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From imitation to creation: the critical yet uncertain transition for Chinese firms

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Abstract

Purpose – This paper aims to consolidate prior research from policy and management domains to identify stages in China's technological learning within the imitation paradigm during 1949-2001, focusing on changes in the government's strategic priorities and policies and the nature, mode and sources of technological learning, then to contrast the firm and institutional features that have emerged under the imitation paradigm with those defining the emerging creation paradigm. The analysis leads to clear implications for both policy and management for the Chinese firms to make this transition and compete in higher value-added global industries.

Design/methodology/approach – An overview and conceptual paper based on observations and literature review.

Findings – This paper derives a parsimonious set of four dimensions to demarcate five stages in the evolution of China's technological learning: the government's strategic priority, nature of technology, the mode and the source of learning. It identifies six factors acting as significant impediments to Chinese firms' transition from imitation to creation.

Originality/value – In the first place, this paper provides managerial implications which are of great interest to Chinese practicing managers to manage their firms' transition from imitation to creation; second, the policy imperatives highlighted by this paper will help Chinese policymakers to design appropriate incentive mechanisms to enable Chinese firms to build up their competitiveness within the creation paradigm and thereby become global competitors. Meanwhile, this paper provides a systematic analysis on the evolution of China's technology development. This five stage-based framework will help practicing managers in China understand whether, which and when Chinese firms can make the transition necessary to compete based on the creation of proprietary resources and capabilities.

Keywords China, Innovation, Technology led strategy

Paper type Conceptual paper

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Introduction

For latecomer firms and nations like China who lag behind technology frontiers, technological learning is understood to be the necessary even if not sufficient basis for industrial development. Learning, borrowing Hobday's (1995, p. 32) definition, is the process by which managers and their firms acquire the contents of the "black box"; namely, the knowledge and capabilities by which inputs are transformed into economically and competitively valuable resources that support national growth and development.

In the Chinese context, and given the current competitive challenge facing Chinese firms, it is particularly relevant to distinguish between these two types and stages of innovation. Otherwise, we miss the paradigm shift that represents a critical competitive challenge for an increasing number of Chinese firms and a major concern of the Chinese Government. Therefore, we see categorize adoption and minor modification of externally-developed technology as fundamentally imitative activities. In contrast, a firm's internal development (whether alone or in partnership) of new technology, resources and capabilities involves what we term creative activities. As some scholars have pointed out (Abegglen and Stalk, 1985, p. 146), successful imitation may be the basis for more pioneering and creative activities. We maintain, however, that the two activities require fundamentally different mindsets, behaviors and organizational capabilities, and that the challenges to shift from imitative to creative are not trivial.

The purpose of this paper is to locate this strategic choice at the firm level – between imitation and creation-based competitive strategies – within China's evolving national context and technological learning process.

This paper derives a parsimonious set of four dimensions to demarcate stages in the evolution of China's technological learning system: the government's strategic priority, nature of technology, the mode and the source of learning (Figure 1). In the following section, we describe five stages and the dynamics of the transitions between them that emerged from our analysis. Based on our distinction between imitative and creative activities, we group the first four stages within a general imitation paradigm, while the fifth stage represents a discontinuous shift to a creation paradigm. This fifth stage – characterized by global competitiveness, knowledge management and Chinese firms themselves as an important source of learning – is only emerging, but represents a development with far-reaching consequences not only for Chinese firms and industries, but those of other countries as well.

Evolutionary stages

China's technological learning since the Chinese Communist Party took control of the country in 1949 can be divided into four historical stages – 1949-1960, 1960-1978, 1979-1991, 1992-2001 – and an emerging fifth stage: 2001-onward (Figure 1). Each of these stages represents a unique configuration of four dimensions – the government's strategic priorities, nature of technology emphasized, mode of learning, and geopolitical source of learning.

Stage 1: 1949-1960

The first stage, 1949-1960, is characterized by a strategic emphasis on industrialization and heavy industry, technology embodied in total production systems and transferred through turnkey plant projects and training abroad, and a reliance on the Soviet Union (Xie, 2004). It began when Mao announced the founding of the People's Republic of China

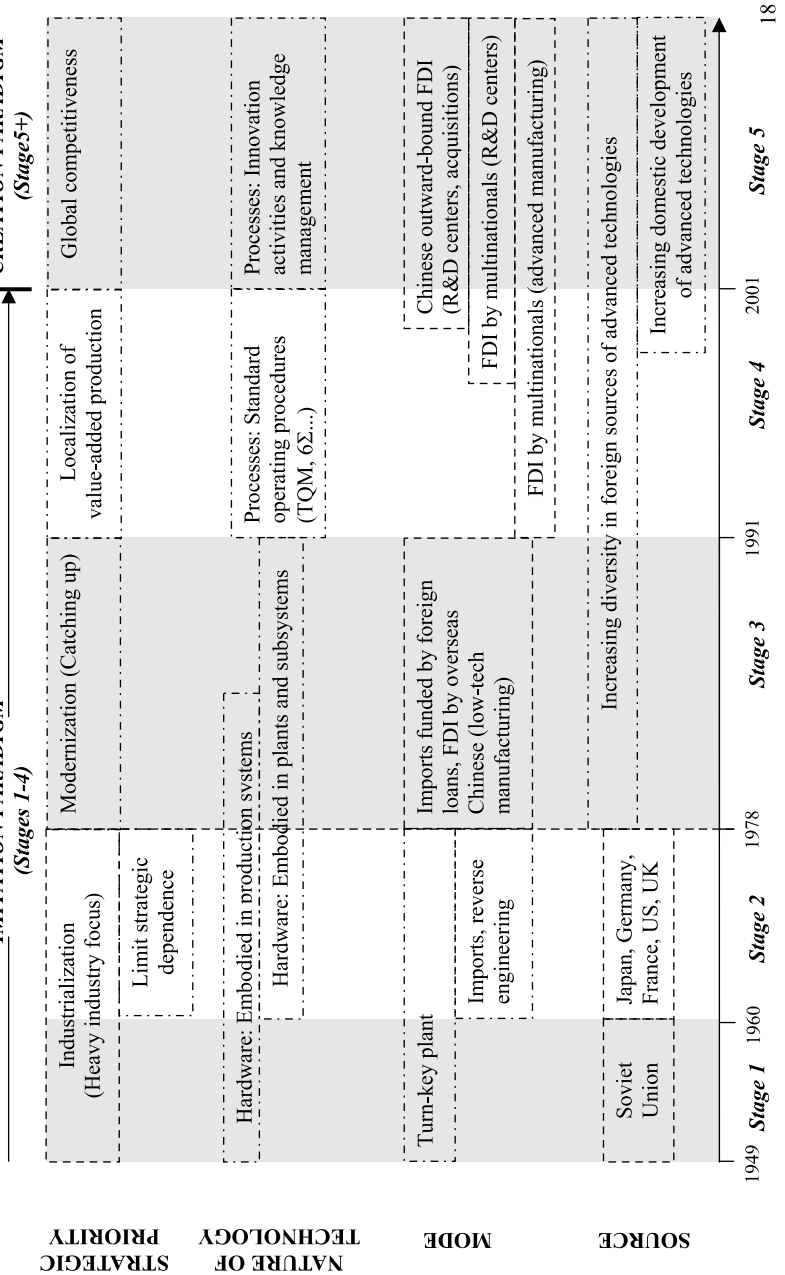

Figure 1.
Stages in China's technological learning

on October 1, 1949. Although there was euphoria attending the end of civil war and hope of a stable government, the country's industrial capacity and economy was in a shambles. China's technological resources and capabilities had atrophied or been destroyed during the preceding four decades of overlapping warlord rule, corrupt Kuomintang (KMT) governance under Chiang Kaishek, Japanese invasion and occupation, and the civil war that the Chinese Communist Party finally won when the KMT fled to Taiwan.

Mao and the Chinese leadership's strategic priority at this time was to industrialize China, not just to replace industrial capacity that had been destroyed, but to increase its production capacity. Their primary concern was the development of heavy industry, including steel, petrochemicals, automotive, machinery and military processing equipment.

Stage 2: 1960-1978

The second stage is characterized by continued strategic emphasis on industrialization and heavy industry, but is marked by a new emphasis on reducing strategic dependence. This change was precipitated by the Sino-Soviet split resulting from the increasingly acrimonious relations between Mao and Kruschev. By 1960 the Soviet technical advisors were recalled from China, and the vast number of Chinese engineers, trainees and students had returned. This became a critical lesson for Mao and the Chinese leadership;, i.e. that dependence on foreign sources of technology, even allies in the communist cause, made China vulnerable.

Two approaches to reducing strategic dependence emerged during this period. Pragmatists, realizing that China could not by itself develop all of the technology it needed, argued that China would not be vulnerable if it diversified its sources of technology. The shift in China's primary source of technology from the Soviet bloc – essentially a monolithic source – to multiple developed countries is one manifestation of this approach and is a defining feature of Stage 2.

Following the normalization of relations with the USA and other countries, Premier Zhou Enlai embarked on a new plant import plan in 1973. The plan was immediately the target of severe criticism by the Gang of Four, the group that had orchestrated the Cultural Revolution and that was vying for control of China as Mao's health deteriorated. They were ideologically opposed to any intimation that China "needed" any other country, whether western capitalist or "revisionist" Soviet. The imports also contributed to a US$760 million trade deficit in 1974, coinciding with rising prices for imports and shrinking demand for China's exports. Although it did not reach Zhou's initial target of US$4.3 billion, China did import over US$3 billion in plant and equipment during the period 1971-1978. Most of these imports were concentrated in petrochemicals, iron and steel, fertilizer, coal and electric power (Shi, 2000).

Stage 3: 1978-1991

The third stage began at the end of the 1970s and was driven by the technocrats in the Chinese Government who recognized that the pace, capacity and effectiveness of China's technological learning was inadequate for China to realize its development objectives. This is signaled by a significant shift in strategic priorities, from increasing production capacity in heavy industry while minimizing strategic dependence, to

modernizing China's agriculture sector, science and technology, industry and military (the "Four Modernizations").

Deng, taking a pragmatic view of China's dependence on foreign sources of technology in order to modernize rapidly, legitimized the opening of new channels with his 1978 Open Door Policy, a crucial shift from the emphasis on self-reliance and limiting dependence that dominated the prior stage. This shift was reflected in a change in the modes of learning during this period. Perhaps, most significant for China's long-term development were the changes in policies that affected human capital development. After more than a decade of chaos and closure, China's education and research system was revived, and a national university entrance examination was held in 1978.

During this period, the government also began to require technology transfer agreements as a condition for capital equipment purchases from developed countries. At this time loans from foreign governments and international financial institutions (i.e. the World Bank, Japan Import-Export Bank, etc.) became a major source of financing for technology imports.

The second significant change in mode of learning – via inward FDI – followed a change in the perception and nature of foreign direct investment during this period (Jolly, 2004, 2006; Zhao, 1995). During this stage, FDI came to be explicitly recognized as a means of achieving the objective of technological learning.

Not only did this FDI create a channel for technology to flow into China, but an unplanned result was its contribution to China's technological capabilities in light industrial manufacturing (Beamish and Wang, 1989). Whereas the Chinese Government was channeling its own funds and foreign loans into heavy industry, most FDI was focused on light industry, including textiles, garments, food, packaging, home appliances, electrical products, toys, watches, leather goods and footwear.

A second result of the inflow of FDI was the emergence of industrial districts during this period, which Zeng and Williamson (2003) call "competitive networks." Examples include the thousands of family businesses in cities specializing in particular products, such as Wenzhou (cigarette lighters and shoes), Chenghai (toys) Shenzhen (toys and Christmas decorations), Shengzhou (neckties), and Jinjiang and Dongguan (shoes).

Stage 4: 1992-2001

The fourth stage began in 1992, when the government shifted its emphasis from modernization itself to localization of value-added activities as a means of modernizing. It is signaled by the point in 1992 when inward FDI exceeded foreign loans and became a major channel for technological learning in China (MOST, 1994).

Since, China's opening in the late 1970s, the central government had cajoled and coerced FDI to transfer value-added activities into China as part of import or FDI agreements. Two factors present at the beginning of Stage 4, however, reduced the incentive for foreign investors to do so. First, until the mid-1990s most MNCs were seeking cost advantages by localizing assembly in China, often for re-export because domestically-generated profits could not be easily repatriated. Even those that intended to sell to the domestic market were undertaking only minimal product localization activities. Second, components and other supplies were not available locally, usually because local suppliers lacked the technological know-how to produce at competitive prices or, more commonly, they were unable to produce according to required technical,

quality or delivery specifications. As a result, the MNCs had no choice but to source higher value-added components abroad.

This second point – the lack of competitiveness of local suppliers – coincided with a realization by both Chinese policymakers and some managers that advanced manufacturing processes and management systems were critical as both quality and price became the basis of competition in more and more industries. During this fourth stage, they began to see the need to introduce standard operating procedures to improve quality and efficiency to complement advanced manufacturing equipment and subsystems. One result was the establishment in 1992 of China's Quality System (ISO 9000) Committee, led by the National Commodity Certification Bureau with the participation of 16 other ministries and bureaus. Its mandate was to promote the diffusion of ISO 9000 in China. Other systems, such as 6-Sigma, also began to receive attention and were implemented by early adopters such as Baogang Steel and Legend (now Lenovo).

Even as a growing number of Chinese firms were upgrading their technical and managerial systems to increase their competitiveness during this stage, more MNCs came to view China as an important market, in addition to their original focus on China as an export production base. This attracted more MNCs making larger average investments and bringing more advanced manufacturing technology than in previous years. By 2001, over 60 percent of the Fortune 500 had established operations in China, most with the intention of serving the domestic market based on their technological advantages.

Third, as the MNCs began to source more inputs locally, they often worked with local suppliers, exchanging long-term contracts for technical assistance to upgrade the supplier. This has served as the base of some firms becoming major suppliers, both domestically as well as internationally. For example, Shenzhen-based and Hong Kong-listed BYD is a manufacturer of lithium ion and nickel cadmium batteries. During its early years, Motorola provided technical assistance to BYD, sending engineers to work on site with those of BYD to improve the quality of its batteries for mobile phones. Today, BYD supplies not only Motorola, but also Ericsson, and is second only to Sanyo globally.

Emergence of STAGE 5 and the creation paradigm

We are proposing that a fifth stage in China's technological learning has already begun, and that it represents a discontinuous change – with decidedly different imperatives and challenges – than the preceding four stages. As we discuss in the remainder of the paper, the fundamental change is from firm and national strategies based on imitating technology developed elsewhere, to strategies based on creating proprietary and competitively valuable resources and capabilities. Although we recognize that the timing and rate of transition to this new stage varies considerably by industry and even firm, China's entry into the WTO in 2001 is a meaningful demarcation at the national level. Like other major policy developments associated with prior stages, WTO entry signals a major development in the government's strategic objectives; namely, to see a growing number of Chinese firms emerge as global competitors. It has a clear policy of nurturing Chinese firms that will be competitive abroad, as well as domestic firms that can compete successfully against multinationals in China.

Along with the change in the government's strategic priority of seeing more Chinese firms that can compete globally on the basis of innovation and creativity, the nature of technology that is important has also changed. Whereas earlier strategic priorities could be met by successfully drawing on a pool of technology developed by others, this new paradigm requires organizations to develop the capabilities to create their own technologies. These capabilities represent not standardized, codified operating procedures, but more tacit and ambiguous formal and informal structures and processes that create new knowledge and manage organizational knowledge effectively.

Some Chinese firms have already recognized this new competitive requirement and have invested abroad as part of their own learning strategy. They are making outward-bound foreign direct investments in new modes of technological learning, beyond the traditional channels of equipment purchases and technology licensing. A small but increasing number of Chinese firms is acquiring firms or subunits of firms abroad to acquire both technologies and the capabilities that generate them. Lenovo's purchase of IBM's PC division in late 2004 is perhaps the most significant example to date. Chinese firms are also accessing advanced technology abroad by establishing technology listening posts or R&D labs and by forming alliances with multinationals, a trend that began in 1995 and that has been increasing significantly since 1999. Huawei, Lenovo, Haier and ZTE Telecom are examples of firms pursuing such objectives through R&D labs in the United States and Japan.

Just as Chinese firms are investing abroad as well as within China to acquire proprietary technology and creative capabilities, Stage 5 is also marked by a rapidly increasing number of multinationals establishing R&D centers in China (Walfish, 2001; Von Zedtwitz, 2004). This expansion of activities in China by these firms represents an important shift in the motivation for FDI. The motivation in prior stages was to exploit the multinationals' ownership advantages (especially product or production technology and investment capital) along with China's cost-related (i.e. locational) advantages, especially production labor. Surveys of MNCs' reasons for establishing R&D facilities in China (Xue *et al.*, 2002) confirm that most of these investments have been localization-focused, i.e. pursuing cost-reduction by using more local raw materials as components and by adapting products to local market needs. Some of these MNCs, however, have established R&D facilities in China not to serve the local market, but to tap China's pool of lower-cost and highly skilled R&D personnel (Wolff and Armbrecht, 2002).

Impediments to the paradigm shift

The Chinese Government can certainly claim that it has made significant progress towards realizing its strategic objectives of industrialization, modernization and localization of value-added production, although there is still considerable variation in performance on these dimensions among sectors, industries and even firms in the same industry (White and Linden, 2002).

The recent impressive export performance of Chinese firms and industries, even the electronics industry, has been a result of their excelling at an imitation strategy. Hence, along with their recent successes, the fundamental limitations of the imitation paradigm have become clear. Specifically, they are competing both domestically and in export markets primarily on price in low-margin industries (home appliances and consumer electronics), or the commodity end of high-tech sectors (i.e. computers, pharmaceuticals, telecommunication equipment), or OEM (garments, toys, watches, shoes and bicycles).

Furthermore, their imitation strategy traps these firms in this market position, as captured in the now-popular phrase among policymakers and management researchers in China: technology imports, lag behind, import again, lag behind again. The lag refers to the inability of most Chinese firms and industries to compete based on innovation (e.g. creation) and thereby realize greater returns on capital.

Why have Chinese firms, except for a few exceptions, not yet graduated from imitators to creators, as firms and industries in other late-learner nations like Japan and Korea were able to do earlier? This question has been a focus of Chinese and foreign researchers during much of China's transition period (Li-hua, 2004; Li-hua and Khalil, 2006; Wang *et al.*, 2006; Chen and Fang, 2003). Reviewing the resulting body of work, six factors emerge as significant impediments to this transition. The first is the lack of adequate absorptive capacity within Chinese firms that have been acquiring technology from outside, whether the source is foreign or domestic (Bai and Xu, 1987).

Even if a firm has some level of absorptive capacity or identifies a potential source of technology, however, a second factor in the Chinese environment – weak or uncertain protection of intellectual property rights and contract law – reduces a firm's access to more advanced technology. Foreign suppliers are understandably hesitant to transfer key technology – product, process and managerial know-how – to Chinese firms (Bosworth and Yang, 2000).

The third factor that researchers have identified is government policy for technology imports (Ding, 1989). Preference has been given to technology import projects that correspond to the government's industrial priorities, and applicant firms were strictly screened to meet these criteria. Moreover, while the government has encouraged technology transfer clauses as part of technology purchase agreements, it has not pushed for provisions regarding the assimilation or local value-added innovation upon imported technology.

The fourth factor is a lack of competitive pressures on firms in many industries, especially those dominated by state-owned firms (Xie, 2001a). Chinese firms in traditionally highly protected industries – including most heavy industries, the financial sector, and distribution – have been protected from direct competition from foreign firms with more advanced technology and innovative capabilities. These firms there lacked sufficient incentives necessary to undertake technological accumulation.

Several scholars have identified weaknesses in related or supporting industries as a fifth factor inhibiting the successful adoption, assimilation and innovation upon acquired technology by Chinese firms (Xie and Wu, 1997a; Xie, 2001b).

The legacy and continuing existence, albeit by different underlying dynamics, of China's disintegrated national innovation system (Liu and White, 2001) is a sixth factor that has inhibited the development of innovative capabilities within Chinese firms. Chinese R&D resources and personnel are primarily located in government-funded research institutes and universities. Any movement in scientific and technical personnel has been from these research organizations to their new commercial spin-offs and subsidiaries, what Gu (1999) includes as new technology enterprises. There has been no significant shift in personnel – whether in absolute terms or as a percentage of employment – from these research organizations to existing firms, especially state-owned enterprises. Nor have these firms been able to attract and retain such personnel, or effectively manage those they have to produce significant innovative outputs.

Imperatives

The critical technology of Stage 5 and the creation paradigm is not the mastery of codified technology, whether embodied in hardware (the technology of Stages 1-3) or standardized operating procedures (Stage 4). Mastery of these technologies will remain necessary at the implementation stage, but is not sufficient to compete based on creation. In order for Chinese firms to move beyond low-cost manufacturing of commodity products, research in both developed western contexts and the Asian late-learners shows that the critical technology will be embedded in organizations and give rise to new, proprietary product and process technologies.

In the following sections, we provide a number of policy and managerial implications inherent in the shift to competition based on creation rather than imitation. Clearly, these are not recommendations for the entirety of Chinese industry; many firms are highly successful within the imitation paradigm, and the domestic and global business environment will reward firms that can compete based on these strategies. For the Chinese Government to realize its strategic objectives of seeing more Chinese firms being able to compete at the leading edge of their industries, however, there are clear imperatives for both policy and management. Moreover, these imperatives represent fundamental differences in structures, incentives and culture from those of the imitation paradigm, and this will be a major challenge to policymakers and managers attempting to make the transition.

Policy imperatives

What can the government do to provide incentives and enable firms to build up their competitiveness within the creation paradigm and thereby become global competitors? There are five areas in which the government can increase the likelihood that more firms will be willing and able to compete within the creation paradigm:

(1) manage the balance between competition and protection, with a clear trend towards competition;

(2) protect intellectual property rights in the interest of domestic firms, even more than foreign firms;

(3) develop contract law and establish clear precedents protecting partners' investments in joint, collaborative arrangements;

(4) align financial sector reform (especially banking) with the objective of forcing firm managers to link strategy with investments in proprietary resources and capabilities; and

(5) increase the incentives for individual top managers to make decisions in the long-term interest of the firms.

First, in some areas, the government should continue its current policies and focus on true and steady implementation. The conditions for China's entry into WTO not only represent a clear shift in balance from protection to competition, but also allows for differences among industries and among firms in their readiness to make this transition (White and Linden, 2002). The Chinese government must follow-through with these conditions in order to avoid any dysfunctional ambiguity of its intentions from the perspective of the managers of SOEs and firms in industries that currently benefit from various forms of formal and informal trade barriers.

Second, the central government's push for greater protection of intellectual property rights similarly sends two important signals to managers of Chinese firms. First, those who have depended on free access to other firms' IPR must see that such free-riding will become untenable sooner rather than later. Second, those who have or can develop their own IPR will see increasing returns to such investments as the government makes it more difficult and costly to free-ride. The firms holding IPR then have a broader choice of IPR strategies;, i.e. from retaining tight control and exploiting it internally, to disseminating it through licensing agreements and receiving the benefits of broader exploitation (i.e. tipping effects and network externalities).

Third, the central government must also see the importance of contract law in supporting collaboration between organizations. In any national or industrial context, collaborative strategies have been an important means of creating new knowledge, especially across organizational boundaries that otherwise separate complementary resources and capabilities. Currently, contract law and, perhaps more critically, its enforcement are questionable even in the rather straightforward cases of technology transfer and licensing, such as occurs in the technology markets (Gu, 1999). These institutions, however, are clearly inadequate for the ambiguities inherent in joint development activities. Weaknesses in these institutions lead managers in organizations – whether research institutes or manufacturers – to rationally perceive a high risk in committing resources to a collaborative venture.

Fourth, lack of substantive progress in the reform of the financial system, and the banking sector in particular, has reduced the incentive and ability of managers to pursue strategies in line with the creation paradigm. In the name of protecting employment, SOEs still receive funding – either directly from the government in the form of loans, or via investors as these firms are ferried to stock market listings – regardless of their performance as technological innovators. The government is missing an opportunity to send a clear signal that funding must be devoted to either creating a competitive position clearly within the imitation paradigm – i.e. a low-cost commodity strategy – or one that will allow the firm to compete within the creation paradigm based on its unique resources and capabilities. Currently, direct and indirect government support for these firms has no such strategic stipulations. As a result, not only do these firms make no improvement in clarifying and implementing their fundamental strategic positioning, but the public and private resources they squander are not available to other firms willing and able to implement a clear strategy.

Fifth, the government must create clear incentives not for "firms" but for their top managers to make strategic decisions that take into account the medium and long-term performance of these firms. Too much of the analysis of the problems of SOEs have attributed incentives to the "firm," rather than focus on the individual-level incentives of the managers of those firms. Currently, the top managers in SOEs (including the listed firms of which the government is the majority shareholder) are appointed by the Personnel Bureau and approved by the Communist Party (either at the provincial or central level, depending on the importance of the firm). Their terms typically last for 3-4 years, after which they are rotated either to the firm's board of directors, or to positions in other firms or government bureaus. They have a clear incentive to maximize relatively short-term performance, even at the expense of longer-term viability. Only by tying more of these managers' personal interests to the performance of the firm will they have the unambiguous incentive to pursue strategies that are truly in the firm's interest.

Managerial imperatives

Assuming that a Chinese firm's top managers have the external incentives or internal initiative to become competitive within the creation paradigm, what are the challenges they face? Although there is tremendous variance among industries and even among firms in the same industry, there are three issues that will be common to all Chinese firms:

(1) managing the shift in organizational identity;

(2) introducing appropriate management systems, especially in HRM and investment decision making; and

(3) seeing collaboration and communication as fundamental strategic issues.

First, we argue that the transition from being a firm competing within the imitation paradigm to one competing within the creation paradigm must be accompanied by a shift in organizational identity. Its employees – especially those crucial to the firm's success within the new paradigm – must perceive themselves as being part of an organization that can and does create unique and valuable resources and capabilities, rather than one that simply lives off the creativity of others. This shift represents a fundamental shift in employees' values, priorities and behaviors, and managing this transition will be a critical managerial challenge in most firms.

Achieving such a shift in perception of organizational identity will depend on a concomitant shift in formal managerial systems and informal organizational processes and culture. For example, whereas strict control over production processes and cost-based decision making may be appropriate for an imitative strategy, they will stifle creative exploration that is necessary to realize creative objectives but that will, in some cases, lead to failure and lost investment. Similarly, existing criteria for investment decisions may be inappropriate and inadequate for the ambiguity of proposals for creative projects. At the same time, undisciplined investment in new projects and attendant resources and capabilities is also a potential danger for these firms. The challenge for most Chinese firms will be to develop internal decision-making systems that help them avoid error on the side of too much, too little or inappropriate investments as they target creative outputs.

Similarly, human resource management systems that are appropriate for a low-cost, mass producer of commodities are not appropriate for the organizational units that are responsible for developing new production technologies or managerial systems. The Chinese firms must be able to manage different types of human resources within the same organization, based on the nature of the tasks required. Managing such intra-organizational plurality within their HRM systems will be a new challenge to most Chinese organizations.

Finally, the issues of collaboration and communication – both internally and inter-organizationally – represent a fundamental challenge for managers wishing to compete in the creative paradigm. One type of collaboration – that between organizations, as in joint R&D projects – has already been discussed in relation to deficiencies in contract law formulation and enforcement. The inability to realize anything besides a market-like transaction severely limits the opportunities for Chinese firms to develop proprietary technologies (White and Liu, 2001). Specifically, their options are limited to make or buy;, i.e. acquiring technology developed elsewhere and relying on their internal capabilities to exploit that technology (and uncertain institutional structures to limit others' access to the

same technology), or developing such technologies independently. Considering that collaborative development and alliances have become a fundamental element of the globally leading firms competing within the creation paradigm in most industries, Chinese firms' limited access to this option is a competitive weakness.

Even internally, however, Chinese managers face a fundamental challenge in achieving both communication and collaboration across organizational subunits. Achieving cross-functional coordination and cooperation is certainly not a problem unique to Chinese organizations, as the extensive research in cross-functional project team management in diverse contexts will attest (Xie *et al.*, 1998).

This may be more of a challenge, however, for Chinese organizations operating in the Chinese cultural context, in which the distinction between in-groups and out-groups is particularly strong (Leung and Bond, 1984). While employees tend to share information effectively with those they perceive to be in their in-group, this has two negative consequences. First, information sharing across groups is very inefficient, and perhaps requires more or different incentives and processes than in contexts in which the in/out-group distinctions are not so extreme. Second, an employee's in-group may not correspond directly to his or her work unit, and may extend across the organization in a way unrelated to the formal organizational structure (i.e. informal networks). So far, there is no research that clarifies the impact of such social structures and dynamics on organizational functioning in China, much less on the more specific issue of how it affects the ability of the organization to generate and exploit new technology. It is clear, however, that managers in these organizations must avoid the dysfunctional aspects of strong in/out-group distinctions and the tension between organizational and personal network benefits.

Conclusions

This paper has presented a framework for distinguishing among stages in the evolution of China's technological learning system since 1949. We have argued that the four stages during the period 1949-2001 are variations within an overall imitation-based paradigm. We have also proposed that since 2001 a fifth stage is emerging that differs fundamentally from the prior four and signals the tentative emergence of a creation paradigm. While Chinese firms in many industries have emerged as successful competitors within the imitation paradigm – relying on rapid adoption of production and managerial technology developed by others – the requirements for Chinese firms to compete within the creation paradigm, at the leading edge of an industry, are quite different. We have proposed specific policy and managerial imperatives in order for at least some Chinese firms to emerge as successful global competitors within the creation paradigm.

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