China's SME Development Strategies in the Context of a National Innovation System

Toshiki Kanamori, Jamus Jerome Lim & Tracy Yang*

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Abstract

With deregulation and globalization, and the direct impact of these developments on economies worldwide, it has become necessary for Chinese authorities to consider an approach that would further attune its economic engine toward sustained growth. This paper argues that certain sectors of the economy—in particular, the small and medium enterprise (SME) sector—may play a significant role in terms of any further reforms of China's National Innovation System, which in turn could spur continued growth. It highlights how issues such as innovation, R&D, and strategic clustering influence the SME sector, and outlines both internal as well as external conditions that may impact the further development of this sector.

KEYWORDS: SME, National Innovation System, network cluster, China
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*Asian Development Bank Institute, World Bank, and Australian National University, respectively. Emails: tkanamori@adbi.org, jlim@worldbank.org, & tracy.yang@anu.edu.au.
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1 Introduction

China is a relative latecomer to modern industry and is—by most standards—a highly successful one. Evidently, China's market-oriented reforms have, thus far, produced remarkable results. China's manufacturing sector has enjoyed high and sustained rates of growth, with shares of GNP and exports rising sharply. The emergence of dynamic small and medium enterprises (SMEs) is, above all, one of the most important outcomes of the entire reform process. SMEs are the major growing force behind China's prominent success in terms of their contribution toward the national GDP (accounting for 40%), scale of assets, diversification of products, and the creation of employment—in spite of offical Party policy that favors state-owned enterprises (SOEs). Despite their significant contribution to the Chinese economy, SMEs have largely been neglected in official thinking about technological issues, although they now do rate a mention in the current long-term plan.

This paper examines the role of SMEs in technological issues such as innovation, research and development (R&D), and strategic clustering. It focuses on the questions that need to be addressed in any further attempts to reshape China's industrial policy, in the context of what is generally regarded as the national innovation system (NIS): What challenges and constraints do the internal economic environment pose for SMEs seeking to grow? How does the external environment, especially China's entry into the WTO, affect the ability of SMEs to operate and compete? What opportunities are available to Chinese authorities seeking to reform its NIS in a SME-friendly fashion?

Although there exists a relatively large literature SMEs in general, most authors have focused on country-level studies that are focused on idiosyncratic aspects of the SME contribution to growth outcomes. The limited empirical evidence is, at best, mixed. Some authors find that small firms have an advantage in highly-innovative, high-skill industries (Acs & Audretsch 1987), while others find that larger firms are better able to take advantage of increasing returns associated with R&D (Pagano & Schivardi 2003). Similarly, while entrepreneurship may be more prevalent in smaller firms (Acs, Audretsch & Feldman 1994), such activity may (Little, Mazumdar & Page 1999) or may not (Little, Mazumdar & Page 1994) translate into productivity outcomes. Recent cross-country evidence, however, casts doubt on the notion that the promotion of SMEs, *per se*, yield systematic growth benefits (Beck, Demirgüç-Kunt & Levine 2005). However, the same paper also finds that the overall business environment influences economic growth.

Given this context, the paper develops an analytical framework that is premised on enhancing the business environment in which SMEs operate. This framework is informed by four distinct theoretical perspectives: Resource-based development in late industrialization (Barney 1991), institutionally-based technological learning (Nelson 1993), network-based competitive strategies (Porter 1990), and the monopolistic competition model of trade (Krugman 1979). Our argument is that, as a late-industrializing open economy, China can enhance the competitiveness of its industries by limiting its shortcomings as a late entrant,

while tapping its unique strategic resources and its integration in the world economy.

The primary contribution of this paper is that it sheds light on these issues by proposing a strategy that is oriented toward small and medium-sized firms. In particular, we make the case for a network cluster strategy that enhances the linkages between existing actors, while building on China's existing NIS. We consider this strategy as particularly suited to China at this stage in its development and transition, since the collective nature of the cluster may help resolve the problem of the "missing middle."[1]

The rest of the paper is structured as follows. The next section presents a basic analytical framework for rapid industrial and technological catch-up based on the SME sector. Section 3 analyzes China in terms of its internal strengths and weaknesses, within the framework of its national innovation system. It also includes a background discussion on the current status of SMEs in China, as well as its industrial policies as they pertain to the SME sector. Section 4 then looks into several general global trends. These trends and economic imperatives are viewed as potential external threats to Chinese SMEs. In response to these threats, it is necessary that China actively harness national policies as a strategic tool for continued progress. These policies are the focus of the next section (Section 5), which is a discussion of the opportunities for future development, especially with regard to strengthening China's national innovation system (NIS) (drawing heavily on the analytical framework of Section 2). Concluding remarks will be made in the final section.

2 An analytical framework

Any analytical framework that deals with the issue of what the proper development strategies are for Chinese SMEs—especially with regard to technological innovation—has to confront the issue of understanding the basic nature of innovation. At the same time, such a framework needs account for the specific circumstances surrounding a transition from a centrally planned economy to a market-oriented one.[2]

In this paper, we introduce an analytical framework that highlights these issues based on a synthesis of four distinct areas of prior research: The resource-based view on late industrialization (Barney 1991), the institutional economics perspective on the technological learning process (Nelson 1993), the innovation network analysis on competitive industrial strategies (Porter 1990), and the monopolistically-competitive model of international trade (Krugman 1979, 1980).

[1] By the "missing middle" we mean the presence of some large enterprises at the top and many small enterprises at the bottom that unable to graduate into the medium-sized category.

[2] The economics of transition literature is varied in its policy suggestions concerning the best strategy for how such a transition should take place. We will not review the vast literature here, but merely point the interested reader to the excellent books by Blanchard (1997) and Roland (2000). Our approach here draws on the work of Porter (2004).

2.1 Resource-based late-industrialization

At the center of the resource-based view is the fact that the superior performance of a country is derived from the pursuit of a strategy that best exploits its unique resource positions (Barney 1991).[3] In this view, then, the development of the technological capability of the nation is premised mainly on competing use of resources, or more specifically, on the allocation and leveraging of resources toward both the use of existing as well as the creation of new technologies, so as to enhance the overall competitive capabilities of the nation's industries. Technological capability development can be conceptualized as either enhancing an existing core competence, or an attempt to build new core competence (Hamel & Prahalad 1994).

This richer understanding of the nature of technology allows a departure from standard models such that technological capabilities can now possess two dimensions: Product technological capabilities and process technological capabilities. The former is more upstream, and focuses on the ability to create, design, and commercialize new products (whether in terms of goods or services); while the latter is more downstream, and is concerned with the ability of the nation to manufacture or produce multiple copies of a given product. These are not mutually exclusive, but rather a fuller conceptualization of the nature of the underlying technological capability of a nation. We adopt this two-dimensional understanding of technology for our analytical model.

2.2 Institutionally-based technological learning

Based on the discussion above of the two dimensions of product and process technologies, this section goes on to examine four modes of the technological learning process for a late-industrializing economy, as suggested by Wong (1999): The product technology pioneering mode, the process capability pioneering mode, the fast-follower innovation mode, and the applications specialist mode.

The product technology pioneering mode involves strong capabilities in terms of product technology, but is relatively weak in terms of process technology. In this mode, new products are pioneered though radical product technology innovation. In addition, the first-mover advantage allows for the establishment of a given innovation as the dominant design, and its consolidation through subsequent incremental innovations. This innovation path is probably most commonly pursued in advanced industrialized countries, and is the most difficult mode for late-industrializing economy. Some recent examples of such an innovation mode are those of Apple's iPod and Japanese hybrid car technology.

[3] There is some parallel to the more classical factor proportions model of trade, where a country tends to produce and export the good for which it is relatively abundantly endowed. The distinction here is that, unlike the Heckscher-Ohlin model, production technologies differ between countries. Moreover, the underlying technological capability of a nation is conceived as *endogenous*—with resource allocation affecting the rate of technological development—not unlike models of endogenous growth (Romer 1986, 1990).

At the other end of the spectrum is the process capability pioneering mode. Here, rather than seeking new product innovation—which may require the costly development of research, innovation, marketing, and branding capabilities, accompanied by a higher risk of product failure—the focus is on developing process capabilities by mastering the latest technologies for low-cost, high-quality product replication. There are several possible approaches to this mode: By the progressive expansion of the vertical scope of process capabilities (via the development of complementary industries from the raw material stage through to the final product stage), or by a concentration on either specialized niche components or process steps, and building its capabilities in that chosen area. In general, this mode requires the constant investment of resources into process innovation technologies, for the purposes of maintaining high levels of productivity in the face of rising factor input costs. This mode is best exemplified by the Asian dragon economies such as Taiwan (in high-technology computer parts and peripherals) and Korea in the 1980s (in steel manufacture).

The applications specialist mode allows for low levels of both product and process technological capability. In this mode, the aim is to become an innovator in the *application* of existing technologies. This usually occurs in a business area where complementary skills already exist. Success in this mode requires the early adoption of new (but available) technologies, and the use of these new technologies in ways that enhance competitiveness in traditional industries. In some ways, this mode may overlap with the process capability pioneering mode, since highly-innovative usages of existing product technologies may be treated as pushing the *service* process technology frontier.[4] This involves more than naïve, straightforward adoption, however: Doing so may run the risk of stagnation. Examples of countries that have successfully adapted to this mode include the United Arab Emirates in its national airline, while much of sub-Saharan Africa provides a negative example of countries that have not adapted well to this mode. With the notable exception of China's successful export sectors, many Chinese SMEs fall into this mode.

Finally, the fast-follower innovation mode captures the enviable circumstance where an indigenous late-industrializing economy is able to move from being a late-follower to fast-follower, and perhaps even toward parity or exceeding established leaders via leapfrogging. Often, economies graduate into this mode from the process capability pioneering mode, where, by taking advantage of technology transfer through licenses and/or imitative learning, it eventually develops an indigenous product technology capability, while maintaining its process technology leadership. However, the converse-starting with high technological capabilities and developing process technologies-is also possible. Japanese car manufacture in the 1990s and German heavy industry in the post-World War II period are examples of each. We adopt this distinction between the four possible realizations of technological capabilities into our analytical model.

[4] At its best, then, this mode seeks to combine an upstream, externally-available technology with internal, often proprietary, knowledge of a downstream application domain.

2.3 Network-based competitive industrial strategies

Given the above modes that we have defined, it is possible to introduce corresponding competitive strategies that accompany these modes. We adapt the generic strategies concept introduced by Porter (1990) and introduce three strategies that are congruent with our framework; namely, the free riding strategy, strategic cluster strategy, and niche strategy.

The free riding strategy corresponds to the applications specialist mode. Here, the approach is to simply free-ride off the available technologies developed by others. However, as suggested above, without adequate insight into the business or market—such that new technologies can be leveraged to best improve competitiveness and productivity—there is a risk of falling behind.

Strategic clusters seek to form alliances in order to gain competitive advantages. This strategy can be used profitably under the fast-follower innovation mode, although the cluster strategy can be applied to the process capability pioneering mode as well (especially for moving into the fast-follower innovation mode). Almost by definition, this strategy is best adapted to SMEs, since their size and outlook make them more flexible and adaptable in terms of developing complementary relationships within a strategic cluster. The successful execution of this strategy requires the repositioning of firm image from low-end, low-tech producer to high-quality, high-sophistication manufacturer over time.

The niche strategy fits best into either the product technology pioneering mode or process capability pioneering mode, as firms within the economy concentrate on becoming the supplier of specialized niche products or process steps.

Figure 1 summarizes the conceptual framework that we have developed for the purposes of understanding domestic technological capabilities. In order to allow for an international dimension, we now incorporate some insights from the monopolistic competition model of international trade.

2.4 Monopolistically competitive trade

We open our hitherto closed-economy approach by adapting the Krugman (1979, 1980) model of monopolistic competition to our model of domestic technological innovation.[5] As before, we allow technology to change over time, and we allow for resource endowments to differ between countries. Now, opening the economy to trade provides yet another mechanism for increasing returns: That of a larger market with consumers that have a love of variety.

With an international market, an economy can adopt either a high or low export orientation. In general, it is in the interests of firms to seek to produce products for export. However, with differential levels of productivity, coupled

[5]The primary insight of the model of international trade is the role that Dixit-Stiglitz style monopolistic competition plays in the determination of international trade patterns. With economies of scale in production and the ability to costlessly differentiate their products, trade allows for increasing returns that produce gains from trade even in economies with identical tastes, technology, and factor endowments. The model has served as the basis for understanding the phenomenon of intra-industry trade.

		Product Technology Capability	
		High	**Low**
Process Technology Capability	**High**	Fast Follower Innovation Mode **(Cluster Strategy)**	Process Capability Pioneering Mode **(Niche Strategy)**
	Low	Product Technology Pioneering Mode **(Niche Strategy)**	Application Specialist Mode **(Free-Riding Strategy)**

Figure 1: Conceptual framework for understanding domestic technological capabilities.

with fixed costs of export, not all firms will be able to adopt an export orientation (Melitz 2003). Therefore, economies that are able to encourage lower fixed costs of exporting—by minimizing red tape, through participation in free trade agreements, and fostering a national innovation system that supports products with an international appeal—will be able to situate themselves in the hyperquadrant with a fast follower innovation mode accompanied by export orientation, where welfare is maximized. We call this the globalized fast follower innovation mode. In general, firms in this mode will also tend to be larger in size (medium as opposed to small), since an export orientation will be accompanied by an expansion of market size and hence the size of the firm, as well as more efficient.[6] Figure 2 captures our ideas with respect to the international technological capabilities.

2.5 Economies from clustering

As discussed in the introduction, one challenge facing the SME sector in China is the problem of the "missing middle." While this may well be an endogenous market outcome, there is a possibility that distortions have arisen as a result of China's (economic) history of central planning. In addition, China's entry into the WTO in 2001 implies that SMEs will be increasingly exposed to global market forces. We consider the creation of a business environment that supports the globalized fast follower innovation mode as an important means of facilitating the continued evolution of existing SMEs in China, which has hitherto comprised of small firms focused on low-skill, final-goods assembly for the domestic

[6]In equilibrium, however, the number of firms in the economy is likely to fall as inefficient firms exit the industry in the presence of free trade. Overall welfare, however, remains higher with trade than in autarky (Melitz 2003).

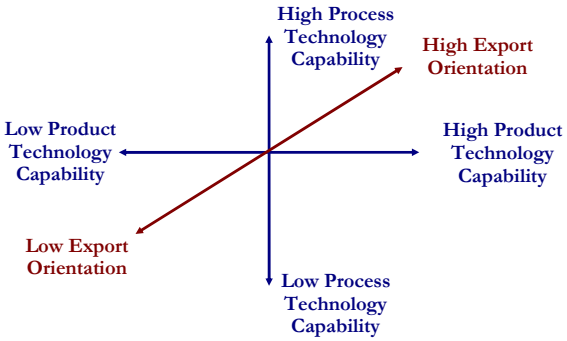


Figure 2: Conceptual framework for understanding international technological capabilities.

market.[7] Moreover, the pursuit of such a strategy is most complementary to China's existing position as a late-industrializing economy with high rates of technology transfer, and seeking to exit the applications specialist mode with the development of indigenous innovative capability.

Entering the globalized fast follower mode requires an upgrade of both size and technology, in order to further development and to enhance the productivity of industries in global markets. More specifically, our analytical model suggests that a network cluster strategy, pursued concomitantly with an international outlook, is the best approach for doing so. The successful pursuit of such a strategy enables firms to increase in size (from small/medium to medium/large), adopt technology that is higher up the value-added ladder (from low value-added to high value-added), and serve global markets (from domestic/import substitution to international/export orientation).

Firms in a cluster benefit from the advantages of agglomeration and external economies of scale; increasingly, the empirical evidence suggests that the key binding constraint for firm growth stems not so much from size *per se*, but from the fact that small firms face limited resources, and when operating independently, cannot access the variety of resources available to larger firms. As a result, clustering allows the benefits of increasing returns due to these external economies to be harnessed.[8] This involves increased cooperation between SMEs within a cluster, in terms of vertical as well as horizontal linkages, both bilaterally and multilaterally.

The economies of scale that exist in a cluster allow the firm to access resources that are typically beyond the reach of a small firm. These include the purchase of inputs, including raw materials and technology; the creation of a

[7] Naturally, such a sweeping statement does not preclude the possibility that certain industries—notably high-productivity exporters such as the textile/clothing and toy sectors—also exist. However, while such export powerhouses easily capture news headlines, they do not represent the majority of the nation's SMEs.

[8] This is a theme that is repeated in the New Economic Geography literature. See Fujita, Krugman & Venables (1999) for a detailed exposition of models in this class.

common pool of skilled workers; the shared use of common capital (such as production machinery); and the pooling of production capacity in order to meet large-volume orders from international buyers. Moreover, economies of scope can be achieved in a cluster by employing common marketing and distribution channels, and by learning from each other about areas such as common markets and product and process improvements. Alternatively, such economies could also be attained by collaboration through producer associations that help open up access to international markets, and which increase small firms' access to government support services. Finally, working within a cluster may also give rise to greater specialization. Firms can concentrate on their core businesses, and evolve a division of labor among firms, thereby achieving greater efficiency in production.

Weighed against these benefits are, of course, costs. These include the cost of ensuring coordination within a cluster, which are realized as transactions costs. These include post-purchase distribution costs; scheduling conflicts when using common capital; and the infrastructure and monitoring requirements needed to ensure compliance with a common system of operating standards. There may also be losses of human capital investments due to worker departures to other firms within the cluster, as well as costs of adaptation and learning. However, given the large external economies commonly associated with knowledge products, the benefits from operating in a cluster are likely to outweigh the costs, insofar as technological issues are concerned.

The case of China is complicated by its transition from a centrally-planned economy. We argue that, in order to reap the full benefits of economies from clustering, the process of economic development needs to emphasize a collaborative process between the government, private firms, and research and educational institutions (Porter 2004). This evolution is summarized as Figure 3.

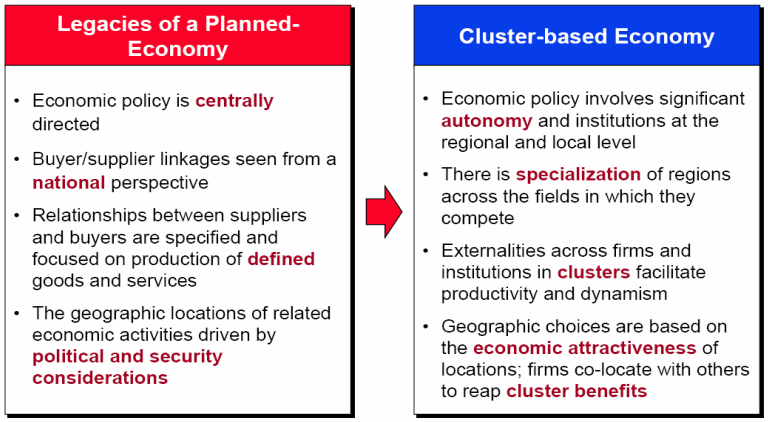


Figure 3: Transitioning from a centrally-planned economy to a cluster-based economy.

There is increasing empirical evidence that cooperation among SMEs that share business interests such as markets, products, and infrastructure needs is more likely when these enterprises operate in close physical proximity (Duranton 2005; Henderson 2003). This physical proximity, in our view, is best achieved when the development of these clusters operate as a network within the framework of the broader NIS.

2.6 Network clusters and the National Innovation System

In addition to cooperation between SMEs in a cluster, the cluster also allows SMEs to interact with institutions in their surrounding environment. These institutions include—but are not limited to—universities and R&D institutes, banking and other types of financial intermediaries, non-financial intermediaries (such as marketing and human resource firms), and relevant government departments; we define these institutions as functional agents. Moreover, certain policies may also impact the cluster. Essentially, our model sites the network cluster within the broader National Innovation System; this national innovation system is comprised of the set of innovation actors, the linkage mechanisms among them, and the policies and institutional factors that influence the performance of each of the innovation sectors. We illustrate these components and their linkages in Figure 4.

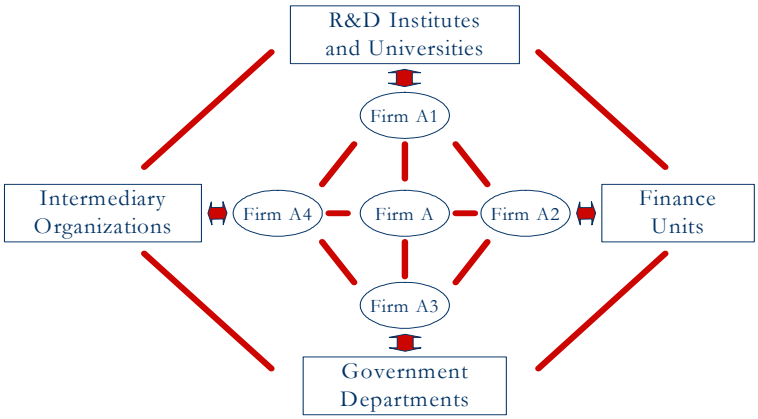


Figure 4: The network cluster within the National Innovation System.

The above setup allows us some flexibility in classifying the linkages that exist within the NIS. For example, a vertical cluster can exist with the configuration

$$Firm\ A + Firm\ A1/A3 + Research\ Institutes + Government\ Departments.$$

Alternatively, a network cluster can exist with the full set

$$Firm\ A + Firms\ A1, A2, A3, A4 + Functional\ Agents.$$

Although most firms in a cluster or network may be small, we define an "organized cluster" as a cluster that exhibits active cooperation and maintains directed linkages among participating firms, usually with the involvement of government policymakers at either the infrastructure or coordination level. This occurs when SMEs in a cluster or network evolve together, after the realization that, by working together as a group, they obtain advantages that allow them to compete in the global economy, which they may not possess if they act as individual, isolated small enterprises.[9] As the cluster matures, the focus shifts toward establishing new relationships with other network clusters, and consolidating relationships with the functional agents.

3 The internal environment and input conditions

The statistical definition of SMEs varies by country, and is usually based on the number of employees, capital, or the value of assets and sales volume. According to the Chinese Government, SMEs are roughly characterized as having less than 200 employees, with sales value lower than 300 million yuan or capital value lower than 400 million yuan. For the purposes of the present paper, we will adopt this relatively inclusive definition, although more specifically the term SME is used in the context of small and medium-sized firms in the technology sector, producing tradable (technological) goods and services.[10]

3.1 The early development and current status of SMEs

Historically, China's industrial organization has not been a product of market forces. Industrial enterprises in China were a creation of the pre-1979 Soviet-style command economy. Enterprises were not really business organizations, but factory units under the active direct supervision of central and provincial government industrial bureaus. The SME sector in China was first allowed on the fringes of the economy, and was initially regarded as a supplement to the state and collective sectors. Faced with restrictions and biases, SMEs, at an early stage, had to establish close links with the local bureaucracy and operate under a high degree of informality. However, because of the decentralization and strong bureaucratic incentives to promote local development, the system was both flexible enough and sufficiently responsive such that it allowed for the cumulative development of SMEs. Yet, this has only been possible since the late 1970s (in agriculture) and the 1980s (in various manufacturing industries).

[9] Note that such organized clusters involve non-equity-based linkages among firms. Collaboration occurs as a result of either firms possessing similar degrees of market power but holding complementary assets, or a dominant firm that acts as a coordinator by setting standards for other firms within the cluster.

[10] For a fuller discussion of China's classification of SMEs, we refer the reader to the working paper version.

According to Wang & Yao (2004), several factors have been identified as having contributed to the dynamic development of SMEs. First, the fast growth of the SMEs in China was made possible by the reforms carried out in both rural and urban areas. The rural reforms have re-established the family farming system and raised the prices of agricultural products. The enhanced productivity provided critical initial capital for the establishment of numerous small firms in the rural areas. The urban and industrial reforms have gradually released resources to the market, so SMEs that were not covered by plans could get access to needed materials. Second, a large market for consumer goods was left unaddressed prior to the 1980s as a result of the heavy industry-oriented development strategy pursued by China under the centrally planned economies. This gave SMEs a perfect opportunity to fill the gap. Third, China is a country with abundant labor, especially in its rural areas. Further opening up to foreign trade also allowed SMEs to expand further by taking advantage of the relatively abundant labor force.

As evident in Table 1, there are currently slightly less than 270,000 small and medium-sized enterprises in China,[11] accounting for 99% of all registered enterprises, 64% of total output value, and 55% in sales revenues. In terms of employment expansion, SMEs accounted for above 77 percent in the industrial sectors. Table 2 shows the evolution of the SME sector in China. There has been a steady increase in the absolute number over the period 1999–2005, with little change in the shares held by small and medium enterprises.

The ownership structure of Chinese industrial enterprises, summarized in Table 3, suggest a significant increase in private enterprises relative to state-owned enterprises. In 1999, private enterprises numbered 14,601, or slightly more than 9% of the national total. In the same year, the 50,651 state-owned enterprises accounted for 31% of the national total (note that these proportions do not control for firm size). By 2005, the proportions of the two stood at approximately 45% and 6%, respectively. This pattern is reflective of the rapid privatization process that has occurred in the past decade in China. A similar pattern can be seen for collective-owned and cooperative enterprises vis-à-vis limited liability and share-holding corporations.

The early development of privately-owned SMEs played an active role in absorbing workers that were laid off or dispersed from both SOEs as well as urban collective enterprises. According to the Information Office of the State Council, between 1998 and 2003, nearly 19 million workers laid-off from SOEs, to be re-employed by private SMEs.

The provincial distribution of SMEs in China is highly unequal, as is economic activity more generally (Table 4). Several regions, notably the three eastern coastal provinces of Guangdong, Jiangsu, and Zhejiang, have such a concentration of SMEs that they account for approximately 38% of all enterprises and 35% of all employment. The next largest concentrations, in Shandong and Shanghai, are also on the eastern coast. The dominance of the coastal re-

[11] Note that if self-employed businesses—such as leasehold farm households and individual partnerships—are also classified as SMEs, this number is far larger, with estimates of as high as 40 million.

Table 1: Main economic indicators of all industrial enterprises, 2005[†]

	Number of enterprises	Gross industrial output value, current prices[‡]	Total assets[‡]	Revenue from principal business[‡]	Total profits[‡]	Annual average number employed (10,000 persons)
Size of enterprise						
Large-sized enterprises	2503	1264.36	95078.32	6645.29	6801.42	1582.42
Medium-sized enterprises	27271	76436.36	83738.56	4087.70	4210.33	2216.49
Small-sized enterprises	242061	83918.78	65967.36	4092.66	3790.78	3097.04
Total	271835	251619.5	244784.24	14835.65	14802.53	6895.95

[†] Source: **?**.
[‡] Values are units of 100 million yuan.

Table 2: Main economic indicators of all industrial enterprises, 1999–2005[†]

	1999		2000		2001		2002		2003		2005	
	Number of enter-prises	Gross industrial output value, current prices[‡]	Number of enter-prises	Gross industrial output value, current prices[‡]	Number of enter-prises	Gross industrial output value, current prices[‡]	Number of enter-prises	Gross industrial output value, current prices[‡]	Number of enter-prises	Gross industrial output value, current prices[‡]	Number of enter-prises	Gross industrial output value, current prices[‡]
Size												
Large	7864	31582.21	7983	38303.21	8589	44815.99	8752	51128.32	1984	48914.24	2503	251619.5
Medium	14371	9857.21	13741	10689.81	14398	18217.90	14571	14189.19	21647	47065.22	27271	91264.36
Small	139798	31267.62	141161	36680.64	148269	38090.58	158234	45458.97	172591	46291.76	242061	76436.36
Total	162033	72707.04	162885	85673.66	171256	95448.98	181557	110776.48	196222	142271.22	271835	83918.78

[†] Source: **?**.
[‡] Values are units of 100 million yuan.
[*] Notes: Data for 2004 were unavailable. Data for 2003 and 2005 are calculated using new criteria (discussed in the appendix of the working paper version).

Table 3: Number of industrial enterprises by status of registration, 1999–2005†

	1999	2000	2001	2002	2003	2004	2005
Domestically funded	135,196	134,440	139,833	147,091	157,641	219,309	215,4484
State-owned enterprises	50,651	42,426	34,530	29,449	23,228	*n.a.*	16,824
Collective-owned enterprises	42,585	37,841	31,018	27,477	22,478	*n.a.*	15,935
Cooperative enterprises	10,149	10,852	10,864	10,193	9,283	*n.a.*	7,481
Joint-ownership enterprises	2,771	2,510	2,234	1,964	1,689	*n.a.*	1,176
Limited liability corporations	9,714	13,215	18,956	22,486	26,606	*n.a.*	41,972
Share-holding corporations limited	4,480	5,086	5,692	5,998	6,313	*n.a.*	7,192
Private enterprises	14,601	22,128	36,218	49,176	67,607	*n.a.*	123,820
Other enterprises	245	382	321	348	437	*n.a.*	*n.a.*
Enterprises with Funds from Hong Kong, Macao and Taiwan	15,783	16,490	18,257	19,546	21,152	28,399	27,559
Foreign Funded Enterprises	11,054	11,955	13,166	14,920	17,429	28,766	28,828
National total	162,033	162,885	171,256	181,557	196,222	276,474	271,835

† Source: **?**.
* Unavailable data are denoted by *n.a.*.

Table 4: Main indicators of enterprises and SMEs by region, 2003[†]

Region	No of enterprises		Employed persons		Total assets[‡]	
	Total	SME	Total	SME	Total	SME
Beijing	4,019	3,975	1,008,107	742,371	517,798	315,905
Tianjin	5,341	5,295	1,152,757	906,454	462,667	286,151
Hebei	7,923	7,822	2,702,428	1,885,149	697,554	377,007
Xhanxi	3,613	3,556	1,824,851	1,171,786	456,520	245,182
Inner Mongolia	1,653	1,622	721,519	465,723	243,908	145,448
Liaoning	6,842	6,747	2,419,852	1,535,868	918,058	464,127
Jilin	2,284	2,253	1,014,771	708,658	367,495	177,585
Heilongjiang	2,567	2,518	1,331,382	722,879	449,900	168,901
Shanghai	11,098	11,024	2,200,059	1,871,531	1,160,899	682,963
Jiangsu	23,862	23,655	5,693,256	4,686,449	1,630,867	1,050,920
Zhejiang	25,526	25,404	4,819,569	4,325,307	1,252,666	1,013,704
Anhui	4,158	4,099	1,489,384	996,945	371,919	186,165
Fujian	9,208	9,168	2,213,532	2,029,243	490,248	406,306
Jianxi	3,051	3,026	961,219	744,058	226,875	131,301
Shandong	16,177	15,913	5,954,189	4,323,858	1,446,160	754,636
Henan	9,091	8,980	3,173,199	2,205,095	657,513	339,594
Huben	6,271	6,205	1,985,994	1,528,222	684,302	317,144
Hunan	5,967	5,911	1,584,395	1,277,818	364,269	234,757
Guangdong	24,494	24,312	7,411,714	6,536,032	1,912,647	1,505,666
Guangxi	2,871	2,846	829,338	716,612	219,037	177,481
Hainan	619	617	120,049	110,130	45,538	40,387
Chongging	2,241	2,198	844,740	644,017	236,333	130,206
Sichuan	5,448	5,380	2,016,228	1,474,719	602,349	353,243
Guizhou	2,129	2,106	655,341	485,191	195,860	102,985
Yunnan	1,995	1,969	663,570	539,227	303,350	181,805
Tibet	325	325	27,723	27,723	9,153	9,153
Shoanxi	2,493	2,430	1,121,236	770,641	36,722	184,013
Gansu	2,884	2,854	778,212	482,945	219,188	89,101
Qinghai	400	391	142,432	84,651	87,148	40,655
Nigxia	418	404	228,038	125,556	73,610	34,158
Xinjiang	1,254	1,233	396,597	294,054	20,967	106,396
Total	196,222	194,238	57,485,680	44,418,912	16,880,770	10,253,045

[†] Source: **?**.
[‡] Values are units of 1 million yuan.

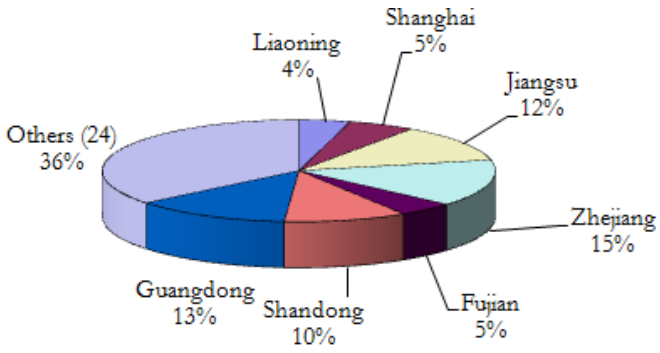
gions in SME activity can also be seen in Table 5, which is based on data from 2005, and replicated graphically in Figure 5.

The Chinese government has, recently, taken some active steps to promote the SME sector. It has adjusted related legislation and policies, and launched a series of policies and initiatives. In June 2002, China introduced the "SME Promotion Law, 2006–2010," which includes, among other initiatives, measures that would dismantle institutional barriers that would hinder the development of privately-owned SMEs, as well as promote a greater level of scientific and technological innovation as well as spur upgrading (Chen 2006). However, while the policies sketched out in the Law seeks to improve the overall business environment and increased the expansion potential of SMEs, it does not actually address the longer-term development of SMEs within the framework of the existing NIS. As a result, the initiatives outlined in the Law does not fully exploit the external economies that would be fostered when a cluster-based strategy is adopted.

Table 5: Main shares of enterprises and SMEs by region, 2005[†]

Region	SMEs (%)	Employees (%)	Assets (%)	Tax (%)
Coast	72.5	69.6	70.2	66.3
Central	16.7	18.4	15.8	19.1
West	10.8	12.0	14.0	14.6
Total	100	100	100	100

[†] Source: **?**.



Source: China International Association of Small and Medium Enterprises (2006)

Figure 5: Share of SMEs by region, 2005.

3.2 Constraints on Chinese SMEs

Problems facing Chinese SMEs are many and varied. Chinese SMEs are constrained from achieving economies of scale in the purchase of such inputs as equipment, raw materials, finance, and consulting services; are often unable to access global markets; and are also limited in their performance in increasingly open, competitive domestic markets. Because of their size, it is difficult for Chinese SMEs to access such functions as training, market intelligence, logistics and technology. As such, they are unable to take advantage of market opportunities that require large volumes, homogeneous standards, and regular supply. Furthermore, firms compete more and more not only on the basis of prices, but on the basis of their abilities to innovate, or upgrade. Improvements in product, process, technology, and organizational functions such as design, logistics, and marketing have become the critical success factors in firm competitiveness in a globalizing economy. Chinese SMEs are thus under pressure to innovate, to upgrade their operations in order to participate in international markets. However, they often lack the resources to do so.

Late-industrializing economies, such as China, tend to be restricted by the technology gap. This technology gap can be decomposed into three aspects: Innovation lag, process lag, and customer lag.

Innovational ability involves the levels of creation and developmental capability in science and technology. Examples in this context are R&D capability and re-engineering skills. It has also been argued that the late-industrializing economies suffer from an innovation lag in the form of a steeper learning curve and a later start in the patent race, as compared to the advanced economies. Process capability refers to the infrastructure and infostructure that supports human capital and the firm's ability to make multiple copies of a product or to deliver repeatedly a service once the product or service performance specification is given. The relative shortage of physical systems used to transmit and store intellectual material and the inadequate public R&D infrastructure in China poses a threat. Finally, China may suffer from the disadvantage of being a latecomer to the industry—a phenomenon that leads to customer lag. For example, advanced industrialized economies may enjoy the benefits of first-mover advantage and capture a larger share of consumers and subsequent switching costs (as embodied in brand recognition, user sunk costs, and so on) may act as a barrier to entry for China.[12]

Perhaps the greatest internal challenge that China faces, going forward, is the issue of a relatively underdeveloped and structurally shaken domestic financial system. This has a direct impact on SME business activity, since small firms—unable to bypass bank intermediation in order to raise funds directly from capital markets—are more likely to find that financial constraints are bind-

[12]However, the counterargument is that latecomers enjoy the possibility of leapfrogging due to the ability to pass over obsolete technology and not having to deal with an excess of legacy infrastructure. On balance, it appears that the costs of China's relatively late entry into the world economy probably dominate the benefits of this late entry. The issue of legacy infrastructure is also discussed below.

ing in the absence of bank loans.[13]

Financial constraints arise in the SME sector for different reasons. The literature highlights distinctive differences in terms of SME access to as well as form of financing, as compared to large firms. For example, smaller companies may choose to limit their issuance of outside equity so that ownership control of their firms is not diluted (Hamilton & Fox 1998). Similarly, it is more difficult for the smaller (and younger) SMEs to access debt financing, since they generally have shorter banking relationships and face greater asymmetries of information. As a result, they face higher interest rates and are more likely to be required to pledge collateral (Berger & Udell 1995; Saito & Villanueva 1981).

SMEs in transition economies, such as China, face additional constraints unique to their environment. Characteristics common to transition economies in the initial stages of reform—such as a high concentration of firms in the industrial/manufacturing sector, the underdevelopment of financial systems, and low legal and governance standards (Gros & Suhrcke 2001)—exacerbate the challenges faced by SMEs. These constraints may be classified along the lines of internal and external constraints. In the context of Chinese SMEs, several constraints appear to be more relevant than others.[14]

Internal constraints stem mainly from informational asymmetries, leading to credit rationing on the part of bank lenders. These include: Differential financial treatment due to ownership, region, size, and industry; the relatively low levels of accountability of credit, compounded by false accounting and bookkeeping records; the absence of credible collaterals; a lack of transparency; weak corporate governance and management skills in the SME sector; and risks that arise due to the specific markets that SMEs operate in. External constraints derive from the failure of bank competition; cost-effectiveness of loans to SMEs; underdeveloped and incomplete capital and commodity markets; and the perception—a remnant of socialist mindsets—that SMEs are second-tier firms. The implication of these constraints is that the proportion of SMEs receiving bank loans is very low: Economywide, only 10% of the estimated 3 million private enterprises are able to obtain financial support in the form of a bank loan (China International Cooperation Association of Small and Medium Enterprises 2005, p. 100).

The role that VCs play in filling the financing gap faced by China's SMEs, therefore, is critical. The increased marketization and privatization of the Chinese economy has brought with it an ownership transformation and, with it, greater synergies between the respective sectors. It is likely that future growth opportunities in the SME sector will rely heavily on the development of this VC-SME nexus.

[13] In more mature financial markets, venture capital financing may be available to make up for credit rationing problems associated with more traditional bank loans. We discuss the development of the venture capital industry in China in the working paper version. For a fuller discussion of the development of the financial market in China over the period 1990-2000, see Shi (2001).

[14] These are discussed more fully in the working paper version. See also Wang (2004) for a detailed discussion.

3.3 Industrial policies and challenges for the innovation system

It is well known that, in general, centrally-planned economies lack an incentive structure for promoting innovation as well as the organizational mechanisms to translate science and technology (S&T) resources into either industrial or commercial products, or innovation. Prior to the period of market-oriented reform, many problems appeared. First, most of the talented scientists involved in S&T were located in military research labs and research universities, thereby creating self-contained ivory towers that were inaccessible for the most part to industrial enterprises. Second, even though the industrial research institutes—under various industrial ministries and bureaus—were assigned to serve industrial needs, they were usually trapped within the vertical authority of their respective ministries or bureaus. There existed almost no direct horizontal channels among research institutions and enterprises across the authoritative boundaries of the various ministries or bureaus. Third, within the same administrative authority, communication between research labs and enterprises was more or less along vertical channels via administrative organs at the top. Direct horizontal links between labs and enterprises were often secondary.

Economic reform in China has been accompanied by a shift in technological and industrial policies away from the nationalistic strategy of self-reliance which prevailed until the 1980s. The government has moved toward a more pragmatic strategy of importing advanced technology and directing domestic technology development toward commercial purposes. This has included several "five-year plans" since 1952, as well as key technology programs, such as the 863 program and the Torch Program. Economic necessity has led to further changes, as China realizes the importance of upgrading its technology rapidly in order to further enhance productivity growth. In 1998, the State Science and Technology Commission changed its name to the Ministry of Science and Technology (MOST); its name change coincided with a functional shift toward serving enterprises, especially SMEs. This has occurred mainly through encouraging innovation, upgrading management practices, promoting science parks and incubators, and overseeing the development of human resources needed in S&T field. China's expenditures on scientific and technical activities, over the period 2001 through 2005, are summarized in Table 6.

By and large, economic and enterprise reforms over the last 20 years have dramatically altered the structure and dynamics of China's innovation system. As a result, the system is no longer characterized by a strict division of labor among functionally specialized organizations. New policies and institutional reforms have fundamentally changed the way decisions over activities—such as resource creation and allocation in the innovation process—are made. Moreover, operational and strategic decisionmaking has also been decentralized. This has been accompanied by an initiative that forces organizations to compete with each other, based increasingly on their ability to perform functional activities more effectively and efficiently.

Nonetheless, evidence of improved diffusion and implementation of tech-

Table 6: Expenditures on scientific and technological activities[†]

	2001	2002	2003	2004	2005
Funding for S&T activities[‡]	2,589.4	2,938.0	3,459.1	4,328.3	5,250.8
Government funds	656.4	776.2	839.3	985.5	1,213.1
Self-raised funds by enterprises	1,458.4	1,676.7	2,053.5	2,771.2	3,440.3
Loans from finance institutions	190.8	201.9	259.3	265.0	276.8
Expenditure on R&D[‡]	1,042.5	1,287.6	1,539.6	1,966.3	2,450.0
Basic research	52.2	73.8	87.7	117.2	131.2
Applied research	175.9	246.7	311.4	400.5	433.5
Experimental development	814.3	967.2	1,140.5	1,448.7	1,885.3
Proportion of expenditure on R&D to GDP (%)	0.95	1.07	1.13	1.23	1.34

[†] Source: **?**.

[‡] Values are units of 100 million yuan.

nological innovation is, in some cases, indirect or ambiguous. On one hand, the explosion in product choices that have become available to industrial and individual consumers suggests real improvements. On the other, researchers attempting to track changes in productivity that would reflect improved production methods, implicitly based on better production technology, have found mixed results. Some authors claim that SME productivity has risen throughout the 1980s and early 1990s (McMillan & Naughton 1992; Rawski 1994), while others argue that there has been little improvement after a one-time increase in the early 1980s (Woo 1997).

Other researchers have argued that there have been dramatic improvements in the development, diffusion, and implementation of technological innovations. Gu (1999), for example, has carefully documented the emergence of new technology enterprises. She describes this as an "unlocking" of R&D assets from research institutes, since over 80% of these new technology enterprises are spinoffs, or are primarily supported by research institute and universities. This phenomenon is largely the result of cuts in central government funding to these research organizations, coupled with changes in the legal and regulatory environment that allows them to establish such new ventures. These new technology enterprises are leading the commercialization of advanced technology in the most science-intensive industries, such as computers and information technology, biotechnology, and new materials. Not only have the new technology enterprises generated their own profits, but they have also made new technology embodied in production equipment and inputs available to other manufacturers, thereby supporting quality and productivity improvements in these organizations.

An abundant and skilled labor force, combined with economies of scale, has naturally played a key role in China's trade success. China is no longer—as traditionally perceived—solely an exporter of supply capacities, specializing in pure assembly activities. It is now also involved in R&D activities. According to Secretariat (1998), high-technology transnational corporations have set up over 100 R&D centers, mostly in Shanghai and Beijing. These R&D centers have played a crucial role in enhancing the innovative capability of foreign affiliates and upgrading their activities. The budgetary expenditure on science and research since 1970 is summarized in Table 7.

As of early 1990, China has approved the establishment of 53 STIPs (Science and Technology Industrial Parks), including the renowned Zhongguancun Science Park in Beijing (the so-called Silicon Valley of China), as well as other regional development zones. This initiative is part of the wider Torch Program, which was drawn up in 1988 with the aim of developing new high-technology industries in China. The program has also seen the expansion of Technology Business Incubators (TBIs)—which are based on the idea of business incubators in industrialized countries—as well as an innovation fund for small technology-based firms.

The Torch Program has also been bolstered by the Decision on the Reform of the Science and Technology Management System, made in 1985 by the Central Committee of the Communist Party of China. The program seeks to promote commercialization through venture investment by universities, the

Table 7: Budgetary expenditure on science and research (S&R) with share of relevant indicators, 1970–2005[†]

Year	S&T promotion funds[‡]	S&R operating expenses[‡]	S&R capital construction[‡]	Other S&R expenses[‡]	Total S&R expenditure[‡]	Share GDP (%)	Share expenditure (%)
1970	14.78	1.68	4.05	9.45	29.96	1.33	4.61
1971	19.95	2.5	4.27	10.96	37.68	1.55	5.15
1972	18.71	3.44	4.49	9.46	36.1	1.43	4.71
1973	19.41	5.09	3.07	7.02	34.59	1.27	4.27
1974	20.59	7.13	3.05	3.88	34.65	1.24	4.38
1975	24.59	9.49	2.67	3.56	40.31	1.34	4.91
1976	21.65	10.34	4.17	3.09	39.25	1.33	4.87
1977	22.35	11.64	3.9	3.59	41.48	1.3	4.92
1978	25.47	15.46	6.66	3.3	52.89	1.46	4.76
1979	28.41	18.6	9.4	5.88	62.29	1.54	4.89
1980	27.57	19.63	11.27	6.12	64.59	1.43	5.33
1981	24.12	21.45	10.46	5.55	61.58	1.27	5.52
1982	26.38	22.37	11.17	5.37	65.29	1.23	5.66
1983	35.51	25.13	11.9	6.56	79.1	1.33	6.12
1984	42.32	30.09	14.74	7.57	94.72	1.32	6.13
1985	44.35	32	18.83	7.41	102.59	1.14	5.56
1986	49.63	34.56	20.3	8.08	112.57	1.1	4.83
1987	50.6	29.5	22.87	10.82	113.79	0.95	4.65
1988	54.05	35.65	19.7	11.72	121.12	0.81	4.48
1989	59.13	38.45	17.91	12.38	127.87	0.76	4.21
1990	63.48	44.44	17.47	13.73	139.12	0.75	4.03
1991	73.32	54.15	18.4	14.82	160.69	0.74	4.21
1992	89.41	57.16	24.55	18.14	189.26	0.71	4.31
1993	106.56	65.59	33.95	19351	225.61	0.65	4.27
1994	114.22	87.9	36.06	30.07	268.25	0.57	4.26
1995	136.02	96.86	38	31.48	302.36	0.52	3.92
1996	155.01	109.66	48.55	35.41	348.63	0.51	3.77
1997	189.97	127.12	42.74	49.03	408.86	0.55	3.67
1998	189.9	151.92	47.28	49.5	438.6	0.56	3.43
1999	272.8	168.06	52.89	50.1	543.85	0.66	3.6
2000	277.22	189.03	61.52	47.85	575.62	0.64	3.28
2001	359.64	223.08	63.37	57.17	703.26	0.73	3.36
2002	398.6	269.85	69.99	77.78	816.22	0.78	3.32
2003	416.64	300.79	111.06	147.05	975.54	0.72	3.5
2004	483.98	335.93	95.9	179.53	1095.34	0.69	3.29
2005	609.69	389.14	112.5	223.58	1334.91	0.73	3.53

[†] Source: **?**.
[‡] Values are units of 100 million yuan.

transfer of research results from universities and the Chinese Academy of Sciences, and the dual employment of professors and researchers, all of which has led to many ventures being launched from universities. In addition, industrial clusters—mainly STIPs—have formed that boast strong university affiliations, such as TsingHua and Beijing University in Zhongguancun. Finally, the commercialization of technology has also been matched with measures that include the simplification and unification of procedures for launching new businesses, as well as increased support for encouraging the return of students that have studied abroad.

The existing clusters in China are primarily located in export processing zones—usually in the coastal areas—and are mostly limited to the production of standardized consumer or low-technology goods made for mass markets (such as furniture, consumer electronics, and textiles and garments). There is usually little innovation,[15] and R&D activity, if present at all, tends to be negligible. A subset of these firms may be integrated into global supply chains, but such integration is minimal, and the relatively homogeneous nature of their products makes them highly vulnerable to changes in demand from abroad. To the extent that firms seek to improve their competitive position, the strategy is often through cost-cutting measures. Overall, there is complacency in the conduct of business, which is usually based on the copying or licensing of products, using machinery imported from abroad.

4 The external environment and demand conditions

The deregulation of financial and product markets and the liberalization of trade, investment, and capital movements are creating a more interdependent world. This has been accompanied by the rapid development and spread of knowledge, which has been facilitated and accelerated by technological progress. Globalization has increased the awareness concerning the value of specialized technology, and is at the same time putting tremendous pressure on all economic actors—individuals, firms and organizations/institutions—to increase their levels of adaptability, innovation, and process speed. Nowhere is this more evident than in China, which joined the WTO in 2001, and is today one of the largest recipients in the world of foreign direct investment (FDI).

Competition between firms internationally is fostered the increasing size of the market that has been opened up by new information and communication technologies. Competitive pressures in the international economic environment are allowing more efficient firms to expand and causing the less efficient ones to shrink or disappear. Increased international competition in turn spurs firms to create new products and adopt more efficient production processes, and consequently, this changes the nature of the production function. New growth

[15] Except, perhaps, for supplier-driven innovation, such as through improved inputs and the introduction of new machinery.

theory,[16] therefore, has proposed modifications to neoclassical models of growth that allow innovation to be an intrinsic part of future growth rates (Romer 1986, 1990).

While, in principle, the process of globalization and increased international competition should, *a priori*, be expected to make it easier to narrow gaps across countries, the accelerating pace of change and difficulties of many developing countries in getting started may, in effect, bring about the opposite (unexpected) result. Indeed, these trends may have given rise to three overarching challenges.

The first challenge concerns the existing institutional regime. Technological change combined with increased economic interdependency will intensify and alter the nature of international competition and this in turn adds to pressures for adjustment and restructuring that can adversely affect late-industrializing economies such as China. In addition, entirely new markets (for example, e-business, online trading, and other forms of electronic commerce) are being created through increased networking and the gains from network externalities.

The potential gains of these externalities to the private and public sector are enormous, with possible dramatic reductions in the cost of delivering goods and services, and major effects on governance through the reorganization of administrative institutions. Unlike advanced economies, it is also believed that the "rules of the game" for a competitive, transparent, equitable economy are not sufficiently developed or enforced in China.

The second challenge involves the importance of a developed information infrastructure. The national information infrastructure includes more than just the physical facilities used to transmit, store, process, and display voice, data, and images. Non-physical infrastructure, such as the legal and regulatory regime, plays an important role as well. Non-physical infrastructure also includes the intellectual and innovational climate in the country. Without an attractive environment for innovation, skilled manpower will simply relocate to other regions that offer a superior alternative. Thorny issues such as intellectual property protection, privacy, security, data protection, electronic payments and currency, and wide-ranging consumer protection issues have to be addressed in national legislation and regional strategies; each with tremendous social and economic implications.

An inappropriate legal and regulatory environment can disempower local entrepreneurs and cause international investors to look to other countries. In East Asia, where effective and consistent public policies and institutional regimes are often weak or absent, these issues associated with the non-physical infrastructure pose major challenges. China, in particular, has a clear handicap—its ability and commitment to policing and enforcing the rule of law in intellectual property is either absent or questionable—and as a result, upgrading to the latest technologies may be more difficult to implement. Addressing these needs

[16] New growth theory, or endogenous growth theory, was pioneered by Romer (1986). This subsequently enjoyed important contributions by himself (Romer 1990) and others (Aghion & Howitt 1997; Grossman 1991; Lucas 1990). The literature has attempted to deal with how increasing returns allow long-term growth to be self-sustaining, an issue that the neoclassical growth literature (Solow 1956) had treated as exogenous.

will require developing a dynamic information infrastructure that can facilitate the effective communication, dissemination and processing of information. China cannot afford to rest on its laurels, but at the same time, should not indiscriminately jump the gun.

The third challenge concerns human resources development. Access to information (local or global) is meaningless unless it can be converted into relevant application. Hence, many of the information technology applications presuppose a highly skilled labor force. These require researchers and technicians across a spectrum of information technologies, a workforce that can use the new production technologies and a general population that can use these products and services effectively. At the same time, the educational requirements for the information economy are increasing in complexity. This rapid development of human resources is a critical challenge for China. As such, the development of strategies to enhance and attract a core of knowledge workers is a serious agenda facing China.

5 Opportunities for future development

While China clearly faces challenges in the face of a rapidly globalizing economy, there exist some potential opportunities that, when appropriately leveraged, can be used to offset the existing disadvantages. In this section, we draw on our analytical framework developed in Section 2 to show how China can create and intensify its innovative capacity and hence re-adjust its strategic directions.

Essentially, we envision the way forward for small and medium enterprises is for them to position themselves in the top-right hyperquadrant of Figure 2. In particular, by pursuing what we call a globalized fast follower innovation mode—which emphasizes an upgrading of both product and process technologies, coupled with an export orientation—China's government can foster an environment that allows its SMEs to be competitive in the global economy.

Given China's existing economic policymaking structure—premised heavily on the former Soviet Union's model of establishing functionally specialized organizations, whose activities and interactions would be managed by a central government body and not between each other (Lo 1997; Maruyama 1990)—any successful move toward the globalizaed fast follower mode must take into account the appropriate scope of government involvement. Since the central government has hitherto been the primary manager of both the internal activities of these functionally specialized organizations, as well as the transfer of resources between them and between the government and each of these organizations, disconnecting future development from the existing government infrastructure would be tantamount to reinventing the wheel.

What this suggests is that reform of the SME sector—vis-à-vis technological aspects—is best undertaken in the context of the existing NIS. Indeed, the key advantage of operating through China's NIS today that the establishment of actors is not an issue. The necessary actors, illustrated in Figure 4, are, by and large, mostly in place. More important are the changes in organizational

boundaries surrounding the activities that occur within the NIS, as well as the incentives that exist for actors to undertake these activities and to perform well. Clearly, this needs to be undertaken concomitantly with an effort to enhance the linkages between actors.

We view measures that enhance the linkages between actors as crucial for the continued strengthening of China's NIS. The network cluster strategy is particularly suited to China's development strategy at this point, since the collective nature of the cluster may help resolve the problem of the "missing middle." China has a surfeit of small enterprises that cannot grow because of informational and other market failures associated with its economic history of communism, and its current status as a transition economy.

The primary weakness of the existing cluster infrastructure in China is that there is little or no integration that would afford the network economies that a directed cluster strategy would afford. With low levels of technological spillovers, limited local entrepreneurship, and little involvement of the government as intermediary agents, existing clusters are not viable as a medium and long-run strategy for upgrading the SME sector. One needs to be careful in the form of government intervention, however: Experience shows that forcing clusters to develop in a particular manner—other than being in potential violation of WTO rules—often leads to multiple inefficiencies, and undermines the competitiveness of the cluster as a whole. Intervention, therefore, should be limited to intermediation, as opposed to direct involvement.

The measures that we consider include providing a positive regulatory environment where private businesses can operate efficiently; fostering inter-firm cooperation through policies such as tax incentives and benchmarking; addressing the asymmetric information problem through advisory services and the training of human resources, coupled with micro-level financial reform; and promoting domestic and international technology transfer via an institutional infrastructure that supports such transfers.[17]

5.1 Regulatory environment for private business

Chinese firms often suffer from a regulatory framework that imposes high costs in terms of both time and money in their relationships with government authorities. In the short run, nationwide reform may not be realistic. However, at the local level—such as within a network cluster—the government is beginning to provide a fair degree of latitude insofar as local governments' ability to institute local policies are concerned. This enhances ownership and hence

[17] It is important to keep in mind that SME policy in China is largely guided by the "Act on the Promotion of SMEs," which came into effect in 2003, and is the only such act dealing with SMEs. The Act includes policy measures such as financial support, support for start-up businesses, and support for technological innovation and market expansion. The Act also states that the Chinese government will be involved in information provision and training services for SMEs. However, the wording in the Act is very brief and ambiguous, and does not provide any specificity in terms of proposed measures. As such, one could argue that there currently remains no comprehensive SME policy in China; perhaps the best characterization of the current SME policy direction is that remains mostly ambiguous.

has the potential to redirect local authorities' incentives away from neglect and toward commitment. The danger here, of course, is that providing such flexibility also engenders the danger of greater bureaucratic red tape and (possibly) corruption, which is inimical to growth (Djankov, La Porta, Lopez-de Silanes & Shleifer 2001).

A balance must clearly be reached in terms of practical measures that would provide a positive environment for private business establishment and operation. These measures include the establishment of long-term consultation mechanisms between the local business community and local government, the removal of unnecessary red-tape and rectifying bureaucratic procedures to promote efficiency, the introduction of agencies that assist in business formation at the local level, and the provision of better training of local civil servants, coupled with meritocratic recruitment policies. The experiences from advanced industrial countries suggest that such an inclusive approach at the local level can potentially reap beneficial outcomes (Organisation for Economic Co-operation and Development 1996, 1997). With the success of the local level in place, the same strategy may then be feasibly attempted at the state/province level. China has already demonstrated some success in this regard in its Special Economic Zones. The natural next step is to allow the diffusion of these zones into the macroeconomy in general, using as a model the regulatory environment of Hong Kong.

5.2 Stimulating inter-firm cooperation

Chinese firms that are currently organized as clusters often do not engage in much inter-firm cooperation. When the cluster hosts a number of competitive firms—and possibly even world-class manufacturers—the opportunity exists for these firms to play the role of demonstrators of best practice, which may be profitably imitated by the other firms in the cluster. Why, then, is such behavior uncommon in Chinese industrial clusters? There are two main reasons. First, the uncompetitive environment under the centrally-planned economy, where every firm produces according to quota, has bred an attitude of complacency. Second—and related to the first—being sheltered from internal competition, these firms have no additional incentive to upgrade their manufacturing processes toward attaining best practice, or are simply ignorant of their underlying problems. As such, creating an awareness of the necessity for substantial improvements is a crucial precondition for intensified inter-firm cooperation.

Of course, such changes will not come easily. Firms that have acted independently in the past will not easily switch to a mode of close cooperation; this is not only because of an absence of trust, but also since engaging in cooperation may involve high fixed as well as transactions costs, especially at the outset. However, if government policy can highlight the advantages of cooperation within the network cluster, perhaps by offering tax incentives to do so, the discounted value of engaging in cooperative behavior may then exceed their persistence with the *status quo*. Alternatively, policymakers can adopt benchmarking with firms elsewhere (or with a world-class firm within the network cluster, if one exists), which may then clarify for firms just how far behind they

are from the industry leaders.[18]

5.3 Information, advisory, and training

As mentioned earlier, informational asymmetries are currently a significant inhibitor of SME growth in China, especially with respect to the financial constraints that they face. One advantage of the network cluster approach is that information may be more easily shared, due to physical proximity. Moreover, the economies of scale that accompany organization as a network cluster may make it feasible for financial institutions to establish long-term relationships with the network *cluster*, as opposed to individual SMEs. As far as policymakers are concerned, the government can play a role in the dissemination of information by establishing dissemination standards. Moreover, the unique position of the state as a central actor also means that it may have more up-to-date information on technology, market structures, and regulatory mechanisms.

At present, the Chinese NIS has both venture investment funds as well as a general investment fund to support high-technology firms. However, these do not offer much by way of support for SMEs, in part because of informational asymmetries, and in part because of the relatively immature financial sector. Policymakers can help the development of the financial sector by encouraging collaboration between different classes of financial organizations, especially within a network cluster context, and hence promote the evolution of innovative financial schemes that are targeted toward the needs of SMEs, such as leasing, factoring, venture capital, e-finance, and securitization of SME debt.

A related problem that existing clusters in China face is the poor match that occurs between the supply of and the demand for trained personnel. Often, the demand for qualified workers outstrips supply, in part because the labor market fails to operate adequately as a signaling device for training institutions. More specifically, while most graduates in China do find jobs, it is unclear whether their respective training institutions are equipping graduates with the skills that are the most critical (and needed) for the job at hand, or whether market conditions for skilled labor in China's overheated economy are so tight that firms are willing to accept applicants that possess qualifications that are only remotely relevant to the job. This is a form of market failure that can potentially be addressed within a network cluster setup. Since research and training institutes are located within the network cluster, they are closer to the ground in terms of understanding the network cluster's specific human resource needs. In addition, the government can also act as intermediary agents that organize clearinghouses that facilitate the exchange of human resource needs between firms and training institutions, and aid in the matching process of skills training to firm needs. This would facilitate the placement of China's growing numbers of foreign-educated university graduates. Moreover, such intermediaries can also provide subsidies for the training of highly specialized human resources that may be needed in a

[18] Moreover, a joint benchmarking exercise may have a catalytic effect in terms of encouraging more intense exchanges between firms on technical issues, such as when employees from different firms are jointly trained in benchmarking techniques.

network cluster—positions such as high-skill manufacturing personnel and and quality assessment workers that are currently under-supplied by the domestic labor market.

5.4 R&D and domestic technology transfer

Finding support for R&D is usually a challenge in developing countries, and China is no different. Moreover, the mere creation of an infrastructure for the promotion of R&D activities does not necessarily imply that such an infrastructure will be put to use. Undoubtedly, SMEs do benefit from easy access to cutting-edge research, since they may not be able to afford such functions on their own. However, the mere availability of such research is only a necessary but insufficient condition for their use, if there does not exist a channel between research institutions' R&D output and the use of this R&D as an input in the production processes of firms. In this regard, communication is key. By providing a forum where such dialog can take place, policymakers can encourage firms and institutions to talk to one another, and cooperative partnerships may arise with a greater understanding of each other's specific aims and requirements. In addition, such a forum may also provide an avenue for airing misunderstandings and addressing conflicts that arise in the process of cooperative activity. Such fora also play an important role in promoting the utilization of research results, through conferences and meetings that announce new findings, or in helping in the process of technology matching.

How can the government build such fora? In industrialized countries, business associations often endogenously develop in order to fill this important role of moderators and facilitators. China's history of suppressing free social association thus has a direct impact on its economic sphere. A compromise would be for Chinese policymakers to relax rules of business-related associations, in order to allow such organizations to be founded and grow in China. These associations can also then form the basis for more sophisticated new institutions, such as formal and informal business network structures, cooperative R&D centers and institutes, and special interest representation.

Another approach is for the government to establish intermediary organizations that act as brokers in the formation of inter-firm networks within network clusters. Such an organization can then assist companies as they seek to link up with a range of support services. The goal of such an organization, therefore, is not so much to actively promote technology transfer *per se*, but rather to offer a medium by which SMEs can make clearer demands to technology suppliers, such as universities, technological institutes, and industrial development centers. This will render technology transfer more demand-driven, and hence cater to the idiosyncratic cultural aspects of the domestic Chinese market. At the same time, the organization can also create a national referral network, which will permit these suppliers of technology and know-how to be better matched with SMEs that have need for their specific technology. As such, "innovation networks" can be established that involve firms and institutions such as universities, R&D institutes, and engineering consultancies. These networks can

be the basis for indigenous research capabilities, and hence wean China off its dependence on foreign designs and process methods.

5.5 International technology transfer

The vast flows of FDI into China have also brought some degree of international technology transfer. However, much of the international technology transfer that has occurred has been somewhat limited by concerns over intellectual property (IP) protection, as well as the constraint of (currently) relatively low levels of human capital, especially in areas such as quality management, logistical control, and worker motivation. An NIS network cluster, by addressing these two issues, is an ideal way to foster both the conscious transfer of as well as incidental spillovers from international technological know-how.

Since network clusters enhance domestic technology transfer as well as provide a greater motivation for worker training, human capital can be upgraded in order to facilitate international technology transfer. Moreover, technological knowledge can also be acquired from external sources by, for example, the use of international consultants, licensing arrangements between local and foreign companies, sending local workers abroad for training, and encouraging multinationals' affiliate plants to engage in mentoring partnerships with their local supply chains-all of which benefit from the infrastructure and stability provided by a network cluster. One possibility is for local intermediary agencies, in considering investment projects, to adopt a two-tier system that distinguishes between local and foreign firms, perhaps by offering tax incentives to foreign firms that have demonstrably high levels of technological know-how. These foreign companies can then be matched with local industries in global supply chains, which would help drive local firms toward upgrading their own knowledge base.

Inevitably, one issue that needs to be considered in the medium to long run is that of IP rights, since this issue hampers international technology transfer, and in addition is a recurring complaint after China's entry into the WTO. Currently, China's IP regime remains marginal at best. While there are, arguably, strategic arguments to allowing the free (or easy) use of IP goods that exhibit the low marginal cost of production property, especially in a developing country, in the medium to longer run China will need to begin to develop a more comprehensive intellectual property regime, especially if it is to encourage the indigenous development of research.[19] A step forward may be to establish network cluster-specific intellectual property offices that take enforcement more seriously, especially within the network cluster. With repeated interactions, IP violations may be more easily detected, and enforced. This can then, in future, be expanded into regional IP strategy headquarters. This decentralized approach may be more feasible than China's existing centralized approach, headed by the State Intellectual Property Office (SIPO).

[19] However, it is important to note that the specific mechanisms that should underlie a functioning system of intellectual property rights, as currently understood, remains highly debated (Boldrin & Levine 2002; Romer 2002).

In summary, the dynamism of the network cluster induces local governments as well as intermediary agents to build up supporting institutions and target specific policies toward the rapidly-evolving clusters. These features distinguish network clusters from simple agglomerations of foreign investments such as those that exist in export processing zones; in the latter, agglomeration economies are usually confined to the final assembly stage, and inter-firm cooperation is almost nil. Strengthening the NIS system in China in this regard is therefore an important and useful step forward.

6 Conclusion

In this paper, we have sought to provide directions for developing China's SMEs, in the context of a national innovation system. To that end, we have introduced an analytical framework that draws on several distinct literatures, and have used the framework as the basis for strategic policy suggestions. We have also made an argument about why we believe that this approach allows for rapid industrial and technological catch-up, while avoiding as far as possible China's current constraints, especially in terms of the financial sector.

The economic strategies that we suggest are by no means unique to the Chinese experience. In this sense, understanding SME development in another East Asian economy—Japan—may offer insights into policy approaches that may also prove to be viable for China at this stage in its economic development.[20] Although these two economies are clearly distinct in terms of both their economic as well as political structures, Japan's historical progress toward a mature SME sector does suggest strategies that China can adopt in its own development. In particular, Japan's decision to encourage joint partnership between SMEs and academic institutions, together with its innovative approaches toward SME financing, do echo somewhat our own discussion of these issues. A detailed comparative approach is something we leave for future research.

While we have offered much by way of economic policy, we wish to stress that our ideas build on the existing infrastructure that has already been pursued by the Chinese government. Given that China has less of a technological legacy, we feel that such marginal changes are more productive that a wholesale reform of the national innovation system. In that sense, we are confident that our approach is consistent with the broader development strategies that are currently made in Beijing. This *political* viability is important if the policies that we have outlined are to have any chance of implementation.

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[20] A comparative analysis of the development of Japan vis-à-vis China's SME sector is beyond the scope of this article. However, in the working paper version, we provide a parallel analysis of the evolution of Japan's SME sector and her experience with the industrial cluster strategy.

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