and Asian) have a primary school enrolment ratio of around 100%; this means that the amount of enrolments is as large as the population of the age group that corresponds to that level. However, the secondary and tertiary enrolment rates in China are considerably lower than in all other countries. The statistics show that, compared to other countries, the number of people from the age groups that correspond to the secondary and tertiary level that are actually enrolled is very low. Access to higher education remains limited in the 1990s (Wang, 2003) and still in more recent years: for instance, in 2004 only 12.7%.

[insert Table 2]

Secondly, the figures indicate that engineering, management and literature are attracting the most students and deliver the most graduates (**Table 3**). The reasons for this are harder to find. It is possible that engineering subjects attract the most students because these subjects are often in the spot-light of government policy; for example the 10th Five-Year Plan focuses on engineering and science related topics such as computers, telecommunications, biotechnology. Furthermore, the promotion of high-technology products has increased the socio-political legitimacy of such specializations. Management studies are also attracting more students: the number of students enrolled in management studies has increased by 24% in 2003 and the number of management graduates almost doubled in 2003 (46%). However, management studies are still ill-developed and ill-promoted and the absolute number of management graduates remains low. The level of education and management training among Chinese managers continues to be a major concern for foreign invested enterprises (FIEs) even though the situation has improved since the mid-1990s (see for instance, Tsang, 1994).

[insert Table 3]

Thirdly, in order to import superior knowledge in China's economy, a quantity of students are sent abroad every year. At the beginning of the reforms, in 1978, official records state that 860 students studied abroad and 248 returned. In 1993, there were already 10,742 students abroad with only 5,128 returning (China Statistical Yearbook, 2004). In 2003, the ratio of students abroad to students returned was even more unbalanced, according to official statistics: 117,307 remained abroad, while only 20,152 returned. If these statistics are correct, one may speak of a trend: more people are going abroad than returning; and illustrating the so-called 'brain-drain' (Cao, 1996), even though it is impossible to assess the quality of the students that (did not) return. At least half of Chinese students are extending stays or trying to seek permanent residency in foreign countries. The Chinese Embassy in the US estimated that from the 160,000 Chinese students that came to the US, in the past 20 years, only

20,000 had returned by 1998. Several scholars point to the seriousness of this problem (Saxenian, 2003; Zhang and Li, 2001).

Fourthly, the management and finance of the educational system has improved considerably as a result of deregulation. A considerable change is the new two-level management system consisting of central and local governments with the latter as the main management body. The state gave more autonomy to the local government and institutions (Mok, 2002). The local government is playing a key role in compulsory education, while central and provincial governments are dominant in higher education. In occupational and adult education, social partners, including industrial organizations, businesses and public institutions, are playing a more important role; suggesting the development of on-the-job training. The local governments are also increasingly stimulated to develop higher education and enhance the relationship between education and regional economic and social development (Mok, 2002).

Furthermore, universities are no longer funded exclusively by the government (Mok, 2002). Calculations from the official statistics of the China Statistical Yearbook indicate that the state's share of educational funding was 84% in 1990 and dropped to 67% in 2000. However, this does not indicate that the government invests less in education but that there is more investment from other sources; the total funds more than doubled every five years, in the last two decades. China received educational funds from UNESCO, UNICEF, UNFPA, UNDP, the World Bank and many other international organizations. Furthermore, the government allowed privately-funded educational institutions and private schooling on other levels. Wang (2003) shows that even though the private financing of education has risen, the distribution is not even and that the distribution of educational funds is even more skewed if one takes private financing into account. Furthermore, it must be noted that China only spent 2.5% of GNP on education in 2001, whereas other developing countries, such as the Philippines, India, South Korea and Singapore spend more than 3% and Thailand and Malaysia more than 4% of GNP of education (UN, 2002).

It is clear that the formal educational system is being upgraded but still remains underdeveloped to meet the needs of the ICT industry. Overall, the size of investments in the formal educational system increased and the management improved. There is a wide range of curricula available at various levels of education

and more – but still too few – students enter higher education. The large amount of engineers that graduate every year suggests a sound human capital base for high-technology firms. The case study at the end of the chapter illustrated how this can lead to a highly-educated group of technical employees. However, the gross enrolment ratio of students in tertiary education is comparatively low and the quality of education is hard to assess. For instance, the training and education of managers seems ill-developed. Overall, China has a low percentage of college-educated workers and lags behind developed world standards (Heckman, 2005).

On the job training: upgrading management

On-the-job training has become an important strategy for developing technical but foremost management skills (Xiao and Tsang, 1999). The Decision on the Reform and Development of Adult Education (1987) stipulated that job-related training should get the highest priority as a tool to develop job-specific skills that cannot be provided by the formal educational system. The decision has been implemented in various ways: integrated on-the-job training, job-related technical drills, short-cycle training classes, thematic lectures and supervised self-study (Xie, 1994).

Data on training in Chinese companies is almost absent, save for some case studies on human resource practices. Cooke's (2002) study on two manufacturing companies show two different approaches. One firm, a beer company, obliged employees to spend 100 hours on training each year to enhance management skills and the production-related skills. The firm had contracts with two universities to provide management training, professional and technical training and further education (for example for shop/office-floor employees). In general, the Chinese State Commission organizes several courses and programs for managers and teachers in collaboration with international institutions and organizations (Ding, Fields, and Akhtar, 1997). Another firm, a motor company, provided hardly any training, partly because of the low demand for training because there was little innovation and a static workforce. Ding, Fields and Akhtar (1997) study 158 foreign-invested firms in the Shenzhen Municipality investigated human resource management practices of mainly manufacturing industries and some service and trading industries. They found that managers in FIEs in the electronics manufacturing sector received the most training and in the trading business the least. Overall, more than 60-70% of the managers of

FIEs in China received training. Of the non-managerial personnel, approximately 50% received training. The major explanation for such high figures is that many FIEs have the obligation to train employees under the Labour Law.

Based on fragmentary information, it is hard to say anything definite about the incentives or constraints rising from on-the-job training. However, the cases show that such training is often provided by firms and that it is directed at upgrading both management and technical skills. As a building block of human capital, on-the-job training is important but the commitment of firms to such training is unclear. In the case study at the end of the chapter we see that on-the-job training also is a way to cut education and recruitment costs.

PRIVATE CAPITAL ACCUMULATION: WITH THE HELP OF YOUR FRIENDS

When it was said earlier that the development of the ICT industry was accompanied by the emergence of new firms producing new products, then the question is not only where did the competence come from (the question of the educational system) but also where did the capital necessary for establishing new firms come from. China witnessed a large increase in private capital as is shown by the growth of private capital flows (from USD 8.107 billion in 1990 to USD 59.455 billion in 2003) and significant increase in savings deposits (from 7.12 billion RMB in 1990 to 103.618 billion RMB in 2003). However, an overall increase in private capital does not necessarily mean an increase in private investment. **Figure 3** shows private investment[10] as a percentage of GDP over the period 1980-1999[11]. There is an overall increase in private investment: from only 3.7% in 1980 to 17% of GDP in 1999. Especially from the early 1990s onwards the share of private investment in the Chinese economy is growing.

[insert Figure 3]

On the one hand, an increase in private capital boosts demands for new products, as was repeatedly the case in the computer hardware - and software sectors. On the other hand, it boosts investments. The People's Daily (2005) reports in several articles that domestic private capital drives the economy. For instance, domestic private capital

investment now accounts for 50% of Shanghai's total infrastructure construction industry. Beijing has seen over 60% of housing investments made by private investors. Many transformed Chinese firms under high financial pressures look for outside financing to realize growth and find private equity investors important partners and an important complement to creditors in shaping the incentives of firms.

The private capital market, however, remains underdeveloped. Private equity, especially venture capital, finds it hard to reach firms, even though most of the venture capital is directed to the high-tech industries (Batjargal and Liu, 2004). There are no regulations with respect to the legal and organizational structures and would-be investors, mainly local governments, set up limited liability corporations. The Company Law, however, inhibits investments of more than 50% of capitalization in subsidiaries or other entities, thus preventing firms from investing more than 50% of their assets in other things than cash-equivalent securities (Tenev, Zhang, and Brefort, 2002). The result is that the 'common' legal form of venture capital firms in advanced economies such as the United States - the limited liability partnership - is thus not recognized (Batjargal and Liu, 2004). The main problem is not that the limited liability partnership is the only possible form venture capital firms should adapt, but 'all venture capital firms are registered and operate as limited liability companies, adding confusion as well as serious risks to the processes by which venture capital firms raise, invest, and manage funds.' (Batjargal and Liu, 2004: p.159). Furthermore, as Tenev, Zhang and Brefort (2002) observe '… the state still plays a ubiquitous role as fund sponsor, investor and manager.' (Tenev, Zhang and Brefort, 2002: p. 72), thereby inhibiting risky investments with potentially high returns. Reforms of the legal framework should promote the development of private capital and equity markets, but for the moment they are insufficient. Concluding, the accumulation of private capital is a strong incentive but the development of a private capital market is highly constrained by state intervention. With the private capital market still underdeveloped, the establishment of new firms needs to fall back on traditional, social forms of money raising, such as loans from family members, or friends. With most venture capital in the hand of local government agencies, access to capital also depends on successful lobbying and good relations with such agencies.

MEETING LOCAL DEMAND THROUGH CUSTOMIZATION AND COOPERATION: A HANGZHOU ERP SOFTWARE FIRM

The following case is a first exploration of how an ICT firm in China dealt with specific incentives and constraints. The main questions in this case are: what kinds of incentives and constraints had the firm to deal with? And how did the firm manage to benefit from the incentives and mitigate the risks from the constraints? Given the exploratory nature of the study, a case study is the best methodology as it is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, and is often used in contemporary empirical and explorative studies to identify information on how and why certain phenomena occur (Yin, 1989). The analysis relies on an in-depth interview with a manager of 'Firm 6' in the Spring of 2006[12]. The firm is introduced in the first paragraph and the subsequent paragraphs deal with the incentives and constraints.

Background

Firm 6 is a small, privately owned software development firm with 20 employees in Hangzhou. Firm 6 develops ERP[13] software and cooperates with other firms on joint software projects. Hangzhou is the capital of Zhejiang Province, one of the most advanced and richest provinces of China[14]. The customers of the firm are both state and non-state owned business customers. When Firm6 started its operation the biggest challenge was to attract these customers. Being a new firm in a new industry, it was hard to get a piece of the pie. Over the years, Firm 6's customers increased, as did their demand for software products and services. The demand of both state and non-state owned business customers is increasing but there are no significant changes in demand and the customers are loyal to the firm. Most of the work is done in relatively large project teams (8-10 persons) and 90% of the employees are skilled workers, having an engineering degree. Of all employees, about 20% have a management function and 10% of the employees are temporary workers (part-timers). The organization of work is straightforward: the majority of employees work exclusively on software development; and the firm's decisions are kept in the hands of the management.

Competition

Competition is becoming stronger but the firm does not see any problems arising from this. *On the one hand*, there is no real threat since competitors do not often introduce new, competitive products and it is extremely hard to copy the firm's products/services because of the highly customized nature of the work: software involving the customer to a great extent and customer-specific investments and innovations. Many software firms face the serious risks of software piracy, but Firm 6's highly customized client-involved work offsets these risks. Competitors do offer substitute products but they are merely integrated combinations of other products. *On the other hand*, there is no foreign competition. Even though there are a lot of foreign firms in Hangzhou and foreign investment in the industry is large, Firm 6 is not affected by increased foreign pressure. There are basically two reasons for this: first, they localize production in Hangzhou, addressing the specific needs of firms in Hangzhou; and second, the work is extremely customized making it hard to imitate or provide substitutes.

State support

The firm enjoys the benefits of a local government which supports the ICT industry and does not intervene very much in the operations of the firm. Hangzhou is well known for two things: tourism and light industry. The policy of the government in Hangzhou is focused on the developed of light industry and especially promotes its ICT industry, focusing on telecommunication services, software and some equipment manufacturing. The interviewee revealed a reasonable confidence that legislation will protect the firm. The legal requirements are straightforward and there have been no significant changes that affected the firm. A good relationship between the firm and the local government enables it to learn about state policy changes quickly, reducing the risks of uncertain institutional changes. There are almost no specific requirements from state agencies, banks or any other institution regarding any of the firm's decisions and no restrictions on the use or development of the firm's key resources, such as labour, land and capital.

Location and Zhejiang University

The firm enjoys a positive business environment with, due to the high concentration of ICT firms in Hangzhou. The interviewee told us that there are many other firms in the software industry, not necessarily offering the same products and services that could serve as examples. There are many success stories but also many failures: these enable the firm to learn and cope with the risks of being a new firm in a new industry.

Furthermore, the firm cooperates with Zhejiang University, a leading technology university in China, for the development of R&D capabilities. Innovations of Firm 6 are incremental – due to the customized nature and client-involved decision making – and often developed in cooperation with the university. Furthermore, new employees are easily recruited from the university even though the firm prefers in-house training of employees because it lowers costs. In-house training is facilitated by a project team approach to software development and peer training.

The case shows that the firm benefited from several of the incentives identified in this chapter, such as increased market demand, strong engineering education, preferential policies, and geographic concentration of the ICT industry. With a local market, cooperation with Zhejiang University and the (local) government and customization of products and services it devised strategies to build a strong human capital base, and cope with increased local competition and ruling out foreign competition, and changing institutional requirements. The firm met local demand through cooperation and customization.

DISCUSSION AND CONCLUSION

The remarkable growth of China's ICT industry calls for explanation. This analysis shows that the state intervened both directly and indirectly in order to mobilise greater resources in the ICT industry:

(1) Investment: FDI, venture capital, private savings
(2) Human capital: formal and informal education, foreign expertise
(3) Entrepreneurship: knowledge sharing, arm's length regulation and new SOEs

Firstly, an increase in foreign investment inflow, a growing – although still very limited – venture capital market and an increase in private savings as a result of deregulation of foreign and capital policy have boosted investment and competition. Whereas the central government sets the overall targets, individual firms are increasingly in control of the management of foreign capital inflow, coming predominantly from Hong Kong, Taiwan and Japan. Accumulation of private capital in combination with increasing legitimacy of the ICT industry's products and services in the domestic market boosted private investments. *Secondly*, the government attempts to upgrade China's human capital base through a thorough reform of the formal educational system and increased emphasis on on-the-job training in combination with imported foreign expertise. The overall investment in the formal educational system has increased but it remains too weak to supply the demand for innovation in the ICT industry. *Thirdly*, one of the major goals of state intervention was the promotion of entrepreneurship. The state's arm's length approach to regulation and promotion – often direct subsidisation - of specific ICT initiatives has created many incentives for entrepreneurs. Furthermore, the state's knowledge sharing initiatives, involving R&D institutes, banks and technology zones, has resulted in new forms of profit-oriented SOEs; collective or collective-private enterprises subordinate to specific R&D institutes.

In sum, there are basically five factors that shape the operations of firms in China's ICT industry: overall economic growth; direct and indirect state intervention; increased foreign investment inflow; development of human capital; and the accumulation of private capital. Each of the factors gives rise to specific incentives and constraints (**Table 4**) that shape the operations of firms in China's ICT industry. The identification of these incentives and constraints and their sources adds to our understanding of the forces with which ICT firms in China have to deal. A case study of a local ERP software firm in Hangzhou - based on an in-depth interview - shows that the firm met local demand through cooperation and customization, thereby coping with competition, China's low human capital base and changing institutional requirements. The case thus illustrates how one individual firm managed several constraints and benefited from several incentives.

[insert Table 4]

It would be interesting to explore how firms actually dealt with and used these incentives and constraints. The case study in this chapter is a first exploration but a further structural exploration of the various sectors and firms in the ICT industry would be insightful. Chinese ICT firms must have developed certain competences to deal with the uncertainties of the business environment, use the incentives appropriately and cope with the constraints. The building of relationships with relevant partners (such as the state or a foreign partner) and the development of an appropriate human resource system indicate this. How such competences are built, maintained and used needs to be further explored.

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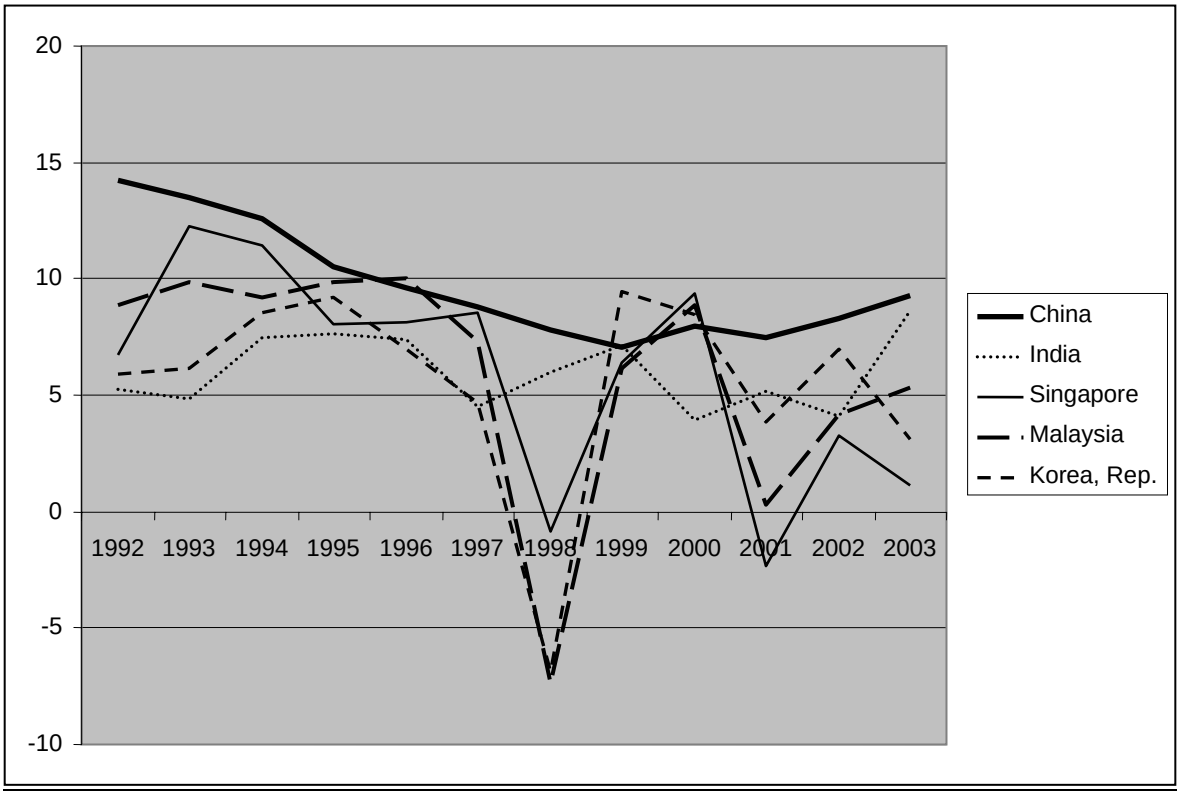
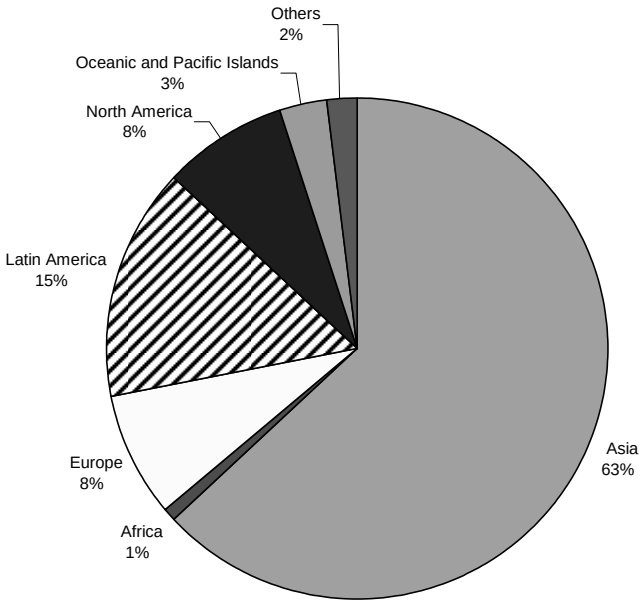
Figure 1: GDP growth rates compared 1992-2003



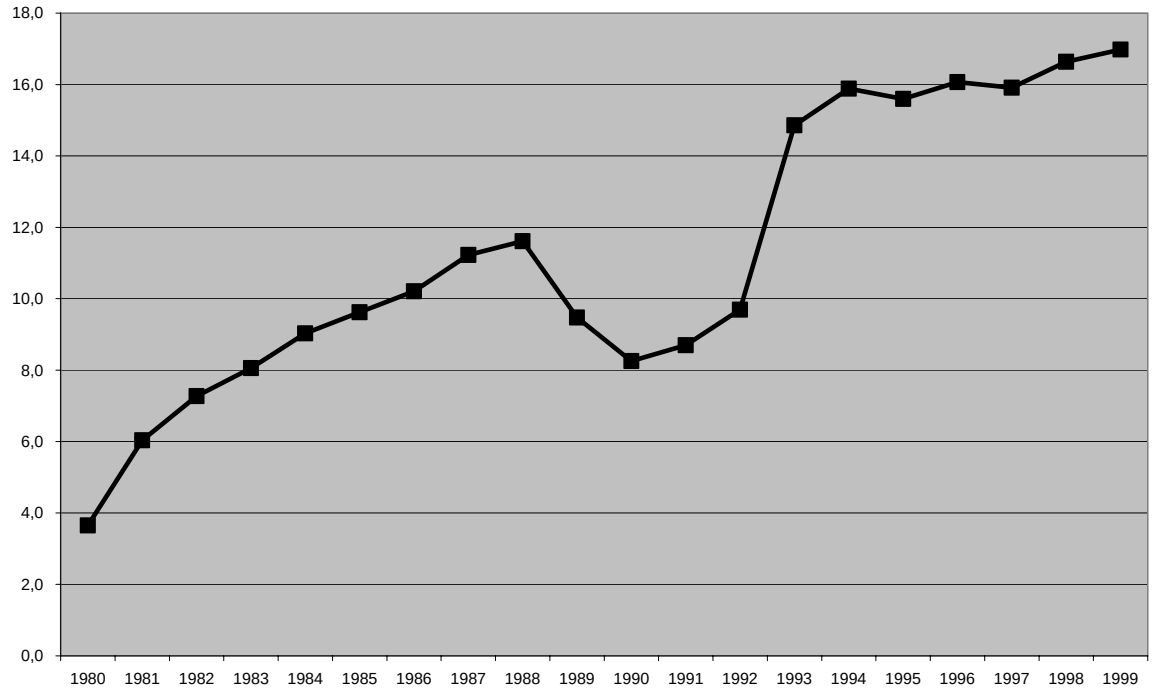
Source: World Development Indicators, 2005

Figure 2: Foreign direct investment per region in 2004



Source: China Statistical Yearbook 2005

Figure 3: Private investment as percentage of GDP (1980-1999) in China



Source: IFC (forthcoming) Stephan Everhart and Mariusz A. Sumlinski. "Trends in Private Investment in Developing Countries:Statistics for 1970-2000"

Table 1: Reforms in foreign regulation

Phase	Regulatory reform	End of phase
1979 - 1985	Law of the PRC on Joint Ventures Using Chinese and Foreign Investment	High inflation
1986 - 1991	PRC Law on Foreign Enterprises	Tianman Square Incident
1992 -	- 1990 Amendments to the Joint Venture Law - 1991 Income Tax Law for Enterprises with Foreign Capital and Foreign Enterprises - 1992 Deng Xiaoping's South China tour	

Table 2: School enrolment ratios in 2003: international comparison

	United Kingdom	United States	Germany	France	Finland	Korea	China	Japan
School enrollment, primary (% gross)	101.0	100.3	103.2	105.0	101.7	100.1	113.9	100.7
School enrollment, secondary (% gross)	157.9	94.1	98.9	107.7	125.9	94.2	68.2	102.5
School enrollment, tertiary (% gross)	59.0	70.7	N/A	53.6	85.3	77.6	12.7	47.7

Source: World Development Indicators, 2005

Table 3: Students per major in 2003

	Graduates of higher education	Student enrolment in higher education
Total	**1877492**	**11085642**
Philosophy	1196	5974
Economics	88181	604135
Law	110416	560916
Education	117072	592123
Literature	286889	1719230
History	13905	56673
Science	173031	1004506
Engineering	644106	3693401
Agriculture	50057	249671
Medicine	111356	814741
Management	281283	1784272

Source: China Statistical Yearbook, 2004

Table 4: Incentives and constraints

Factor	Incentives	Constraints
(1) Economic growth		
	Market demand (domestic and foreign) Increased income per capita Investment opportunities Upgrading information infrastructure Being a new industry	Increased competition Uncertain economic environment
(2) State intervention		
	Promotion of entrepreneurship New SOEs: role of governance mechanism Preferential policies for High-tech industries Geographic concentration	Direct control over specific sectors Zones as institutional control devices Preferential treatment hinders normal market process => inhibiting risky investments => state-chosen 'innovative' firms
	Indirect intervention in factors 3-5	
(3) Human capital development		
	Strong in engineering and science education Increased involvement of local governments Diverse sources of funding Increase in investments On-the-job training: upgrading both technical and management skills	Limited access higher education Weak management education Potential 'brain drain' Low number of educated personnel
(4) Private capital accumulation		
	Overall growth of private capital Increased demand and investment Direction of venture capital to ICT industry	Underdeveloped private capital market => no regulation with respect to legal and organisational structures => investments over 50% of capitalization are inhibited => unclear regulation with respect to venture capital
(5) Foreign investment inflow		
	Technology transfer Capital accumulation Importing management skills Hong Kong / Taiwan => imitation => learning: technical and management skills => investment => trade	Competition from foreign firms Uneven distribution of investments Round- tripped foreign investment Possibly inhibiting private sector

[1] All of the following statistics are derived from China Statistics Yearbook on High Technology Industry (2003) and China Software Industry Association (2003).
[2] Besides Nokia, Motorola and Siemens, Alcatel and Ericsson are other foreign investors in telecommunications.
[3] Foreign PC makers refer to all non-Mainland Chinese PC makers; even though the PC makers are predominantly from Hong Kong and Taiwan.
[4] The East Asian growth economies of South Korea, Taiwan, Hong Kong and Singapore are often referred to as 'tigers'.
[5] Even though these aggregate forces also have consequences for individual industries within the economy, such as the ICT industry.
[6] One notable exception is the recent IFC (2005) description of the players and the markets, which is highly informative even though it is descriptive in nature.
[7] For an informative overview of the early history of China's computer industry, including both software and hardware, I refer to Zhang and Wang (1995). For an overview of China's telecommunications industry I refer to Fan (2004) and Mu and Lee (2005).
[8] To some extent this is also a result from the Silicon Valley fever that became prevalent in the 1980s in both developed and developing countries (Wang, Wu, Li, 1998).
[9] Many different forms of ownership co-exist in the zones: state-owned, collectively owned, privately owned, joint-stock, overseas-invested and others. They have in common that (1) they receive a certain favourable treatment of the government, (2) most of them are spin-offs from research institutes or universities and (3) the majority operates in the information technology industry (White, Gao, and Zhang, 2002).
[10] Private investment is defined as the difference between total gross domestic investment and consolidated public investment.
[11] These data are obtained from the IFC data set "Trends in Private Investment in Developing Countries:Statistics for 1970-2000" and does not include more recent years.
[12] Firm 6 of the fieldwork interviews done by the author in the Spring of 2006 in Hangzhou, China. Due to the confidentiality agreement, I refer to the firm as 'firm 6'.
[13] Enterprise Resource Planning
[14] This makes Hangzhou not representative for the rest of China, but does make it a city at the forefront of economic development in China.