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**The People's Republic of China's Small and  
Medium Enterprise Development Strategies in  
the Context of a National Innovation System**

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## **Abstract**

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

**KEYWORDS:** SME, National Innovation System, network cluster, the PRC  
**JEL CLASSIFICATION:** O32, O53, P31

# 1 Introduction

The PRC is a relative latecomer to modern industry and—by most standards—a highly successful one. Evidently, the PRC’s market-oriented reforms have, thus far, produced remarkable results. The PRC’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 the PRC’s prominent success in terms of contribution toward the national GDP (accounting for 40%), scale of assets, diversification of products, and the creation of employment. Despite their significant contribution to the PRC’s economy, SMEs tend to be neglected in official thinking about technology, although they now do rate a mention in the current long-term plan.

This paper examines the role of SMEs in the identification of 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 the PRC’s industrial policy, in the context of what is generally regarded as the national innovation system (NIS). In addition, this paper also offers an analytical framework informed by four distinct theoretical perspectives: The resource-based analysis in the context of late-industrialization (Barney 1991), the institutional economics perspective concerning technological learning processes (Nelson 1993), the innovation network view with respect to industrial competitive advantage (Porter 1990), and the monopolistic competition model of trade (Krugman 1979). As a late-industrializing economy, the PRC can enhance the competitiveness of its industries by limiting its shortcomings as a late entrant, while tapping its unique strategic resources.

This paper will shed 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 the PRC’s existing NIS. We consider this strategy as particularly suited to the PRC at this stage in its development and transition, since the collective nature of the cluster may help resolve the problem of the “missing middle.”<sup>1</sup>

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 the PRC 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 the PRC, 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 the PRC. In response to these threats, it is necessary that the PRC actively harness national policies as a strategic tool for continued progress. This section is followed by a discussion

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<sup>1</sup>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.

of the opportunities for future development, and in particular policy ideas for strengthening the PRC’s national innovation system (NIS) (Section 5); much of the section’s strategic directions draw on the analytical framework of Section 2. Concluding remarks will be drawn in the final section.

## 2 An analytical framework

Any analytical framework that deals with the issue of what the proper development strategies are for SMEs in the PRC—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.<sup>2</sup>

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 the late-industrialization (Barney 1991), the institutional economics perspective on technological learning process (Nelson 1993), the innovation network analysis on industrial competitive strategies (Porter 1990), and the monopolistically-competitive model of international trade (Krugman 1979, 1980).

### 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).<sup>3</sup> 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,

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<sup>2</sup>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).

<sup>3</sup>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).

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 through 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.

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 Taipei, China (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.<sup>4</sup> This involves more than naive, 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.

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.

### 2.3 Network-based industrial competitive 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.

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

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.

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

Figure 1: Conceptual framework for understanding domestic technological capabilities.

We open our hitherto closed-economy approach by adapting the Krugman (1979, 1980) model of monopolistic competition to our model of domestic technological innovation.<sup>5</sup> 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 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

<sup>5</sup>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.

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.<sup>6</sup> Figure 2 captures our ideas with respect to the international technological capabilities.

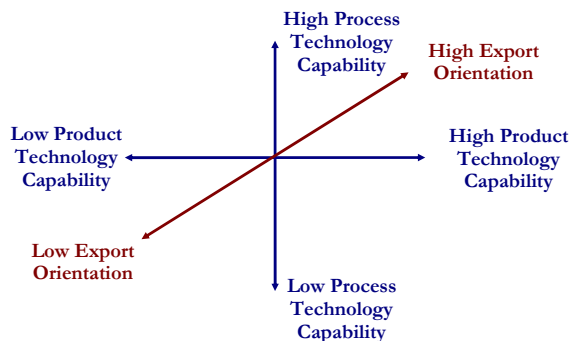


Figure 2: Conceptual framework for understanding international technological capabilities.

## 2.4 Economies from clustering

Entering the globalized fast follower innovation 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 consumer/low-tech to low/high-tech), 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.<sup>7</sup> This involves increased cooperation between SMEs within a cluster, in terms of vertical as well as horizontal linkages, both bilaterally and multilaterally.

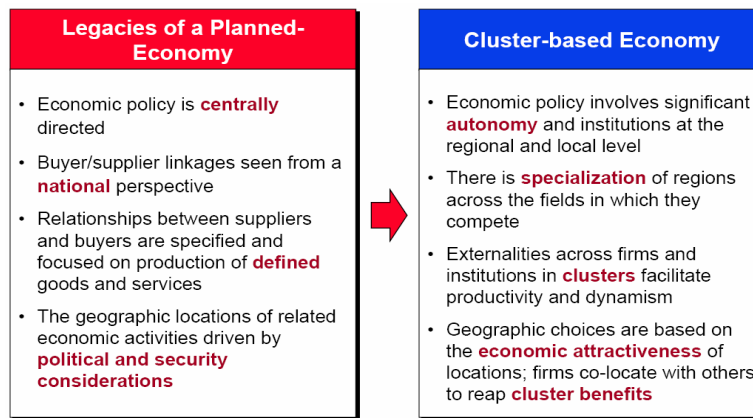
<sup>6</sup>In equilibrium, however, the number of firms in the economy is likely to fall as inefficient firms exit the industry in the presence of free trade. Overall welfare, however, remains higher with trade than in autarky (Melitz 2003).

<sup>7</sup>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.



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 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.

The case of the PRC 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.



Source: Porter (2004)

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. 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.

## 2.5 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 thus 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.

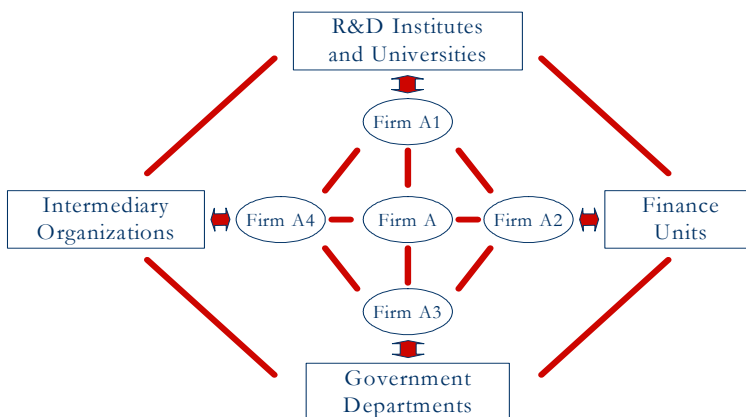


Figure 4: The network cluster within the National Innovation System.

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

$$Firm A + Firm A1/A3 + Functional Agents.$$

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.<sup>8</sup> 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

#### 3.1 Defining SMEs

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. The PRC adopts a rather complicated classification system, with at least two kinds of classification methods. The first method is based on output capacity and is applied to industries with a limited number of products. For example, in the electricity sector, *small* is defined as an annual production capability of fewer than 50,000 kilowatts, *medium* is between 50,000 and 300,000 kilowatts, and *large* is over 300,000 kilowatts. The second method is based on the original value of fixed capital and is applied to firms with diversified products. However, the definition of what constitutes an SME differs in different sectors. This is summarized in Table 1.

According to the PRC Government, SMEs are roughly characterized as having less than 200 employees (with the exception of 3000 employee for the construction industry), with sales value lower than 300 million yuan or capital value lower than 400 million yuan.<sup>9</sup> 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.

#### 3.2 The early development of SMEs

Historically, the PRC's industrial organization has not been a product of market forces. Industrial enterprises in the PRC 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 the PRC 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

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<sup>8</sup>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.

<sup>9</sup>Definition released by the State Economic and Trade Commission, State Developing Planning Commission, Ministry of Finance and National Bureau of Statistics of the PRC (Feb 2003).

Table 1: Classification of SMEs<sup>†</sup>

Sector	Variable	Unit	Medium	Small
Industry	Payroll	Population	300–2000	Under 300
	Annual revenue	Million yuan	3000–30000	Under 3000
	Total assets	Million yuan	4000–40000	Under 4000
Construction	Payroll	Population	600–3000	Under 600
	Annual revenue	Million yuan	3000–30000	Under 3000
	Total assets	Million yuan	4000–40000	Under 4000
Wholesale	Payroll	Population	100–200	Under 100
	Payroll	Population	3000–30000	Under 3000
	Annual revenue	Million yuan	100–500	Under 100
Retail	Payroll	Population	3000–30000	Under 3000
	Annual revenue	Million yuan	1000–15000	Under 1000
Transportation	Payroll	Population	500–3000	Under 500
	Annual revenue	Million yuan	3000–30000	Under 3000
Post	Payroll	Population	400–1000	Under 400
	Annual revenue	Million yuan	3000–30000	Under 3000
Hotel and restaurant	Payroll	Population	400–800	Under 400
	Annual revenue	Million yuan	3000–15000	Under 3000

<sup>†</sup> Source: The New Tentative Classification Standards on the Small and Medium-Sized Enterprises (SMEs), National Bureau of Statistics of the PRC (2003).

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). 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 the PRC 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 the PRC under the centrally planned economies. This gave SMEs a perfect opportunity to fill the gap. Third, the PRC 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.

### 3.3 Earlier 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 the PRC 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 the PRC 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. The PRC’s expenditures on scientific and technical activities is summarized in Table 2

By and large, economic and enterprise reforms over the last 20 years have dramatically altered the structure and dynamics of the PRC’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 2: Raising and utilization of funds for scientific and technical activities, 2002<sup>†</sup>

	Amount (yuan)	Growth over previous year (%)	Proportion to total expenditure of scientific and technical activities (%)
The total amount raised for scientific and technical activities	293.8 million	13.5	-
The total expenditure of scientific and technical activities	267.15 million	15.5	-
The expenditure of enterprises on scientific and technical activities	178.78 billion	17.3	66.9
The expenditure of state scientific institutions with independent accounting	62.02 billion	14.4	23.2
Of which are institutions of higher learning	20.42 billion	23.1	7.6
Labor cost of personnel engaged in scientific and technical activities	65.46 billion	19.2	24.5
Fixed assets purchase and construction cost	72.26 billion	4.4	27.0

<sup>†</sup> Source: Ministry of Finance, Ministry of Science and Technology, and National Bureau of Statistics of the PRC (2003).

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.

### 3.4 Current status of SMEs and clusters

There are currently 39.8 million SMEs in the PRC, accounting for 50% of the country’s asset value, 60% in turnover, and 60% in exports. It is commonly acknowledged that the PRC’s trade performance has been remarkable over the last decade. Particularly impressive has been its ability to gain significant global market shares in the labor-intensive as well as medium- and high-technology sectors. Between 1996 and 2000, the share of high-technology products in exports increased from 14.2% to 22.4%. the PRC’s exports of computers, mobile phones, and electronic circuits also more than tripled during this five-year period.

An abundant and skilled labor force, combined with economies of scale, has naturally played a key role in the PRC’s trade success. The PRC 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 breakdown in R&D expenditures for 2002 is summarized in Table 3, while Table 4 provides an overview of R&D expenditure as a share of sales income.

As of early 1990, the PRC has approved the establishment of 53 STIPs (Sci-

Table 3: Decomposition of R&D expenditure, 2002<sup>†</sup>

	Amount (billion yuan)	Growth over previous year (%)	Proportion of total R&D expenditure (%)
Total R&D expenditure	128.8	23.5	-
Expenditure on fundamental research	7.4	32.7	5.7
Expenditure on applied research	24.7	33.4	19.2
Expenditure on experimental development	96.7	20.6	75.1
Expenditure of enterprises	78.8	25.0	61.2
Expenditure of state scientific research institutions	35.1	21.0	27.3
Expenditure of institutions of higher learning	13.1	27.5	10.1

<sup>†</sup> Source: Ministry of Finance, Ministry of Science and Technology, and National Bureau of Statistics of the PRC (2003).

Table 4: R&D input intensity, 2002<sup>†</sup>

	Intensity (%)
Total	1.0
Electric machinery and equipment/ Equipment manufacturing industry	1.8
Electronic and communication equipment manufacturing industry	1.7
Conventional machinery manufacturing/ specialized facility manufacturing industry	1.3
Transport and communication facilities manufacturing/ Instruments and meters, office machinery manufacturing/ Rubber production industry	1.2
Medicine manufacturing industry	1.1

<sup>†</sup> Source: Ministry of Finance, Ministry of Science and Technology, and National Bureau of Statistics of the PRC (2003). R&D input intensity is defined as the proportion of R&D expenditure to sales income.



ence and Technology Industrial Parks), including the renowned Zhongguancun Science Park in Beijing (the so-called Silicon Valley of the PRC), 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 the PRC. 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 the PRC. The program seeks to promote commercialization through venture investment by universities, the 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 the PRC 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,<sup>10</sup> 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.

### 3.5 Constraints on SMEs in the PRC

Problems facing SMEs in the PRC are many and varied. Such 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 SMEs in the PRC to access such functions as training, market intelligence, logistics and technology. As such, they are unable to take advantage of market

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<sup>10</sup>Except, perhaps, for supplier-driven innovation, such as through improved inputs and the introduction of new machinery.

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. SMEs in the PRC 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 the PRC, 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 the PRC poses a threat. Finally, the PRC 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 the PRC.<sup>11</sup>

Perhaps the greatest internal challenge that the PRC 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 binding in the absence of bank loans.<sup>12</sup>

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

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<sup>11</sup>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 the PRC'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.

<sup>12</sup>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 the PRC in Appendix A.1. For a fuller discussion of the development of the financial market in the PRC over the period 1990-2000, see Shi (2001).

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 the PRC, 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 SMEs in the PRC, several constraints appear to be more relevant than others.<sup>13</sup> 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: Only 30 percent of the total number of enterprises that need loans fulfill the requirements and submit formal applications.

The role that VCs play in filling the financing gap faced by the PRC's SMEs, therefore, is critical. The increased marketization and privatization of the PRC's 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.

## 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

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<sup>13</sup>These are discussed more fully in Appendix A.2. See also Wang (2004) for a detailed discussion.

actors—individuals, firms and organizations/institutions—to increase their levels of adaptability, innovation, and process speed. Competition between firms internationally is fostering 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 theory,<sup>14</sup> therefore, has proposed modifications to neoclassical models of growth by viewing technology as an intrinsic part of the economic system. As a result, technology itself becomes a key factor of production (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 the PRC. 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 the PRC.

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

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<sup>14</sup>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.

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. The PRC, in particular, has a clear handicap—the existence of legacy systems makes upgrading to the latest technologies more difficult to implement. Addressing these needs will require developing a dynamic information infrastructure that can facilitate the effective communication, dissemination and processing of information. The PRC 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 the PRC. As such, the development of strategies to enhance and attract a core of knowledge workers is a serious agenda facing the PRC.

## 5 Opportunities for future development

While the PRC 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 the PRC 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—the PRC’s government can foster an environment that allows its SMEs to be competitive in the global economy.

Given the PRC’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 transition 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 is best undertaken in the context of the existing NIS. Indeed, the central issue in the PRC's NIS today is not so much the establishment of actors. The necessary actors 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 linkages between actors.<sup>15</sup>

We view measures that enhance the linkages between actors as crucial for the continued strengthening of the PRC's NIS. The network cluster strategy is particularly suited to the PRC's development strategy at this point, since the collective nature of the cluster may help resolve the problem of the "missing middle." The PRC 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 the PRC 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.<sup>16</sup>

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<sup>15</sup>Linkage is an activity that is not the preordained domain of any particular type of actor; indeed, it may instead be the result of the effect of a particular institution on organizational actors, rather than a particular actor.

<sup>16</sup>It is important to keep in mind that SME policy in the PRC 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 PRC's 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 the PRC; perhaps the best characterization

## 5.1 Regulatory environment for private business

Firms in the PRC 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 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. The PRC 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

Firms in the PRC 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 the PRC’s 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.

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of the current SME policy direction is that remains mostly ambiguous.

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.<sup>17</sup>

### 5.3 Information, advisory, and training

As mentioned earlier, informational asymmetries are currently a significant inhibitor of SME growth in the PRC, 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 PRC's 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 the PRC 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 the PRC 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 the PRC's overheated economy are so tight that firms are willing to accept applicants that possess qualifications that

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<sup>17</sup>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.



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 the PRC'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 network cluster—positions such as high-skill manufacturing personnel 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 the PRC 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. The PRC'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 the PRC. 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 the PRC off its dependence on foreign designs and process methods.

## 5.5 International technology transfer

The vast flows of foreign direct investment into the PRC 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 the PRC’s entry into the WTO. Currently, the PRC’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 the PRC will need to begin to develop a more comprehensive intellectual property regime, especially if it is to encourage

the indigenous development of research.<sup>18</sup> 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 the PRC's existing centralized approach, headed by the State Intellectual Property Office (SIPO).

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 the PRC in this regard is therefore an important and useful step forward.

## 6 Conclusion

In this paper, we have sought to provide directions for developing the PRC'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 the PRC's current constraints, especially in terms of the financial sector.

The economic strategies that we suggest are by no means unique to the PRC's 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 the PRC at this stage in its economic development.<sup>19</sup> 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 the PRC 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.

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 PRC's government. In that sense, we are confident that our approach is consistent with the broader development strategies that are made in Beijing.

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<sup>18</sup>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).

<sup>19</sup>A comparative analysis of the development of Japan vis-à-vis the PRC's SME sector is beyond the scope of this article. However, we provide a parallel analysis of the evolution of Japan's SME sector and her experience with the industrial cluster strategy in Appendix A.3.

This *political* viability is important if the policies that we have outlined are to have any chance of implementation.

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## Appendix

### A.1 The venture capital industry in the PRC

This appendix discusses in detail the venture capital industry in the PRC.

SMEs often face difficulties in gaining access to standard forms of credit due to their lack of collateral and the tenuous nature of their business establishment. In more mature financial markets, bank credit and regular trade credit comprise only part of the financial landscape, and financial innovations may offer other forms of credit that help ease financing obstacles faced by SMEs. This appendix looks into one alternative form of financing that is developing in the PRC: The venture capital (VC) industry.

The institutionalization of the PRC’s venture capital is simultaneously an extension of transition-era policy trajectories and an attempt to answer problems that could not be solved within the framework of other institutional systems. Early initiatives for the development of the VC industry in the PRC were largely theoretical, and usually resulted in little actual action. High-level policymakers failed to pay much attention to this industry, hence resulting in the establishment of only 23 VC firms in its earlier development phase. In 1998, the People’s Political Consultative Conference changed its stance and sought

to rapidly engage itself in the process of the PRC's risk investment industry development. This concomitantly set the stage for the subsequent upsurge in VC firms; within three years the number of VC firms established skyrocketed from 59 to 246. Among these registered venture capital firms, four distinct categories of VC firms can be identified, each with different ownership structures, objectives, and operational features (see Table A.1).

The main sources of VC funding in the PRC are government and state-owned enterprises, with private and foreign institutions and individuals comprising only a small percentage. The founding of domestic VC firms began with the establishment of local government-financed venture capital firms (GVCFs) in 1991–1993 in selected provinces, before expanding to other provinces by the late 1990s and early 21st century. University-backed VC firms (UVCFs) rapidly followed GVCFs, and generally followed a relatively similar mode of operation. Corporate-backed VC firms (CVCFs) were officially sanctioned following Announcement No. 1 at the Ninth Conference of the NPC in 1998, and—in contrast to GVCFs and UVCFs—tend to invest directly in newly listed shares or to make mid-to-long term investments, instead of high-risk investments. Finally, there are a fair number of joint venture and foreign VC firms operating in the PRC, although these generally choose to invest in the offshore holding companies of Chinese enterprises due to numerous foreign exchange controls and limited exit options.

The PRC's venture capital system has developed rapidly, but this development is far from even across activities, and the system remains immature in terms of regulatory (and related) institutions. There are no national-level regulations that govern the VC industry, although various departments act to assist in regulating the industry at the provincial level. However, local guidelines are only effective locally, and this occasionally leads to confusion and inefficiencies. Harmonizing these laws at national level will help take the PRC's VC market to the next stage.

Beyond regulatory issues, the VC industry in the PRC faces several challenges, going forward. First, the immaturity of financial markets in general leads to limited channels for VC exit. Existing mechanisms are inefficient and cumbersome, and VC firms taking their portfolio companies public face greater realization risk than otherwise. There is no easy fix to this, and only time will tell whether greater domestic financial market integration is forthcoming. Second, the market for investment professionals remains very thin. Most venture capitalists remain inadequately trained and lack sufficient experience, as well as exposure to international best practices. This suggests a role for government to relax immigration restrictions in order to import foreign professionals with the relevant VC management experience and expertise.

## **A.2 Constraints in financing SMEs in the PRC**

This appendix outlines the consensus in the literature on financing constraints generally faced by SMEs in the PRC.

Table A.1: Comparison of government, corporate, university, and foreign venture firms in the PRC<sup>†</sup>

	Government	Corporate	University	Foreign
Ownership structure Initial/primary investor	SOE/limited corporation Local government	Limited corporation Listed companies	Limited corporation University/firms	Limited partnership Investment funds/ corporations
Primary objective	Promote local high- tech industry and commercialization	Attain higher ROI than alternative investments	Commercialization of university's S&T	High ROI
Investment focus	High-tech Early Local	High-tech Late/Expansion Local/Regional	High-tech Early Universities/regional	High growth/potential Growth Major metropolitan
Preferred investment stage Geographic distribution				

<sup>†</sup> Source: Adapted from White, Gao & Zhang (2005)



1. Poor management and supervision, ill-defined property rights and local government interference have all contributed to the PRC's long-term financial losses. According to official estimates, at 2002 year-end, non-performing loans were 514.7 billion yuan or 37% of total loans.
2. The absence of an effective fiscal system at sub-national level leads to local governments running chronic budget deficits (International Finance Corporation 2002), which in turn leads to administrative interference in local financial institutions as these governments seek out tax revenue.
3. The predatory practice of local officials in extracting various taxes from peasants may be a systemic, as opposed to behavioral, problem (Bernstein & Lü 2003), perhaps due to the wider problem of a partially reformed political economy.
4. Regional variations in terms of peasant burdens and the availability of basic necessities suggests a vicious circle that perpetuates the existing gap between the richer coastal provinces and poorer interior (Wong 1999). This is further exacerbated by a nondiscriminatory federal tax policy (Byrd & Qingsong 1990).
5. The banking system is a highly centralized one—loan provision is dominated by the Big Four: the Industrial and Commercial Bank of China, Bank of China, Construction Bank of China, and Agricultural Bank of China—which believe that the cost and risk of providing loans to SMEs is still high vis-à-vis SOEs.
6. Incomplete capital markets due to informational asymmetries and imbalances in the control and supervision mechanism lead to difficulties for SMEs in bidding on projects requiring large financial resources. Resources available for SME investment in 2001 showed that 2.3% came from the national budget, 1.9% from foreign countries, and the rest was self-financing (82%) (Asian Development Bank 2002).
7. Incomplete commodity markets due to the repeated entry of SMEs into the same low-entry-threshold markets, which results in the further degradation of these markets in terms of excess supply.
8. SMEs in the PRC have low accountability of credit, with widespread incidences of false accounting and bookkeeping, which hinders further development of their businesses due to discriminatory credit rationing. This lack of access may be the biggest barrier for the development of private SMEs (All-China Federation of Industry and Commerce 2002).
9. SMEs in the PRC, especially the small and private ones, have no or little credible collateral, since most of them are set up as family-oriented or small-sized businesses (International Finance Corporation 2006).

10. SMEs in the PRC still lack transparency in terms of their business performance. As much as 96% of private enterprises are owner-operated, and such firms usually dislike disclosing information about their business performance (All-China Federation of Industry and Commerce 2002).
11. SMEs in the PRC have weak corporate governance and management skills. In many cases, they have fatal shortfalls in their corporate governance structure, primarily due to their dependence on the model of family-oriented management (International Finance Corporation 2006).
12. SMEs in the PRC are still relatively small in size and their production capability and product structure are usually unilateral, resulting in the production of counterfeit, low-quality goods (International Finance Corporation 2006).

### **A.3 Japan's SME sector and industry clusters**

This appendix provides a case study of Japan as a country that has demonstrated the evolution of SMEs toward internationally-competitive global firms.

#### **A.3.1 The evolution of Japanese SMEs**

The historical development of Japan's SME policy can be summarized in four stages. The first stage (1945–1954) was a period of reconstruction after World War II. The period laid the foundations for future SME policy. The SME Agency was established, and its goal was mainly focused on providing financial and organizational support to SMEs. Government institutions that provided financing to SMEs were also established. In the second stage (1955–1972), Japan experienced a period of rapid economic growth, and against this background, sectoral measures to modernize SMEs were introduced. Furthermore, preferential tax treatments were introduced. The years 1973–1984 marked a period of stable economic growth where the Basic Law of SMEs, as well as the Act on the Promotion of Modernization of SMEs, were enacted. The focus for SME policy shifted toward human resource training and technology enhancement, as well as sectoral revitalization programs. The government also provided guidance to SMEs on how to prepare for the liberalization and opening up of their respective markets. In the fourth stage, which began in 1985 and extends to the present, there has been a greater focus on supporting SMEs and in launching new businesses, together with changing existing, low-performing businesses. In order to promote R&D, SME policy has sought to streamline and consolidate SMEs. This period has also been accompanied by a shift toward a more market-based policy approach.

There are generally two underlying philosophies concerning SMEs: The first is that SMEs are one of many market participants, and it is more important for policy makers to ensure a fair and competitive market environment in order to promote the development of SMEs. The second philosophy is more cognizant

with Japan's SME policy after the World War II through to the 1970s. This philosophy explicitly recognizes the various disadvantages that SMEs face vis-à-vis large enterprises, and hence the primary objective of SME policy is to provide a protective environment where these SMEs can nurture and grow. Accordingly, SME policy in Japan has traditionally been embedded within larger-scale industrial policies. Various market-distortionary measures—such as preferential tax treatments, favorable government subsidies, and favorable lending by government-affiliated financial institutions specialized in SME financing—were also introduced to support and protect SMEs.

This, however, has since evolved to recognize SMEs as market participants—and, critically, as contributors to the national economy—possessing diversified skills and innovational capacity. SME policy has also gradually shifted from protectionism toward a more market-oriented approach. Measures to this effect include developing strategies on working out a fair and competitive market environment, and providing support to SMEs in order to enhance their competitiveness; as a result, start-up businesses and ventures have strengthened since the mid-1990s. In this limited sense, one can argue that the philosophy underlying Japan's SME policy has moved closer to that of the United States (Kanamori & Zhao 2005).

Presently, it has become more and more important for Japan's SMEs to strengthen R&D activities and introduce higher value-added products with lower costs, in order to survive in the market where competition with other countries (in particular with East Asia) are being intensified under the globalized economy. Surveys of Japan's SMEs have also concluded that SMEs do not necessarily lag behind large enterprises in R&D (Small and Medium Scale Enterprise Agency Various). Nevertheless, there are concerns that SMEs face a relative shortfall of managerial resources, and need to engage in collaborative efforts with others, so that they can complement each other and pursue innovation in a more effective way. Likewise, with a focus on R&D that directly relates to new products, SMEs tend to rely on academics and research institutions as far as basic theoretical research is concerned. From this viewpoint, SMEs may find it potentially beneficial to pursue partnerships with research organizations. This is, in fact, what Japan's SME policy currently promotes, with a growing interest in academia-industry partnerships, and joint practical research projects.

Partnerships with other enterprises that have different technical skills, or different markets, would also be helpful for many SMEs if they are to enhance their complementarity with one another. Possible elements of such a partnership arrangement would include the importance of the combination of different knowledge and skills, possibly through partnership with a variety of entities such as local universities, the government, private research institutions, large enterprises, as well as other SMEs; and the importance of designating a core entity and hence creating a clear division of responsibility, and so maintaining good governance among partners.

As in the PRC, financial issues are major bottleneck for SMEs in Japan. Japan has addressed SMEs' financial difficulties primarily by utilizing policy-lending financial institutions specializing on SMEs. However, in this regard, a

few new trends have emerged recently.

First, there has been a change in the attitude of commercial banks to the SME financing. The main reason behind seems to be that due to the real estate bubble, that has led to a re-evaluation of the requirement that immobile property be used as a safe collateral for loans. Banks have begun to try to monitor SME performance in various ways, and by developing relationship banking with SMEs, banks are starting to see SMEs as concerns from a long-term and qualitative perspective. Second, there have been new innovations in transaction banking instruments, where commercial banks now decide to provide loans based on various financial statements and accounting information. The typical example is the credit scoring model, which scores the credibility of each SME based on its past credit history and debt outstanding. However, short loan term lengths and the absence of past credit histories limit the applicability of the model. Third, SMEs are increasingly beginning to tap capital markets, although this remains relatively small, at about 4 percent.

### A.3.2 Japan's experience with industry clusters

The approach to addressing industrial clusters in Japan is best summarized in terms of five main strategies: Network development within the cluster; sales network expansion; financing issues; human resource development; and government policy.

- As the size of a cluster expands, some strong network facility becomes more important. For this to strengthen the linkage between participating SMEs, regional industry-supporting organizations and associations, large enterprises, and trading houses (*shosha*) would be useful, as would coordination with the industrial policy initiated by the local governments.
- The expansion of the sales promotion network is an issue, and one idea is to create local trading houses (local *shosha*), or to recruit and make use of human resources who have experience with trading houses.
- To address the financing issues requires the promotion of relationship banking in cooperation with the Financial Service Agency. In addition, there is a need to strengthen the capability of commercial banks so that they can properly assess the level of technology and intellectual property (IP) of SMEs; SMEs likewise should also recruit and develop staff that are familiar with commercial banking operations, IP rights, and are capable of attracting venture money.
- It is important for SMEs not only to develop technical engineers but also to develop human resources that are familiar with IPR, business coordination and market research.
- The most important objective in government is to acknowledge the cluster strategy as a viable and valid policy to pursue. This would involve identifying issues and challenges and to carefully work out government policies

and ensure budget appropriation for such policies. Currently, the policy scheme worked out has main three pillars: To support and strengthen networks within the cluster, to support businesses, and to support and strengthen the ties with related organizations. The core ministries for these are METI (Ministry of Economy and Industry) and MEST (Ministry of Education, Science and Technology). In particular, METI local bureaus play a coordinating role for regional clusters.