The Pacific Review
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rpre20

China's dualist model on technological catching up: a comparative perspective

Jenn-hwan Wang [a]
[a] Sun Yat-Sen Graduate Institute of Social Sciences and Humanities, National Chengchi University Taiwan, ROC

Available online: 20 Nov 2006

To cite this article: Jenn-hwan Wang (2006): China's dualist model on technological catching up: a comparative perspective, The Pacific Review, 19:3, 385-403

To link to this article: http://dx.doi.org/10.1080/09512740600875168

The Pacific Review, Vol. 19 No. 3 March 2006: 385–403

Routledge
Taylor & Francis Group

China's dualist model on technological catching up: a comparative perspective

Jenn-hwan Wang

Abstract The central question of this paper is whether China can go beyond simple technological transfer and toward innovation in this age of globalization. By adopting an institutionalist perspective, this paper argues that China has developed a dualist model during its economic transitional period in which the foreign sector has been isolated from domestic firms, while the domestic industrial sectors have also failed to develop organic linkages among themselves to facilitate technological learning and generate innovation. This paper discusses four major institutional arrangements that deeply influence China's technological development – the institutional logic of economic reform, the state's industrial policy, the financial system and the industrial structure. It suggests that, owing to these institutional elements, China has neither developed economies of scale, as compared with the South Korean case, nor has it built up a network-type of economy similar to its Taiwanese counterpart in order to generate the mechanisms needed for technological innovation.

Keywords China; Taiwan; South Korea; IT industry; technological innovation; technological catch-up.

Introduction

The Chinese economic reforms implemented since 1978 have profoundly changed the landscape of its society. Currently, not only has China become one of the largest recipients of foreign direct investment (FDI) but since 2002 it has also become the second largest information technology (IT) producer in the world economy (MIC 2004a). However, in a way that differs from both South Korea and Taiwan where the main producers have been domestic firms, it is foreign firms that have been the main contributors to China's

Wang, Jenn-hwan is Professor in the Sun Yat-Sen Graduate Institute of Social Sciences and Humanities, National Chengchi University Taiwan, ROC.

Address: No. 64, Sec. 2 ZhiNan Road, Wenshan District, Taipei City, Taiwan 11605, ROC. E-mail: wangjh@nccu.thu.edu.tw

The Pacific Review
ISSN 0951-2748 print/ISSN 1470-1332 online
http://www.tandf.co.uk/journals
DOI: 10.1080/09512740600875168

outstanding performance in the IT industry. The central question is thus whether China can utilize the enormous foreign investment together with its huge market size to nurture its domestic firms' technological capability and thereby increase its competitiveness.

Existing studies on whether foreign firms have transferred technological know-how to Chinese firms exhibit mixed results. While some argue that foreign firms, through joint ventures and the development of local supply chains, have transferred some of their technological skills and knowledge to Chinese firms (Cheung and Lin 2004; Ding 1997; Feinstein and Howe 1997; Jiang 2002; Suttmeier 1997; Wall and Yin 1997; Zhou and Xin 2003), others maintain that because foreign firms tend to cluster in economic enclaves and are preoccupied with quality, they rarely establish network relationships with local firms. Therefore, the degree of technological transfer is very limited (Gabriele 2002; Huchet 1997; Lemoine and Ünal-Kesenci 2004; Wang 2004). While these studies' diverging interpretations may have resulted from their different concerns and methods of data collection, in this paper I argue that the controversy has misfired because technology and knowledge are embodied in manufacturing equipment, which will necessarily lead to a transfer of knowledge to local firms if the latter purchase advanced manufacturing equipment from foreign sources. Therefore, the real issue is not whether or not foreign technology has been transferred to local firms, but rather whether or not the local institutional arrangements can generate technological learning and upgrade local firms' technological capability toward innovation.

There are two conflicting perspectives regarding technological learning and upgrading. The first view stresses the importance of economies of scale in technological innovation. According to Schumpeter (1950) and Chandler (1991), large firms with their abundant resources are more able to engage in technological and organizational innovation. The second view, or the external economies perspective, by contrast, highlights the importance of dense networking among a large number of competing and cooperating firms that can create an environment that favors technological innovation and learning (Amin and Thrift 1992; Piore and Sable 1984; Saxenian 1994). The South Korean model fits the first view while the Taiwanese model can be better explained by the second view. This paper will argue that China's technological development fits neither of these models. Instead, its pattern more resembles that of a dualist model in which the foreign sector has not established organic relationships with domestic firms, and domestic firms have not built institutionalized linkages among themselves to facilitate collective learning and innovation. As a result, the Chinese IT industry has neither been able to achieve the economies of scale of its South Korean counterpart nor the external economies that characterize the Taiwanese model in its pursuit of technological innovation.

In adopting an institutionalist approach to account for China's technological development, this paper argues that the Chinese dualist model has been

derived mainly from the institutional logic of the Chinese economic reform, in which the state adopted a dual-track approach that simultaneously maintained the planned sector while gradually opening its territories to market competition. However, due to the decentralized state structure in which local government enjoyed a high degree of autonomy in managing its economic governance, this resulted not only in the central state's failure to pick national champions based on the existing state-owned enterprises (SOEs), but also in a lack of production networks and organic linkages among domestic firms or between foreign and local enterprises.

The dualist features of China's IT industry

The increasing importance of China's high-tech industry can be observed from the following statistics. Its share of high-technology goods[1] as a proportion of exports of manufactured goods increased from 5.9 percent in 1992 to 22.8 percent in 2002. In terms of its high-tech export products, electronics and IT products in 2002 accounted for 92.5 percent of all high-tech production value. These figures indicate that IT products have become the major industry in China's high-tech sector (National Bureau of Statistics 2003: 465). Nevertheless, the rapid growth of China's IT industry has to a large extent come about as a result of the contributions of foreign firms. In the category of electronics and communications equipment manufacturing, foreign firms accounted for 71.57 percent of all production value, 65.39 percent of value-added, and 72.21 percent of sales value in 2000 (Jiang 2002: 28). In fact, foreign affiliates (wholly foreign-owned firms) have played an increasingly important role in China's foreign trade. In the high-tech sector, foreign firms contributed 81.5 percent and 82.2 percent of total value in 2001 and 2002, respectively.

Foreign firms' manufacturing activities have been concentrated mainly in the processing of assembled goods, where parts and components have been imported from abroad and reassembled for export. The share of the overall value of high-tech products exported that were accounted for by such processing rapidly increased from 70.2 percent in 1993 to 89.6 percent in 2002. Because of this increase in export and processing trade, the negative balance of import/export values has become larger in recent years, indicating an increase in imports of essential components from abroad (see Table 1).

Nevertheless, the development of China's IT industry is not only reflected in its high growth in exports. In fact, China has achieved enormous growth in its domestic IT market. The growth rate of China's IT industry has averaged more than 30 percent annually since the late 1990s (MIC 2004a). In 1990, China had only 500,000 PCs in a country of more than 1.2 billion people (Kraemer and Dedrick 2002; Lu 2000), but it sold 11.68 million PCs in 2002 alone in the domestic market, a figure surpassed only by those sold in the US market. China has also become the largest market for cell phones in the world, with 243 million subscribers (Ramstad 2003), and it sold over

Table 1 China's high-technology exports, 1992–2002

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Value of exports (US$ billion)	4.0	4.7	6.3	10.1	12.7	16.3	20.3	24.7	37.0	46.5	67.9
Value of imports (US$ billion)	10.7	15.9	20.6	21.8	22.5	23.9	29.2	37.6	52.5	64.1	82.8
Balance (US$ billion)	−6.7	−11.2	−14.3	−11.7	−9.8	−7.6	−9.0	−12.9	−15.5	−17.7	−15.0
% of foreign firms exporting	n.a.	n.a.	n.a.	n.a.	71.5	n.a.	73.7	76.0	n.a.	81.5	82.2
% of processed exports	n.a.	70.2	n.a.	n.a.	n.a.	n.a.	86.2	87.3	n.a.	n.a.	89.6

Source: Ministry of Science and Technology, China (2004a, 2004b).

70 million mobile phones in the domestic market in 2002. Indeed, China is currently not only a major IT producer but also a big consumer. In many sectors of the IT industry in the Chinese market, Chinese firms enjoy either a dominant position (i.e. over 83 percent of the PCs sold in China were local brands) or have a large share (i.e. cell phones, over 50 percent) (MIC 2004a).

The above figures exhibit some noticeable tendencies. First, the fact that foreign firms are engaged mainly in processing/manufacturing indicates that they have established few linkages with domestic firms. If linkages do occur, Chinese firms simply supply small amounts of low-end goods to the foreign firms (Steinfeld 2004). Second, the fact that the increasing deficit in terms of technology import values against export values indicates that China's IT industry depends on higher levels of imported intermediate goods that are not produced domestically. Third, domestic firms' large share of the internal market and foreign firms' dominance in the production values of the IT industry show that Chinese firms have benefited from the massive influxes of FDI in obtaining their industrial supplies from and building production ties with foreign firms, a feat that has already been documented by a number of studies on technological transfer (Cheung and Lin 2004; Ding 1997; Jiang 2002; Wall and Yin 1997; Zhou and Xin 2003).

Indeed, due to the modularizing tendency of the IT industry, the technologies at the lower level have easily been replicated elsewhere in cases where costs are the major concern (Steinfeld 2004; Sturgeon 2002). Strong competition among major IT firms in the 1990s led to the formation of global production networks (GPNs) in which multinational corporations (MNCs) outsourced their production facilities to different parts of the world, except for the marketing function (Ernst and Kim 2002; Yusuf *et al*. 2004). It was in this manner that China was integrated into GPNs through enormous FDI from the late 1990s onwards, and from which point on Chinese firms had the opportunity to access new technologies. Nevertheless, the above figures also exhibit a tendency toward technological dualism in which foreign firms

have established little in terms of a relationship with the domestic sector. It is thus important to investigate the institutional roots of this technological dualism and to determine whether the institutional arrangements of the Chinese political economy can generate technological innovation beyond simple technological transfers.

The institutional logic of the post-socialist reform

The dualistic feature of China's technological development has its roots in the institutional logic of the economic reform. The characteristics of China's economic reform process, as Shirk (1993) describes, include the features of gradualism, decentralization and particularism (cf. Naughton 1996). Because of its gradualist approach, the Chinese state adopted a dual-track strategy, through which separate avenues for development outside the state and the planned sector were created and operated under different rules and conditions. Because of the decentralized state structure, local governments were granted more privileges and power by the central state in managing their local economic affairs in exchange for their political support of the reform programs, which unleashed the political and material incentives for local officials to promote their local economies (Oi 1995). Finally, because of the fragmented nature of the reform programs, a 'particularistic contracting' (Shirk 1993: 16) phenomenon was created in which local authorities were able to lobby the center for special privileges and policy support in dealing with both domestic and foreign investments.

The institutional logic of the reform has given rise to a long-lasting impact on the features of the Chinese economy and its technological development. First, although the central state had been encouraging market competition, it still simultaneously preserved SOEs following the socialist logic in order to justify socialist legitimacy. This resulted in central state industrial policies that were based on the existing SOEs and on encouraging them to compete in international markets. Second, the decentralized state structure led to the emergence of 'local state corporatism' (Oi 1995), which tended to push local economic development without regard for national objectives; or, sometimes, a local government would have its own interpretations even on issues that were controlled by the central state, and these were often the actual determinants of the policy (Segal 2003; Zweig 2002). Third, the institutional logic of economic reform led to strong competition among local governments both to lobby the central state for special treatment and to actively promote local economic development. As a result, economic provincialism occurred (Qian 2000). While all of the above institutional features were favorable to local governments in their pursuit of local economic development, they also created hurdles for the Chinese economy in terms of becoming a national market and gave rise to institutional linkages among industrial firms.

The central state's industrial policies for catching up

As a result of the reform's institutional logic, the Chinese state adopted three industrial policies to foster technological catching up among domestic firms. These policies were implemented mainly to support SOEs that had evolved from emphasizing the import of technology, to joint ventures and to nurturing national champions. First, in the early 1980s, the Chinese state adopted a technology import strategy to transform its technologically out-of-date SOEs. Between 1979 and 1990, China spent US$17 billion on more than 7,000 pieces of technology imported from abroad (Ding 1997: 100). These items were for the purpose of upgrading the SOEs' technology and involved importing mainly hardware and production lines.

Second, the Chinese state implemented a policy that allowed foreign firms access to the domestic market in exchange for technology transfer through joint production or joint ventures, a policy that it referred to as 'exchanging market access for technology transfer' (*yi shichang huan jishu*). Because of the great potential of the Chinese domestic market, many MNCs thus established joint ventures with SOEs and facilitated technological transfer to the Chinese firms (Huchet 1997; Kraemer and Dedrick 2002).

Third, the Chinese state began to promote its own industries by picking national champions. By the mid-1990s, Chinese leaders had decided to implement the 'grasp the large, let go of the small' (*zhuada fangxiao*) policy with a view to building a group of large, globally competitive multi-plant corporations – a policy that emulated Japan and South Korea in terms of establishing world-scale industrial conglomerates. The Chinese state supported these firms by providing soft loans through state procurement, by providing access to technologies developed in state R&D institutions, and by protecting distribution channels which only the domestic firms had the right to operate (Nolan 2001; Smyth 2000).

Through its industrial policies, the central state simultaneously intended to use foreign resources and the developmental state approach to upgrade its domestic firms' technological capability. The reform logic adopted guided the central state reformers to design industrial policies that were based on the existing industrial structure, in which the SOEs were the major players, in order to pursue economies of scale and upgrade technological capability. Nevertheless, while certain degrees of technological transfer indeed occurred in the process (Ding 1997; Jiang 2002), the existing institutional arrangements restrained Chinese firms from moving toward innovation, as will be shown below. These arrangements were related to the characteristics of the Chinese financial system and its fragmented industrial structure.

The state-owned, locally controlled financial system

The financial system is a resource allocation mechanism that facilitates the growth of a country's economy. Prior to the economic reforms in China, the

financial system merely played an accounting role in that it was responsible for allocating capital to the needed SOEs according to the state budget. The objectives of the financial reform in the post-socialist era, however, were to establish the autonomy of the central bank, build a banking system that served to allocate capital based on market rules, and to reform enterprises so that they would perform efficiently in accordance with the responsibility system (Huang 2000; Lardy 1998). The Chinese financial system thus gradually changed into a state-controlled banking system, in which the state-owned banks (SOBs) accounted for about 85 percent of China's total financial intermediation in the late 1990s (Huang 2000: 218). The securities market, by contrast, played a very minor role in providing financial resources to needy economic actors, and accounted for only 8.3 percent of China's total financial intermediation in 2001 (Wu 2002).

Nevertheless, as a result of the embedded relationships among the state, local governments, SOBs and SOEs, the Chinese financial system has been inefficient in terms of allocating financial resources. First, the financial resources in the banking system were used largely to rescue and subsidize the SOEs. Although the enterprise reforms in relation to the SOEs had succeeded in improving management autonomy and incentives, they failed to effectively enforce market discipline because of the SOEs' soft-budget problems (Lardy 1998). This resulted in many of the SOEs recording negative profits. Due to social and political stability considerations, the Chinese state continued to subsidize the loss-making SOEs through policy loans that were mediated by SOBs. In the 1990s, the policy loans accounted for 35–40 percent of total bank loans.

Second, although the Chinese state had intended since 1994 to use the SOBs to promote large strategic SOEs through its policy of picking national champions, this policy did not enable the large SOEs to achieve economies of scale. On the one hand, there were over 1,000 enterprises needing support, which meant that each firm might receive only a small amount of funding for expansion. On the other hand, the policy was passed on to local governments to implement on the basis of forming strategic enterprise groups. As a result, many strategic SOEs emerged at the subnational level. For example, Shanghai alone had fifty-four of these groups and Liaoning province a further ten (Smyth 2000: 722). Moreover, since local governments tended to restrict mergers and acquisitions in order to enable the major local economic players to stay in their localities to support their own regional competitiveness, as a consequence the strategic SOEs were unable to enlarge their scale of operations and extend their reach to the national level. The 'national champions' in reality ended up as little more than local or regional firms that were not comparable with their South Korean counterparts (Steinfeld 2004: 1982).

Third, local governments' constant intervention in the operation of the banking system prevented the SOBs from following market rules. In China, almost all banks were state owned, and bank managers were appointed by

local governments, with the result that they barely had any power to resist intervention. The banks' lending decisions were based mainly on administrative guidance rather than market principles. As a result, most of the bank loans went to SOEs, which accounted for about 90 percent of all bank loans in the late 1980s and still accounted for over 60 percent of them in the late 1990s (National Bureau of Statistics 2000). The most active non-state firms, however, found it difficult to receive loans from SOBs, partly as a result of the unclear property rights of non-state enterprises (which gained legal status only in 1999) that hampered them from receiving loans from the banks. Even though the state supported these high-tech enterprises by providing low-interest loans, the amounts were very limited and SOBs were reluctant to finance these firms (Wang *et al.* 1998). As a result, they either borrowed money from personal networks or relied on individual savings to enter the market (Segal 2003; Steinfeld 2004).

The financial phenomena described above gave rise to two results in relation to Chinese firms' technological development. First, although the Chinese state used policy loans to support domestic firms, the loans were used to rescue the loss-making SOEs rather than nurture selected big firms as they upgraded their technologies. Second, although the Chinese state intended to adopt the South Korean approach by supporting a few national champions, the provincialism of local governments meant that resources were too widely dispersed for this to occur in practice. As a result, the national champions approach was unable to nurture large firms in such a way that they could take advantage of economies of scale to engage in more advanced technological development and compete in the world market.

The fragmented industrial structure

The post-socialist reform had an effect in that the number of SOEs greatly decreased while other types of ownership, especially private ownership, increased rapidly within the industrial structure (partly due to the privatization of smaller SOEs and collectively owned enterprises in the late 1990s). In 2001, SOEs comprised 20.16 percent of all production units, while collectively owned, privately owned and foreign-owned enterprises accounted for shares of 18.11 percent, 43.37 percent and 18.35 percent, respectively. In terms of production value, the respective shares were 18.05 percent, 10.53 percent, 42.89 percent and 28.52 percent (National Bureau of Statistics 2002). Nevertheless, the existing industrial structure has been very fragmented in terms of developing organic linkages so as to foster technological learning.

In the strategic SOEs segment, the operational logic of the national champions policy largely duplicated the vertically integrated approach in the pre-reform era that did not favor the building of local production networks. Having been inherited from the former stage, the strategic SOEs were self-sustained units that produced core products in-house and built captive supply chains in the local areas. Sometimes the financially sound

strategic SOEs were forced by local governments to assume ownership of insolvent organizations in order to save them from bankruptcy. In addition, these SOEs preferred to increase their competitiveness either by lowering their prices to expand their market share or by importing components directly from abroad. Even when they had to buy components from local suppliers, they had no intention of building local clusters and stable supply chains (Steinfeld 2004: 82). For example, according to China's official statistics in 1999, the share of large and medium-sized enterprises' expenditure on in-house R&D, purchases from domestic technological markets, and the importation of technology constituted 56 percent, 2.5 percent and 38.1 percent of their science and technology investment (which included technology imports, the renovation of existing equipment, and R&D), respectively (quoted from Sun 2003: 379). These figures changed only slightly to 57.4 percent, 4.4 percent and 38.2 percent, respectively, in 2002 (Ministry of Science and Technology 2005). In addition, for every $100 that state-owned electronics and telecom firms spent on technology imports in 2002, only $1.20 was spent by them on similar domestic goods (Gilboy 2004). Local suppliers ended up supplying products to rural industries and less competitive SOEs. The result was that linkages among both large and smaller Chinese firms remained weak.

The foreign sector did not develop production network relationships with local firms either. Because of China's open-door policy and local governments' generous provision of tax incentives, foreign IT firms were funneled into the high-tech experimental zones of the coastal provinces, starting from Guangdong, via the central coastal areas (Shanghai, Jiangsu, Zhejiang), and to the northern coastal areas (Beijing, Tianjin, Shandong). In 2002, these three areas accounted for 84 percent of all IT firms, produced 74.7 percent of the total value of the IT industry, and contributed 86.7 percent of China's total IT export value (National Bureau of Statistics 2003: 134–5).

The heavy concentration of IT firms in these areas indicates that the clustering effect can be produced through interactions among firms. However, the cluster effect occurs mainly among foreign firms, especially among Taiwanese firms (MIC 2004a), rather than between foreign and domestic firms. Despite the joint venture firms that were encouraged in the early 1990s, the relationships between foreign firms and local firms were established mainly through two channels, the first of these being the production network relationship. This type of relationship involves some technological transfer, since, in order to ensure the quality of their products, the MNCs will send blueprints and sometimes engineers to local producers. However, this type of relationship rarely occurs due to the lack of incentives on the part of both MNCs and local governments to do this. The MNCs would rather import good-quality components or purchase them from other foreign firms in the locality than from local Chinese firms. Similarly, local officials do not want to create trouble for MNCs in order to maintain a 'good' investment environment. Thus, as Gabriele (2002: 339) observes: 'while competition from more

advanced foreign firms contributes to intensify Chinese enterprises' own training and learning efforts, FDI *per se* does not significantly contribute to technology transfers and to the productivity growth of local firms'.

The second type of relationship between domestic and foreign firms is the buyer – supplier relationship, in which Chinese firms buy components and semi-finished or completed products from foreign firms and manufacture or re-label them into final products, as in the case of the PC and cell phone industries. In a way that differs from the production networks model, where knowledge and skills are transmitted from MNCs to contractual suppliers through intensive interaction in production activities, there is little interaction in the production activities between these buyers and their suppliers. In this relationship, while the buyers do not possess a higher degree of technological capability, they do have a channel for marketing the products by purchasing and re-labeling goods obtained from contractual suppliers. This type of buyer – supplier relationship has become the basis for Chinese firms' domestic competitiveness. The best example of this is the relationship between Chinese firms and Taiwanese production networks.

The massive investments made by Taiwanese IT firms in China, in the south in the early 1990s, and in the central coastal areas in the late 1990s, have transplanted similar production networks from Taiwan to China in different industrial clusters (MIC 2004b). Taiwan's IT industry is well known for its networked small and medium-sized enterprises (SMEs) that serve as original equipment manufacturing (OEM) suppliers in producing electronics products for global brand firms such as IBM, HP, etc. (Hobday 1995). As the strong competition among global firms continued during the 1990s, outsourcing increased both in scale and scope. In order to sustain orders and retain their competitiveness, Taiwan's leading firms began to move their manufacturing bases offshore to lower their costs first by moving to Southeast Asian countries and then to China (Wang 2001). Therefore, in 1992, while 90 percent of the IT products of Taiwanese firms were manufactured in Taiwan, this figure had fallen to 22 percent by 2003. In other words, 78 percent of Taiwanese IT products were produced overseas in 2003, with China accounting for 62 percent of the overseas production, having increased from only 14 percent in 1995. Moreover, by 2003, 66 percent of notebook PC production had moved from Taiwan to China, representing a dramatic increase over the 38 percent for 2002. The same tendency can also be observed in the case of liquid crystal display monitors, in that the share of offshore production in China increased dramatically from 58 percent to 80 percent in just two years from 2001 to 2003 (MIC 2004b). In accompanying this move, the production networks of Taiwan's IT industry, including the leading system firms and their suppliers that manufactured motherboards, monitors, CD-ROMs, hubs and network cards, also moved to China to serve the leading firms located nearby.

Although there is no exact figure for Taiwanese firms' contribution to the Chinese IT industry, it is safe to assume that it ranges from 40 percent

to 80 percent, according to *Business Week* (2005).[2] It should be noted that Taiwanese firms not only manufactured desktop and notebook PCs for Chinese firms but also manufactured cell phones and other essential electronics components. In order to tap into the Taiwanese production networks, most of the major Chinese IT firms, such as Legend (now Leveno), Great Wall, Tong Fang, etc., moved their manufacturing bases into the southern or central coastal areas where the Taiwanese networks were concentrated the most. The Taiwanese networking firms, however, became economic enclaves that rarely engaged in production networking with local firms.[3] This was due to quality control considerations as well as the sufficiency of the networking Taiwanese firms in the host regions.[4] This pattern can be found to exist throughout the foreign sector, as observed by many other studies (Gabriele 2002; Lemoine and Ünal-Kesenci 2004; Wang 2004).

In short, in the 1990s, the state's encouragement and the size of the market favored growth of the Chinese IT industry that has been based largely on FDI and which has enabled Chinese firms to have a better opportunity to access foreign technologies. The industrial clusters established by foreign firms have also enabled Chinese firms to tap into the networks to quickly increase their market shares. However, the above discussion has shown that while foreign firms have tended to locate themselves in economic enclaves, large Chinese firms have neither operated on a sufficiently large scale to have sufficient resources to engage in innovative activities, nor have they developed production networks with smaller local firms. Instead they have preferred to adopt a short-term strategy by importing components and lowering their prices in order to enlarge their market share. In both cases, there have been few interactions that might have facilitated intensive interaction with local firms and promoted technological learning. This dualist model in relation to technological catching up is thus very different from the South Korean and Taiwanese cases.

China's dualist model versus the South Korean and Taiwanese models

China's dualist technological development exhibits different characteristics as compared to both the South Korean and Taiwanese models. The South Korean model tends to adopt the Schumpeterian approach that stresses economies of scale, with the state strongly supporting the development of giant conglomerates, the *chaebol*, to develop domestic technological capability. Contrariwise, the Taiwanese model lays more emphasis on external economies in which the technological weakness of the dominant SMEs is compensated for by external linkages, such as production networks among firms and state-sponsored R&D institutes that create an environment favoring technological innovation and learning. The Chinese dualist model neither has the characteristics of scale economies nor does it exhibit the features of external economies.

The South Korean model of catching up is characterized by economies of scale that have resulted from the state's strong support of its domestic firms. Essentially, South Korea's economic development has been characterized by three major elements, namely the state's strong leadership, the state-owned banking system, and the dominance of the *chaebol* in the industrial structure (Amsden 1989; Kim 1998; Kong 2000; Woo 1991) prior to the 1997 financial crisis.

The Korean state's strong interventionist industrial policy was embodied in its economic nationalism where the intention was to build a strong economy based on domestic ownership. In order to achieve this goal, the Korean state promoted industrialization through the big push approach that involved incurring enormous foreign debt as well as mobilizing domestic savings, to nurture the *chaebol* through the mediation of the state-owned banks (Kong 2000; Woo 1991).

Due to the state's 'unlimited supply of capital', the South Korean industrial structure was highly concentrated. The Korean state's 'picking the winners' approach led to high competition among the *chaebol* (Amsden 1989). The *chaebol* that were able to comply with the state's wishes were able to grow quickly within a heavily protected and favorable environment. The result was that the economy became concentrated in and dominated by a few *chaebol* (Fields 1995; Woo 1991). According to Hamilton *et al.* (2000: 293), the top forty-three *chaebol* accounted for nearly 41 percent of all manufacturing sales in 1989 and contributed considerably more than 50 percent of all export sales.

The high concentration of financial resources in a few national champions gave the *chaebol* the opportunity to build the capability to assimilate existing technologies rapidly. Although the Korean state played an important role in promoting the IT industry during the initial stages, including setting up public R&D institutes, the *chaebol* gradually replaced the state as the major engine for assimilating and improving the technologies in the process (Kim 1997; Mathews and Cho 2000). The business strategy of these companies was to emulate the Japanese production method of producing high-volume standardized commodity products such as memory chips but at a lower cost. However, because of the abundance of financial resources, the Korean *chaebol* were able to devote more resources to accessing new technologies through acquisitions of smaller foreign firms, the purchasing of licenses, recruiting Korean Americans, setting up outpost labs in both Silicon Valley and Tokyo, and devoting more resources to in-house R&D activities (Dedrick and Kraemer 1998; Kim 1997; Mathews and Cho 2000). Through these methods, many of the Korean *chaebol* have currently become leaders in fields such as memory chips, flat crystal displays and many other aspects of the electronics industry.

Compared with the Korean model, the Chinese state was much weaker in the reform process. Because of the decentralized state structure, the central state's approach of picking national champions has not been able to

create economies of scale in the same way that its Korean counterpart has. The Chinese banking system has also not been efficient enough to support the strategic SOEs due to the problems associated with the SOEs and the intervention of local governments. Local governments' provincialism has led to the strategic SOEs merely becoming regional players. Ultimately, the strategic SOEs do not possess enough resources to follow the Korean path of catching up technologically.

The Chinese dualist model similarly does not share characteristics akin to those of the Taiwanese network model that is able to generate technological learning and innovation. Prior to 1990, the Taiwanese economy was characterized by the leadership of the developmental state, the state-owned banking system and an industrial structure based on SMEs (Wade 1990; Weiss and Hobson 1995). However, in a way that was different from its South Korean counterpart, the Taiwanese state did not support large privately owned enterprises, both due to ethnic tensions as well as the state's statist ideology (Haggard 1990; Wade 1990). Moreover, influenced by its defeat in China by the communists, the Taiwanese state made controlling inflation and maintaining stability its major objectives. As a corollary, the state thus engaged in very little foreign borrowing, and the economic development of the past few decades was financed almost entirely by domestic savings.

Because of the state's export-led industrialization policy, huge numbers of SMEs emerged from the 1960s to become the most active players in the Taiwanese economy. Although SMEs experienced difficulty receiving loans from banks, the quasi-policy loan – the export loan – provided a convenient channel, with interest rates much lower than the market rates, for them to engage in manufacturing activities. Until the early 1980s, the SMEs produced nearly half of the value and more than 76.7 percent of Taiwan's exports (Chou and Lin 1999: 45). The proliferation of Taiwan's SMEs gave rise to an industrial structure that was distinct from that of South Korea.

Due to the weakness of the SMEs' R&D capability, Taiwanese technological development in the IT industry depended on four kinds of externalities, namely transnational resources, production networks, overseas Chinese as well as state-sponsored R&D institutes. The transnational linkages between foreign and Taiwanese firms were established in the 1960s and later expanded. Through them many technological capabilities were transferred, especially by means of the OEM method (Hobday 1995). In the IT industry, because of the large volume of OEM orders placed by the MNCs in the 1990s, the leading Taiwanese PC firms began to establish their own production networks to sustain the orders, a pattern that was similar to that already experienced in the garment and shoe industries (Gereffi 1994). This necessarily led to the diffusion of technologies from MNCs to major local firms and then to smaller local suppliers. In addition, Taiwan's development of the IT industry also benefited very much from overseas Chinese networks (Saxenian and Hsu 2001). Not only were many of the IT firms established by returnees, but also the major IT firms recruited them to engage in

production and R&D activities. This contributed to a close relationship between Taiwan and Silicon Valley and shortened the time lag in technology learning. Finally, the state in the process also used the state-sponsored R&D institute, especially the Industrial Technology Research Institute, to develop new technologies and afterwards help transfer them to local firms. In the process, the state also established many experimental labs in the semiconductor industry and later these labs were transferred to private ownership (Dedrick and Kraemer 1998; Mathews and Cho 2000).

From the late 1990s onwards, the Taiwanese IT industry expanded its flexible production system to China and gained second-tier status in the GPNs (Chen 2002; Ernst 2000). The flexibility of the SMEs and the adaptability of the production networks prevented the Taiwanese PC industry from collapsing as a result of the continuous price wars waged by the world's leading firms, such as Compaq and IBM. Ironically, the latter became even more dependent on Taiwanese firms to provide contracted manufacturing products to compete in the world market. Currently, Taiwan has become one of the major producers in the world IT industry. In 2002, for instance, Taiwan produced 61 percent of the notebook PCs, more than 75 percent of the motherboards, and 61 percent of the liquid crystal display monitors for the world market (MIC 2004b).

Therefore, the Taiwanese model does not depend on economies of scale but instead on external economies that can generate collective learning and innovation. In contrast, in the Chinese case, due to the high level of competition among local governments, foreign firms have become concentrated in economic enclaves that have developed few organic network relationships with local firms. The strategic Chinese SOEs, because of their institutional heritage, have rarely built their supply chains with the local firms. In addition, compared to its Taiwanese counterpart, the Chinese state has played a much weaker role in promoting technological development. The result seems to be that weak domestic firms have not been able to generate collective learning by establishing network relationships with the state's R&D institutes, strategic SOEs or foreign firms.

Conclusion and discussion

As discussed above, the Chinese dualist model was derived from the institutional logic of the post-socialist reform, the state's pro-SOE industrial policy, the state-owned but also local government-controlled financial system and the fragmented industrial structure. These institutional factors finally resulted in China's IT industry neither having developed economies of scale nor having built up a networked economy. Therefore, although Chinese firms have established global connections, institutional arrangements are still fragmented (Sun 2003), with the result that they have inhibited industries from developing the internal dynamics that can generate technological learning and innovation.

Can China transform its institutional arrangements so as to build up domestic technological capability and generate innovation in the future? During this stage of globalization, it seems that no late-industrializing country can imitate the South Korean case by supplying unlimited financial resources to a few big firms. The current international neo-liberal trade regime has prevented this approach from being adopted. The Taiwanese approach is therefore a more appropriate one to follow, given that the current Chinese industrial structure has been changing into one that has huge numbers of small SOEs or former collectively owned enterprises that have become SMEs. The important issue that the Chinese economy now faces is how to link these actors into networking collectivities that can generate mechanisms and promote technological learning that leads to innovation.

The Chinese state's new technological policies since 2000 seem to have moved in this direction as it has attempted to build up a new national system of innovation through further institutional reforms (Liu and White 2001). Now the Chinese state not only encourages domestic firms to enter into joint ventures with local universities and R&D institutes but it has also established many integrated circuit design centers for the semiconductor industry in order to become more competitive technologically. Moreover, local governments are using preferential policies to attract returnees from abroad in order to close the technological gap and generate learning capability. Indeed, many small privately owned firms emerged quickly in the early 2000s and were founded by returning Chinese who had studied and then worked for MNCs abroad (Saxenian 2002). Whether or not the institutional transformation can create a type of network economy that links domestic R&D institutes, large enterprises and SMEs together to generate technological learning that leads to innovation is still a question that needs to be addressed in the future. However, it is clear from the above discussion that the current landscape regarding the development of technology in China is still based on a dualist model that is hampering the industry from moving up the technological ladder.

Acknowledgements

The author would like to thank the reviewers for their helpful comments. Thanks are also due to the National Science Council, Taiwan (92-2412-H-029-007) for its financial support and to Tunghai University as well as the Fulbright Foundation for their support of a visit to the Institute of East Asian Studies at the University of California, Berkeley, in preparing this paper.

Notes

1 Here, high-tech industry comprises the following areas: computers and telecommunications, electronics, computer-integrated manufacturing, life science, aerospace and aeronautics, opto-electronics, and biotechnology material (National Bureau of Statistics 2003). IT products in this study refer to products

in the computers and telecommunications, electronics, and computer-integrated manufacturing industries.

2 According to the Ministry of Commerce of China, 72 percent of the value of IT hardware produced in China was contributed by Taiwanese firms in 2000. According to the MIC (2004b), this figure was 70 percent in 2003.

3 Some Taiwanese managers mentioned to the author that they even prevented Chinese buyers from entering production sites in order to avoid the possibility of technological leaks. This was because the Taiwanese firms were engaged mainly in OEM activity which simultaneously produced products for many global brand leaders on the same site.

4 Almost all the Taiwanese managers I interviewed mentioned that they did not need Chinese local component suppliers, except for very peripheral items such as paperboard, and services such as transportation that could be provided only by local agents.

References

Amin, A. and Thrift, N. (1992) 'Neo-Marshallian nodes in global networks', *International Journal of Urban and Regional Research* 16(4): 571–87.

Amsden, A. (1989) *Asia's Next Giant: South Korea and Late Industrialization*, New York: Oxford University Press.

Business Week (2005) 'Why Taiwan matters', *Business Week Online*, 16 May, pp. 16–23.

Chandler, A. (1991) *Scale and Scope: The Dynamics of Industrial Capitalism*, Cambridge, MA: Harvard University Press.

Chen, S. H. (2002) 'Global production networks and information technology: the case of Taiwan', *Industry and Innovation* 9(3): 249–56.

Cheung, K.-Y. and Lin, P. (2004) 'Spillover effects of FDI on innovation in China: evidence from the provincial data', *China Economic Review* 15: 25–44.

Chou, T. C. and Lin, Z. C. (1999) *Tai wan zhong xiao qiye de fazhan jizhi* [*The Development Mechanisms of Taiwan's SMEs*], Taipei: Lian-jing.

Dedrick, J. and Kraemer, K. L. (1998) *Asia's Computer Challenge: Threat or Opportunity for the United States and the World?*, New York: Oxford University Press.

Ding, J. (1997) 'Using imported technology to transform existing enterprises in China', in C. Feinstein and C. Howe (eds) *Chinese Technology Transfer in the 1990s*, Cheltenham: Edward Elgar, pp. 96–114.

Ernst, D. (2000) 'What permits David to grow in the shadow of Goliath? The Taiwanese model in the computer industry', in M. Borrus, D. Ernst and S. Haggard (eds) *International Production Networks in Asia*, London: Routledge, pp. 110–40.

Ernst, D. and Kim, L. (2002) 'Global production networks, knowledge diffusion, and local capability formation', *Research Policy* 31: 1417–29.

Feinstein, C. and Howe, C. (eds) (1997) *Chinese Technology Transfer in the 1990s*, Cheltenham: Edward Elgar.

Fields, K. (1995) *Enterprise and the State in Korea and Taiwan*, Ithaca, NY: Cornell University Press.

Gabriele, A. (2002) 'S&T policies and technical progress in China's industry', *Review of International Political Economy* 9(2): 333–73.

Gereffi, G. (1994) 'The organization of buyer-driven global commodity chains: how U.S. retailers shape overseas production networks', in G. Gereffi and M. Korzeniewics (eds) *Commodity Chains and Global Capitalism*, London: Praeger, pp. 95–122.

Gilboy, G. J. (2004) 'The myth behind China's miracle', *Foreign Affairs* 83(4): 33–9.

Haggard, S. (1990) *Pathways from the Periphery*, New York: Cornell University Press.

Hamilton, G. G., Feenstra, R., Choe, W., Kim, C. K. and Lim, E. M. (2000) 'Neither states nor markets: the role of economic organization in Asian development', *International Sociology* 15(2): 288–305.

Hobday, M. (1995) *Innovation in East Asia: The Challenge to Japan*, Aldershot: Edward Elgar.

Huang, Y. (2000) 'State-owned enterprise and bank reform in China: conditions for liberalization of the capital account', in P. Drysdale (ed.) *Reform and Recovery in East Asia: The Role of the State and Economic Enterprise*, London: Routledge, pp. 214–28.

Huchet, J. F. (1997) 'The China circle and technology development in the Chinese electronics industry', in B. Naughton (ed.) *The China Circle: Economics and Technology in the PRC, Taiwan and Hong Kong*, Washington, DC: Brookings Institution Press, pp. 254–85.

Jiang, X. J. (2002) *Zhong guo de waizi jingji: dui zeng zhang, jiegou shengji han jing zheng li de gong xian* [*The foreign sector in China's economy: its contribution to growth, structural upgrading and competitiveness*], Beijing: The Chinese People's University Press.

Kim, E. M. (1998) *The Four Asian Tigers: Economic Development and the Global Political Economy*, San Diego: Academic Press.

Kim, L. (1997) *Imitation to Innovation: The Dynamics of Korea's Technological Learning*, Boston: Harvard Business School Press.

Kong, T. Y. (2000) *The Politics of Economic Reform in South Korea: A Fragile Miracle*, London: Routledge.

Kraemer, K. and Dedrick, J. (2002) 'Enter the dragon: China's computer industry', *Computer* (February): 28–36.

Lardy, N. R. (1998) *China's Unfinished Economic Revolution*, Washington, DC: Brookings Institution Press.

Lemoine, F. and Ünal-Kesenci, D. (2004) 'Assembly trade and technology transfer: the case of China', *World Development* 32(5): 829–50.

Liu, X. and White, S. (2001) 'Comparing innovation systems: a framework and application to China's transitional context', *Research Policy* 30(7): 1091–114.

Lu, Q. (2000) *China's Leap into the Information Age: Innovation and Organization in the Computer Industry*, New York: Oxford University Press.

Mathews, J. and Cho, D.-S. (2000) *Tiger Technology: The Creation of a Semiconductor Industry in East Asia*, Cambridge: Cambridge University Press.

MIC [Market Intelligence Center] (2004a) *Zhongguo dalu zxun chanye jing zheng li fenxi* [*The Competitiveness of China's Information Industry*], Taipei: MIC.

MIC [Market Intelligence Center] (2004b) *Zxun chanye nian jian 2003* [*Annual Report on Taiwan's Information Industry 2003*], Taipei: MIC.

Ministry of Science and Technology, China (2004a) *Zhong guo keji tongji nian jian* [*China's Science and Technology Statistics*], China Statistical Publishing; accessed at http://www.sts.org.cn/tjbg/jsmy/documents/2003/0609.htm, 12 December 2004.

Ministry of Science and Technology, China (2004b) *Zhong guo keji tongji nian jian* [*China's Science and Technology Statistics*], China Statistical Publishing; accessed at http://www.sts.org.cn/sjkl/gjscy/DATA2003/2003-2.htm, 12 December 2004.

Ministry of Science and Technology, China (2005) *Zhong guo keji tongji nian jian* [*China's Science and Technology Statistics*]; accessed at http://www.sts.org.cn/kjnew/maintitle/MainMod.asp?Mainq=8&Subq=1 http://www.sts.org.cn/kjnew/maintitle/MainMod.asp?Mainq=8&Subq=2, 26 October 2005.

National Bureau of Statistics, China (2000, 2002) *Zhongguo tong ji nian jian* [*China Statistical Yearbook*], Beijing: China Statistical Publishing.
National Bureau of Statistics, China (2003) *Zhong guo keji tongji nian jian* [*China's Science and Technology Statistics 2003*], Beijing: China Statistical Publishing.
Naughton, B. (1996) *Growing Out of Plan: Chinese Economic Reform, 1978–1993*, Cambridge: Cambridge University Press.
Nolan, P. (2001) *China and the Global Economy: National Champions, Industrial Policy and the Big Business Revolution*, New York: Palgrave.
Oi, J. C. (1995) 'The Role of the local state in China's transitional economy', *The China Quarterly* 144 (December): 1132–49.
Piore, M. and Sabel, C. (1984) *The Second Industrial Divide: Possibilities for Prosperity*, New York: Basic Books.
Qian, Y. (2000) 'The process of China's market transition (1978–98): the evolutionary, historical, and comparative perspectives', *Journal of Institutional and Theoretical Economics* 156(1): 151–71.
Ramstad, E. (2003) 'New game, many winners', *Far Eastern Economic Review* (August): 28.
Saxenian, A. (1994) *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Cambridge, MA: Harvard University Press.
Saxenian, A. (2002) 'Transnational communities and the evolution of global production networks: the case of Taiwan, China and India', *Industry and Innovation* 9(3): 183–202.
Saxenian, A. and Hsu, J.-Y. (2001) 'The Silicon Valley–Hsinchu connection: technical communities and industrial upgrading', *Industrial and Corporate Change* 10(4): 893–920.
Schumpeter, J. A. (1950) *Capitalism, Socialism and Democracy*, New York: Harper.
Segal, A. (2003) *Digital Dragon: High-technology Enterprises in China*, Ithaca, NY: Cornell University Press.
Shirk, S. (1993) *The Political Logic of Economic Reform in China*, Berkeley: University of California Press.
Smyth, R. (2000) 'Should China be promoting large-scale enterprises and enterprise groups?', *World Development* 28(4): 721–37.
Steinfeld, E. S. (2004) 'China's shallow integration: networked production and the new challenges for late industrialization', *World Development* 32(11): 1971–87.
Sturgeon, T. (2002) 'Modular production networks: a new American model of industrial organization', *Industrial and Corporate Change* 11(3): 451–96.
Sun, Y.-F. (2003) 'Geographic patterns of industrial innovation in China during the 1990s', *Tijdschrift voor Economische en Sociale Geografie* 94(3): 376–89.
Suttmeier, R. P. (1997) 'Emerging innovation networks and changing strategies for industrial technology in China: some observations', *Technology in Society* 19(3/4): 305–23.
Wade, R. (1990) *Governing the Market: Economic Theory and the Role of Government in East Asia*, Princeton, NJ: Princeton University Press.
Wall, D. and Yin, X. (1997) 'Technology development and export performance: is China a frog or a goose?', in C. Feinstein and C. Howe (eds) *Chinese Technology Transfer in the 1990s*, Cheltenham: Edward Elgar, pp. 169–92.
Wang, C. F. (2004) 'FDI dui bendi jishu jinbu de yingxiang: ji yu dongguan de fenxi' [The impact of FDI on local technology development: the case of Dongguan], in X. Liu (ed.) *Zhong guo chuang xin guanli qianyan* [*Frontiers of innovation management in China*], Beijing: Beijing Institute of Technology Press, pp. 73–94.

Wang, J.-H. (2001) 'Governance of a cross-border economic region: Taiwan and southern China', in G. Drover, G. Johnson and J. Tao (eds) *Sub-regionalism in China and East Asia*, Commack: Nova Science, pp. 117–34.

Wang, S., Wu, Y. and Li, Y. (1998) 'Development of technopoles in China', *Asia Pacific Viewpoint* 39(3): 281–301.

Weiss, L. and Hobson, J. (1995) *States and Economic Development*, Cambridge: Polity.

Woo, J.-E. (1991) *Race to the Swift: State and Finance in Korean Industrialization*, New York: Columbia University Press.

Wu, J. L. (2002) 'The bank reform: the most important issue to the current financial reform in China' [Yinhang gaige: dangqian zhong guo jinrong ga ge de zhong zhong zh zhong), *Papers Series on the World Economy* [*Shijie jingji wenhui*] 4: 3–10.

Yusuf, S., Altaf, M. A. and Nabeshima, K. (eds) (2004) *Global Production Networking and Technology Change in East Asia*, Washington, DC: World Bank.

Zhou, Y. and Xin, T. (2003) 'An innovative region in China: interaction between multinational corporations and local firms in a high-tech cluster in Beijing', *Economic Geography* 79(2): 129–52.

Zweig, D. (2002) *Internationalizing China: Domestic Interests and Global Linkage*, Ithaca, NY: Cornell University Press.