# How Do Chinese Firms Manage Innovation? A Perspective of Dynamic Capabilities

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**Abstract**

Combining the literature on technological catch-up, innovation management and dynamic capabilities, this paper identifies the major problem when firms from developing economies manage the process of innovation when they are approaching the technological frontier. Illuminated by an array of empirical cases of Chinese firms from multiple industries, we find that their common weakness of managing innovation is often the lack of integrating and articulating simultaneously technological change, market change and organizational change in a dynamic way, i.e., a kind of "dynamic capabilities" of management at strategic level. For years Chinese industrial firms have accumulated technological capabilities through different modes (technology transfer, indigenous R&D, and foreign technology acquisition, etc.) and different relationship with customers in the market, now they have to improve the quality of innovation management if they seek to produce significant innovation outcome and compete with the innovative firms from the advanced economies. The findings contribute to research and management practice on how catch-up firms in developing countries can transform themselves from imitators or followers to innovators.

Keywords: innovation management, dynamic capabilities, strategic integration, technological change, Chinese firms

## 1. Introduction

The recent Chinese industrialization has been a rapid integration of SMEs in global networks of contractors, for example in electronics and clothing, and the development of an important domestic light industry which provides parts and sometimes equipment to foreign companies. Now, the challenge to the Chinese firms is to find ways to "move up the global value chain", that is to say, to produce more sophisticated products and be less dependent on international outsourcers (Bironneau, R., R. Arvanitis, F. Bafoil and B. Kahane, 2012). In reality, there are many Chinese firms beginning to move from being simply assemblers or providers to having access to final market of consumption. They want to choose their markets rather than being chosen by their foreign clients. Beyond strong production experience and technology accumulated in business, these Chinese firms try to combine new technologies from different sources in order to adapt to market conditions. Overall, it appears that China is struggling to build a real innovation capacity of industry (Zhao, W. and R. Arvanitis, 2010).

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China's massive industrialization has been actively promoted by its government (Zhao, W., R. Arvanitis and F. La Pira, 2011). Since its first National Development Plan of Innovation in 2000 (Bironneau, R., 2012), the government invested heavily in building innovation capabilities, especially in terms of inputs. China's total R&D investment has risen from $30 billion in 2005 to $200 billion in 2014 (2% of GDP), making it the No. 2 R&D spender in the world in absolute terms since 2006. Chinese universities confer 28700 PhDs in science and engineering per year and Chinese researchers published more than 420000 scientific papers in 2013 (Zhao, W., 2015).

With government support, there were signs of development of innovation capacity through firm R&D as well as creation of R&D centers by multinationals in China. Some iconic companies made seriously investment in R&D, such as Huawei (9% of sales, or 5.9 billion Yuan per year) and Lenovo (2.8 billion Yuan per year). The result was in an increase in both labor productivity (value added per head) and total factor productivity in the manufacturing sector since 1990s. This exceptional growth regime has attracted some argument that Chinese firms have developed a new model of disruptive innovation, called "cost innovation", i.e., making innovations by exploiting low cost labor and materials (Zeng, M. and P. J. Williamson, 2007). A recent McKinsey report also concludes that China has the potential to meet its "innovation imperative" and to emerge as a driving force in innovation globally. Chinese industry is more innovative than is generally acknowledged. Chinese firms have established strong positions in two types of innovation—developing new products and services that address consumer needs, and process innovations that make manufacturing more efficient. But China needs to make more efforts on raising innovation performance in engineering and science for industries (McKinsey & Company, 2015). For Hout and Michael (2014), the speed with which Chinese firms develop new products from existing technologies and ramp up large-scale production is quite impressive. They learned how to produce swiftly to meet buyers' demand for quick turnaround; to adapt designs to use different materials when the original materials were too expensive or unavailable; to modify equipment so that they could make different products; and, above all, to keep costs down. Though Chinese firms don't involve the upstream creation of technology, original designs, selection of materials, and design of equipment, or customer knowledge and marketing savvy, their strong points are mainly downstream industrial competencies. The practices of Chinese firms in managing innovation are characterized by the following ways (Hout, T. and D. Michael, 2014):

- Chinese firms generally keep engineering and manufacturing close, often co-locating them.
- Chinese firms tend to acquire new technologies either through formal licensing deals or by reverse-engineering them, but they keep the physical work of experimentation and production in-house.
- Chinese firms hire more midlevel engineering and manufacturing people, even though they're getting expensive. The added engineering and manufacturing bandwidth gives the Chinese firms possibility of solving difficult problems in product industrialization. As many people know, when Apple had to redesign the screen of its first iPhone at the last minute, its Shenzhen supplier roused its engineers out of bed, developed a better screen, and overhauled the production line—in just four days' time.

However, despite Chinese firms' strong growth in R & D and rapid catch-up in technological capabilities, few of them have built up sustainable technological dynamics on indigenous R & D. In

other word, the innovation capacity of Chinese industry is still "potential" than real (Zhao, W., 2006; 2013). In fact, innovation capacity of firms depends largely on relationships with suppliers and customers, with organizations and institutions that can supply technologies, and with the immediate environment that allows firms to consolidate R & D and engineering activities. This systemic nature of innovation requires not only learning and using of advanced technologies, but also more sophisticated approaches and competencies of management. Firms never come out with new products or improved processes in isolation. For innovation, they have to manage simultaneously the changes in technologies, organizations and markets, and integrate them timely (Tidd, J., J. Bessant and K. Pavitt, 1997). By the time of the 2008 crisis, Chinese firms had already very well taken use of the double trends of globalization of industrial production and standardization of complex technologies. But it was also during this period of time that the weakness of Chinese innovation capacity became evident: Most of Chinese firms begun to touch an "invisible ceiling" of forging ahead to innovate in global competition. They know much better how to use the "common" process and engineering know-how supplied by Western firms to power the global value chains than how to manage the whole company to transform from imitators or followers to true innovators.

How Chinese firms manage innovation? What are exactly the weak points in their management? How can they improve it? Using some Chinese industrial firms as examples, this paper aims to explore certain problems of innovation management that catch-up firms from developing economies have to consider when they are approaching the innovation frontier, either in technology or business model. For these catch-up firms, there is no simple and automatic progression from the early stage of accumulation of technological capabilities to high-level stage of building up of management capabilities of integrating skillfully the complex change processes of innovation. Thus, the paper particularly analyses the characteristics of the catch-up firms' innovation management and summarizes their practice weakness at strategic level as a lack of "dynamic capabilities" of top managers.

This paper is organized in 6 sections. After this introduction, Section 2, based on some existing theoretical literature, will construct a framework to clarify the nature of innovation management for catch-up firms. Section 3 presents data collection process and methodology. In Section 4 and 5, we carry out qualitative analysis on some Chinese firm cases from multiple industries to illuminate precisely their core problems of innovation management. Section 6 concludes.

## 2. Management of Innovation in Catch-up Firms: From Changing Processes to Dynamic Capabilities

In literature, firms in developing economies are often called "latecomers" because they are dislocated from international sources of technology, science and R&D, or even dislocated from demanding users, international markets, advanced user-producer links, clusters, networks, industrial districts etc. (M. Hobday, 1995). When they learn over time to accumulate technological capabilities and progressively carry out some innovative activities, they become "catch-up" firms because they begin to compete with firms at the international frontier in advanced industrial countries (Mathews, J.A. 2006). However, many catch-up firms have experienced substantial difficulty during this process of transformation from imitators or followers to real innovators. The traditional literature of catch-up firms emphasizes on their technological learning process and knowledge acquisition practice while inadequate attention has been paid to their strategic management aspects. On the other side, there is a

large amount of literature on management of innovation and the role of dynamic capabilities in Western innovative firms, which can be a heuristic to explore the managerial aspects of catch-up firms.

### 2.1. Challenge of Developing Innovation Capacity in Catch-up Firms

The existing theory cleaves into two different arguments about how catch-up firms in developing countries can advance from imitation to innovation. On one side, the "sustaining perspective" is represented by the works of A. Amsden and M. Hobday. Amsden (Amsden, A. 1989; Amsden, A. H. and W-w. Chu 2003) identifies that technological learning at shop-floor of firms is the original driving force of upgrading to innovation. She detailed the three aspects of technological learning as: 1) speed of learning (how rapidly foreign technology is borrowed, which depends on investment rate of firm, investing in foreign design, and arrangement of technology acquisition or transfer), 2) scale of learning (whether foreign technology is utilized at the appropriate scale, which depends on how fast the market is growing and whether firm is producing at an appropriate scale), and 3) efficiency of learning (how efficiently foreign technology is employed, which depends on firm's experience related to cumulative production and the effects of learning-by-doing on firm). Very much in line with Amsden, Hobday (1994; 1995) shows how electronics companies in the four dragons of East Asia link their technological learning to export markets; specifically, subcontracting and original equipment manufacturing (OEM) mechanisms acted as a training school for latecomers, enabling them to overcome entry barriers and to assimilate manufacturing and design technology. In contrast with R&D and design-led strategies, catch-up firms often began with incremental improvements to manufacturing processes which led on to minor product innovations. Since the development of technological capabilities during catch-up is a learning process, firms' internal development and design capabilities grow as they move between successive stages from OEM to ODM (original design manufacturing) and OBM (original brand manufacturing), but there is no role for research. Based on East Asian experience, the sustaining perspective asserts that successful catch-up firms may go through a kind of 'reverse product cycle.' They begin with simple assembly processes but gradually and systematically accumulate the capability to modify, design and build their own new product and process technologies progressively. Customers play a major part in this cycle, which proceeds through successively higher value-added forms of production.

China's technological learning at the firm level brings nothing new to this existing model of catch-up in East Asian economies. The Chinese firms followed a mixed pattern of interactive learning, maintaining a variety of sources of technology, keeping a large portfolio of clients and products, accepting to be at the same time manufacturing subcontractors, OEM providers for some products, and autonomous brand makers for others, depending on the market. They introduced new models as long as their foreign clients provided them new blueprints. Even firms advancing more rapidly toward an innovation frontier are in this pragmatic, down-to-earth catching-up model, upgrading cumulatively productive and control knowledge. These catch-up firms, who entered in a transitional stage in upgrading from a basic production to more sophisticated technology development, maintained the same diversified types of contacts with their clients, simply aggregating more sources of knowledge and trying to keep a multiplicity of external sources (Arvanitis, R., Zhao, W., Qiu, H. and Xu, J.-n., 2006).

The other argument about imitation to innovation can be termed as "disruptive perspective". Through the case of a Mexican company Vitro, the largest

glass company in the world after Owen-Illinois, Gabriela Dutrénit (2000; 2004) argues that there is no simple linear progression from the early stage of accumulation of the minimum levels of innovative capability to the management of knowledge as a strategic asset and the deployment of core capabilities. The transition process is complex and while catch-up firms make the breakthrough in innovation, they have to build deeper and broader specialized knowledge and develop new ways of strategic integration. The innovation capability can be reached only through a specific kind of "spontaneous" actions rather than a succession of different stages of formation of technological capabilities. Similarly, based on South Korea's experience from imitation to innovation, Linsu Kim (1997; 1998) argues that cumulative learning of firms takes place through learning-by-doing, but discontinuous learning takes place only in crisis. Effective learning firms (such as Hyundai) construct a crisis by setting ambitious targets intentionally to develop organizational systems and manage their processes to make the crises truly creative. Although creative imitation (producing knockoffs and clones) through reverse-engineering is still important, it is the continuous increase in in-house R&D investment that plays the key role in leap from coping imitation to indigenous innovation. He suggests that catch-up firms shall intensify dramatically their formal R&D activities to engage in independent product innovation and participate actively in global alliances. The continuing debate over whether the technological learning, or the production mode, or the market linkages, or the knowledge management, or the R&D management is the key for catch-up firms to move onto innovation stage calls for more attention to basic theories on management of innovation in Western advanced firms. Indeed, innovators can inspire the followers on which way to take.

*2.2. Managing the Process of Innovation*

At general level, innovation can be regarded as a series of industrial activities translating new technologies and knowledge into products and services in the market. These activities of firms are technical, commercial and economic by nature and consist essentially of interactive learning between individuals and organizations related to implementing new technologies. In a broader sense, innovation involves institutional, organizational and psychological changes in doing business. In management practice, it is more pertinent to take "innovation" as a complex process or processes than just as results of process. As shown by the linked-chain model (Klein, S., 1985), the key activities include "research and knowledge creation", "market exploration and discovering," "invention and analytical design", "details design and test ", "re-design and manufacturing", and " distribution and marketing", etc. They are linked with each other and constitute different feedback loops with different types of innovation. According to Dosi (Dosi, G., 1988), innovation as a process is an adventure of searching and problem-solving. It needs to mobilize and combine public and private (individual-specific and firm-specific) knowledge, general scientific principles, and unique experience. It also needs appropriate procedures of communication among knowledge and implicit capabilities.

Pavitt (Pavitt, K., 2003) identified three overlapping processes of innovation: the production of knowledge; the translation of knowledge into products, systems, processes and services; and the continuous matching of the product of innovation to market demand. The difficulty of managing innovation process lies in the fact that with the increasing specialization of knowledge production and the sophistication of products and contained knowledge, it is more and more difficult to integrate technological opportunities, market demand, and

organizational arrangements just rightly to produce the expected new outcome. To innovate, firms have to coordinate and integrate various specialized knowledge, and carry out learning under conditions of uncertainty. The formal management approach proposed by Tidd, J., J. Bessant and K. Pavitt (1997) emphasizes on supporting the innovation development project through coordinating four strategic aspects: elaborating an innovation strategy, building an organization for innovation, setting up implementation mechanisms of project, and exploiting external links with market and alliance. Similarly, Trott (Trott, P., 2005) defined innovation management as the practice of integrating activities of strategic planning, technology research and development, marketing, and organizing, all based on firm's accumulated knowledge. Thus, the nature of innovation management is not managing the processes of technological change, market change and organizational change separately, but coordinating and integrating all these changes.

In practice, the management of technological change emphasizes on new technology forecasting and evaluation (Christensen, C. M., 1997), new product development (Henderson, R. M. and K. B. Clark, 1990), R&D investment (Cohen, W. and D. A. Levinthal, 1990), and innovative design (Le Masson, P., B. Weil and A. Hatchuel, 2010). These activities reach beyond efforts to improve the efficiency of production or research and development, to include the effectiveness of technological development, which is the translation of technology into successful products and services. Based on the classic model of "innovation diffusion" (Rogers, E. M., 1983), the management of market change had a shift from depending on crude market segmentation and analysis of consumer behavior, to relationship and networked marketing that demands fine targeting of product development and closer linkages with lead customers (Hippel, E. v. 1989 ; Moore, G. A., 2014). The management of organizational change has shifted from an emphasis on change management of structure and culture, to the design and improvement of new mechanism for project implementation and internal work processes, such as knowledge management (Nonaka, I. and H. Teukeuchi, 1995), corporate venturing (Burgelman, K. A. and L. R. Sayles, 1986), and external linkages and networks to profit from innovation (Teece, D., 1986).

However, the knotty part of innovation management is still at firm's strategic level. Since the processes of technological, market and organizational change interact with each other, the management of innovation is inherently interdisciplinary and multifunctional. It compasses the management of R&D, production and operations management, marketing management, product development or organizational development. Strategic managers should match organizational structures and processes which support innovation, and opportunities for, and constraints on, innovation in specific technological and market environments. The key task of managing innovation is how to integrate simultaneously these changes of market, technology, and organization (Tidd, J., J. Bessant and K. Pavitt, 1997). Schumpeter's economics definition of innovation is long overdue for the realization of new combinations of factors of production. But the strategic management focus is more on combination of various change processes. Taking the project management of a radical innovation as example, the first step should be selecting the right disruptive technology. There are two criteria for a disruptive technology: it never exceeds the existing technical performance but exceeds the performance requirements of the market; and it is improving rapidly its own technical performance. Once managers decide to pick up technology for its disruptive nature, the next step is to position the initial market for the technology. Because the technological change implies an

emergence of new market, managers can only detect the new segment relying on weak signals generated from interacting directly with experts, scholars, venture capitalists and potential distributors, and other unconventional channels. Managers can get market information such as who the customers are, which product features they want, and what price they would pay, by fast experimental marketing or market tests through a related or unrelated start-up organization. At the same time, the created start-up organization shall undertake the business development with disruptive technology. Even when the emerging market becomes bigger and stable, this organization's independence in design, production, sales and distribution shall be maintained, instead of being assimilated back into its parent company (Bower, J. L. and C. M. Christensen, 1995).

### *2.3. Dynamic Capabilities: Strategic Integration for Innovation*

The strategic dimensions of managing innovation by top managers can be characterized as a main part of the "dynamic capabilities", which enable firms to create, deploy, and protect the intangible assets that support superior long-run business performance (Teece, D., 2007). Originally, the concept refers to firms' ability to adapt to and exploit changes in their business environment and even to provoke change. According to perceptions of stability or dynamism in the environment, some authors decompose dynamic capabilities into three levels: incremental, renewing, and regenerating capabilities of firm (Ambrosini, V., C. Bowman, and N. Collier, 2009). More precisely, all along the activities of enhancing, combining, protecting, and, when necessary, reconfiguring the firms' intangible and tangible assets, dynamic capabilities can be disaggregated into three specific capacities: (1) to sense and shape opportunities and threats, (2) to seize attractive market possibilities, and (3) to transform the organization to maintain good fit with the business environment (Teece, D., 2007). Sensing means firms actively predict the future, study, search, scan and explore all the development possibilities. Seizing means firms make choice among opportunities, invest to exploit the potentials, and allocate resources to realize development. Transforming means firms fix resources in assets, institutionalize the activities, create new structures and change routines to keep the development trend. Dynamic capabilities are the fruits of entrepreneurial management of managers. Entrepreneurship is about sensing and understanding opportunities, getting things started, and finding new and better ways of putting things together. It is about creatively coordinating the assembly of disparate and usually specialized elements, getting 'approvals' for non-routine activities, and sensing business opportunities. Entrepreneurial management has little to do with analyzing and optimizing. It is more about sensing and seizing—figuring out the next big opportunity and how to address it (Teece, D., 2012).

The very entrepreneurial and forward-looking nature of dynamic capabilities is exactly what management needs for innovation. Though dynamic capabilities are firm-specific and different firms may need expertise in different areas, they are generally manifested by firm's competency of integrating activities of different natures: the exploration of strategic options and certain opportunities, the exploitation of technological endowment and unique intellectual property, as well as its customer base and upstream relations with suppliers, and the organizational "routines" or common aspects of practice in the firm that allow it to adjust to a user needs to get a customer, and to establish a price for products / services without too much regard for competition. This strategic management competence to overview and combine different change processes is a unique asset to firms in innovation-based competition. In large multi-technology multi-market

corporations, headquarters management staff has to develop such dynamic capabilities because they are able to mobilize and allocate resources to innovation project. In capital market and financial institutions, some venture capitalists and investment bankers also build up their visions over innovative projects and use financial tools (portfolio management, option-pricing method, etc.) and corporate governance restructuring power (alliance, merger and acquisition, spin-off, etc.) to combine various processes of changes (Teece, D. and G. Pisano, 1994; Teece, D., G. Pisano and A. Shuen, 1997).

The decomposition of dynamic capabilities into concrete actions of sensing, seizing and transforming has significant implication to innovation management. In fact, strategic integration of technological change, market change, and organizational change requires all these concrete actions in each change process. Therefore, developing and coordinating the dynamic capabilities in every change process constitute the key roadmap of innovation management. As demonstrated by literature, managing firms with some accumulated technological capabilities from developing economies to forge ahead to compete with world-class enterprises at innovation frontier is not an easy job. The combination of detailed breakdowns of dynamic capabilities and innovation process provides a fresh framework to assess and manage the innovation practice of catch-up firms.

## 3. Data and Methodology

The following section will use some cases and examples of Chinese industrial firms to illuminate how they seek to establish innovation capacity in terms of strategic management. The firm cases in textile and electronic industries are all based on primary information collected through visits and in-depth interviews. The main fieldwork in China was carried out between March of 2007 and April of 2009 through the research program "Innovation Potential of Chinese Industries", financed by the Hong Kong –based French Research Center on China (CEFC) in cooperation with the Research Institute of Guangdong Development (Sun Yat-sen University in China). Thanks to the official nature of the research program, most of our firm visits were recommended, arranged and accompanied by local government officials. At each firm visit, in-depth interviews lasting 1-2 hours with senior managers or company owners were undertaken, followed by factory or site visit.[1] The example of Bluestar Company in France was also based on our field visit in 2013.

Firm cases and examples of automobile industry and famous Chinese corporations are from documentary sources, mainly Chinese management magazines and newspaper reports, e.g., New Entrepreneurs (Xin Qi Ye Jia), China Business Week (Zhongguo Shang Ye Zhou Kan), and Caijing (Finance & Economy). The advantage of famous companies is they are always reported by several professional journalists. So we were able to cross-check the information about facts, even they were all news reports.

The sampling of firms for field interviews was principally done by local governments, with their preferences and standards to select "well-established,

1 A list of visited firms during these two years contains mainly: Fenghua High-Tech Corporation (Zhaoqing), TCL Joint-stock Corporation (Huizhou), Huaiji Auto Accessories Company (Huaiji), Zhaoqing Auto Parts & Accessories Company (Huaiji), Dachangjiang Motorcycle Group (Jiangmen), Shuopu Motorcycle Technology Company (Jiangmen), Hedy Group (Guangzhou), Delica Plumbing Equipment Company (Shuikou), Shuikou Technological Innovation Center (Shuikou), Yishion Group (Humen), Humen Textile Innovation Center (Humen), Fumin Fashion City Company (Humen), Xiaiqo Textile Innovation Center (Xiqiao), Dachong Furniture Technology Center (Dachong), Zhengda Pharmaceutical Company (Wuhan), Balance Pharmaceutical Company (Wuhan), Mike Bio-Pharmaceutical Company (Xiamen), North-East Pharmaceutical Company (Changchun), Geely Group (Ningbo), Beijing Oriental Electronics Group (Beijing), Delphi Shanghai Ltd. (Shanghai), Desano Bio-Pharmaceutical Company (Shanghai), and Shanghai-Volkswagen Company (Shanghai).

large sized, relatively well performed and technologically sophisticated local firms and entrepreneurial activities". Many of case firms were located in Guangdong Province, which is often called the "world factory" due to its lion share of China's foreign trade value (25.1% in 2011). These firms, with even the most famous Chinese corporations today like Lenovo or Huawei, all experienced the early development stage of OEM or subcontract manufacturing. So they were all typical Chinese catch-up firms, with better or worse performance.

The firm cases in this paper were studied till 2008/2009, a period of time when most of these quantitatively large enough but qualitatively less innovative firms begun to reach the limits of their long catching up process and meet difficulty in upgrading to innovation level. The 2008 world economic crisis imposed in fact a "window of threat" or "moment of truth" on Chinese industrial firms and exposed them intensively to main problems of innovation management. At that moment, and to some degree till today, it was a big question whether Chinese firms were able to "make the crisis truly creative" and take it as an opportunity to innovate, just like South Korean firms (Kim, L., 1998). With the analysis framework drawn from literature review, we assess each firm's dynamic management (sensing, seizing and transforming) of each innovation process (technological change, market change and organizational change). Based on these detailed assessments of cases, we can identify the key areas of problems in their innovation management, such as integration, coordination, dynamism, and forward-looking, etc.

## 4. Findings on Cases of Chinese Industrial Firms

The Chinese firms studied in this section vary in terms of ownership, size and fame. The textile industry is mainly represented by private small and medium sized local firms who are export-oriented, but at the same time supply domestic market. In electronic industry, larger State-owned firms with higher technological level can be found. Similarly, the automobile firms in this research are large State-owned firms. The limited numbers of the most internationalized Chinese firms are all large joint-stock companies. Nevertheless, all these firms have a more or less similar history of technological capability development starting from OEM (Original Equipment Manufacturing) or subcontracting production for foreign companies as their "clients" or "customers". In terms of developing innovation capacity, these Chinese industrial firms eventually confront the similar or even same problematic of catching up and forging ahead, once they have already accumulated certain amount of technological capability.

### *4.1. Cases in Textile Industry*

As OEM producers, textile firms in south China have become specialized in manufacturing products according to the specifications given by the foreign clients. For local firms in Dachong, a textile cluster in the Western part of Pearl River Delta region of Guangdong, the possibility of innovating in product or process depends very much on their relations with foreign clients. Since 1993, Dachong cluster has become one of the biggest Chinese producers specialized in jeans for export under foreign brands. In terms of technological change, the firms are on a typical path of incremental technological accumulation. They learnt mature process technologies from foreign clients by using imported equipment and doing production jobs on the shop-floor. The product designs were given by foreign firms to exploit the economies of scale in these firms who adopt industrialization-age factory structures. To them, the "market" is the foreign firms who place orders, with which they have very little contact. These local firms have no knowledge in

fact on the final customers of their products, since access to final foreign markets is extremely difficult to them. Foreign orders were decreased enormously during the 2008 economic crisis and the owners of the biggest factories in the cluster collectively attempted to sell directly abroad, with the support from local authority. But they found that the distribution channels to final customers were all controlled by their foreign clients, without them they were unable to interact with the real market. The strength of firms in Dachong includes cheap labor, large scale, and low costs in production. Their weakness is their dependence on foreign clients and the eventual distance from end-market. This weakness in market linkage can be fatal because even with good manufacturing expertise and facilities, the firms are far from the true sources of technology – the users. The factories made improvement in efficiency of using standardized technologies, but the purchasing prices given by clients were so low that their production capacity was very vulnerable to fluctuations in world markets and they had no additional resources to invest in R&D or market detection. As private firms, it was impossible for them to get loans for investing in any new business development activities from banks, who only lend to large State firms.

Yet the low margin in textiles is not unavoidable. On the Eastern side of Pearl River Delta, the clothing firms in Humen district are more successful. In this specialized industrial district, local government established a public technical center, whose duties ranged from fashion designing to copy Western models and marketing to export. This technical center created its own market - a building accommodating hundreds of small business who opened their stands of clothes exhibition. Each year the district holds a competition of young Chinese designers and sends the winners to follow training in an English school of design. The result is that it is easier for firms in Humen to develop and promote their own brands and business networks. Later, the technical center was acquired by a local private garment group Yishion, which had a business of 3 billion Yuan yearly. The technical center thus became a profit center and opened to foreign design companies. Yishion was founded in 1997 as an OEM manufacturer of garments. Later it entered in wholesale business and became an apparel trader specialized in import/export of clothes, which brought it a lot of contacts with retailers in and outside China. Then Yishion discovered a very buoyant market in China - the children's clothing- and created its own brand "Yishion". In 2000, it sold its wholesale business and established its own brand stores by developing a franchise network in China. Until 2008, it had a network of 2,000 stores all across the country and became the 9th biggest apparel group in China. Yishion was no longer a manufacturer under other companies' brands because its franchise stores only sold its own brand products. It even expanded its marketing network in neighboring countries of Southeast Asia.

The big shift from exports to domestic or regional markets of Yishion happened in the beginning of 2007 when it restructured the whole organization in group form and kept its headquarters in Dongguan to focus on developing new activities: new products, fashion design of clothes but also franchise concept stores, and improvement of quality management system. Other than its product line for children, Yishion re-segmented the clothes market and launch four new product lines: leisure clothes series, sport clothes series, fashion clothes series, and business clothes series. After transforming the acquired public technical center to its own platform of design, Yishion recruited new designers and collaborated with overseas design firms to develop new series of products. Every year, Yishion launched 10 thousand new clothes models in the market. At its site of headquarters, initiated by Mr. GUO Donglin, the CEO and his management team, Yishion constructed

a giant "show center" composed of all kinds of concept boutiques and stores designed specially to sell its own brand clothes. Franchisees were solicited to visit the boutiques and select the collections of clothes. Yishion changed its business model from selling clothes to retailers to selling design services, boutique systems and clothes to the franchisees. In upstream activities, Yishion integrated all suppliers in its new IT system and the terminals in the boutiques of its Show Center were also connected with suppliers. In 2002, Yishion already invested to establish a Quality Examination & Test Center (QETC). In 2005, it invested 40 million Yuan to build up a Specialized Quality Examination & Test Laboratory (SQETL) which was the biggest test lab in clothes chemical elements in China. Till 2007, Yishion finally built up a complete QETC with a total investment of 120 million Yuan and more than 1000 employees working on clothes quality. The QETC was able to monitor and test all textile elements from its material inputs to finished clothes. A hot-line service center was also created to receive and treat the complaints and requirements of clients and franchise stores.

Certainly, the firms like Yishion are still far from being innovatively competitive in Western markets. But the key element of Yishion's bigger innovation potential than firms in Dachong lies not merely on its stronger dynamics of technology development through privatization of a public technical center, but also on its investment in market research, sales system, and brand building in Chinese market. The participation in domestic consumption growth generates more comfortable margins to Yishion so that it can continue to invest in design and technical progress. The relative success of Yishion in managing innovation is due to its technological sourcing from Western clients, at the same time its learning actively and directly from final customers and new market segments. This management strategy of parallel learning from both technological providers and final customers in market in fact should suit most of the small and medium sized firms in local clusters of Dachong and Humen. It is also the main lesson which can be drawn from the experience of some State-owned firms in "strategic" industries. These State-owned firms often have the most advanced machines, good work organization, better paid employees, and bigger power over suppliers. Contrary to private firms, they have R&D activities supported by public programs of technology development and easier access to universities and technical centers for cooperation. Moreover, several of these firms are themselves originated from public research centers that are "commoditized" (Bironneau, 2013). They also have arranged partnerships with banks to ensure their investment. But in terms of managing market change, they may not be as good as their private counterparts.

*4.2. Cases in Electronic Industry*

Fenghua Hi-Tech Corporation, located in the Northern part of Pearl River Delta, is a State-owned company benefiting from innovation policy of national and local governments. Founded in 1984, Fenghua was ever the number one producer of electronic components in China and ranked number 8th in the world. Fenghua produced various electronic components, including resistors, capacitors and transistors, with its 16 production lines. It diversified in artificial silica for components used in printed circuit boards and motherboards. From 1999, its business experienced a spectacular growth: in the late of 2000s, Fenghua occupied in the domestic market a quarter of China's production of components and exported to the world (USA, Japan, France, Germany, and Poland). About 70% of their production was for very large customers (Motorola, Thomson, etc.).

Fenghua's production of electronic materials (binders and powders) was also one of the biggest in China. In 1985, it imported a line of production

of silica layers whose technology was "multi layers ceramic capacitor" (MLCC technology) from the United States. At that time, sixteen lines of the same technology were imported into China but only the line of Fenghua was installed and kept. From 1991, Fenghua increased its production capacity and gradually extended its production sites to Shenzhen, Suzhou and Jilin Province. In 1993, it reached to have another capacity of 100 million units of aluminum capacitors. In 1995, it reached to produce 5 billion units of resistors. In 1997, it reached the production of 360 million units of transistors. In 2001, Fenghua set up a production line of MLCC which became its main product, and a production line of magnetic cores with a capacity of 4000 tons a year. In 2002, it had reached the capacity of 80 billion units of electronic components. With the increase of productive capability, the staff number grew from more than 100 to 10,000 employees: 500 employees in the production of powder materials, 9000 in components, and 500 in equipment manufacturing. Indeed, from early enough Fenghua extended its production from components to artificial silica, an essential raw material for all electronic components, and attempted to become technological leader in this field in China. Fenghua decided to focus on materials because it found that that the key process technology could only be identified in material: It also took long time to integrate process technology into the component production. Fenghua, as other component producers, would not leave this key issue in MLCC production controlled by other firms.

The organizational change of Fenghua was rather exogenous. Arranged by Central Government, the company jointly developed local-produced ceramic materials of MLCC with Qinghua University in 1995. In 1996, Fenghua was publicly traded, with 20% of the capital owned by the city government of Zhaoqing, 20% by the State, and the rest floating in the market. With government as major shareholder, Fenghua's development projects of electronic powders and binders were integrated in the National Torch Program and enjoyed financing from Ministry of Science and Technology. In 2000, Fenghua was approved by Central government to increase it's A-share stocks and collected 1.1 billion Yuan to invest in its project of "National Base of Large-scale Components" approved also by the government. To support the technology development of Fenghua, the government established 3 technology centers at national level and one research institute inside the firm. Government allocated to it more than 1000 experts in electronic technology. Fenghua was selected as one of the 36 pilot stations of post-doctoral research in firms at national level. To assure the sales of its products, the government designated Fenghua as the key national supplier of localized components for mobile telecommunication products.

With such huge financial support, technological aid, and market access from State, Fenghua built up technological competences in material technology, equipment technology, transformation technology, painting technology, and some design and test technology. However, during 2001-2004, the whole electronic components market fell down. During 2001 to 2003, high frequency PCs had rigid exigencies of the components and that required technological breakthroughs of component producers. At the same time, small scale products such as mobile phones needed also new components. Therefore the old products were in end of their life cycle, and the market demands of traditional components were in decrease. In Chinese and international markets, there were increasing demands for new products, smaller but with higher quality. Fenghua, with 5% of sales allocated to R&D, responded by investing additional 30 million Yuan for R & D to modify its product lines. Its Research Institute successfully developed new resistor in MLCC (capacitor) in replacing silver and BAI metal by NIE metal. During 2000 to 2006, Fenghua

developed 140 new technologies: 20% of them were inventions and others were practical new designs. In 2006, Fenghua recovered its sales with 1.2 billion Yuan revenues.

During this period of time, Fenghua's R&D was directed to high added value materials (binders and powders), mainly for MLCC. Before 2001, 60-80% of MLCC cost was of materials; but after 2001, only 30-40% of MLCC cost was of materials, and high-valued components only had 20% cost of materials. Besides, conventional products had 40-50% of cost for manufacturing, but high valued products contained 80% of cost for manufacturing process, mainly for equipment investment. Therefore, Fenghua turned its R&D focus from materials to specific equipment. As a first step, Fenghua developed test equipment, such as Auto Optical Inspection Equipment. With own-produced equipment, Fenghua could economize 200-300 million Yuan in capital budgeting. Yet most of its equipment was still imported. Fenghua emerged as a main player in high and middle voltage products. With lots of investment in equipment, it reached the economy of scale very easily. But for products of same capacity, it had gaps with Japanese companies and competitors in the world market.

From 2005 to 2006, Fenghua found that there was a big change on the demand side from its clients. Before, the clients purchased electronic components one by one. So Fenghua sold its components by piece and had to negotiate every year with its downstream clients on prices of every component. But suddenly, clients turned to competitors to purchase the integrated-set of components to save money. It brought a big reduction of prices in the market. Fenghua did not predict the market change, but had to plan producing integrated-sets to serve its clients. Once again, Fenghua found itself in a very disadvantageous position in face of upstream IC designers. Once the IC design finished, Fenghua could only accept and produce according to the architectural design of IC. Fenghua would like to have designers integrate their components in IC design in early phase. So it negotiated with some IC designers, and even created a joint research laboratory with a Taiwanese IC firm of mobile phones who had strong ties to a US institute and foreign companies. Nevertheless, for Fenghua, becoming a system integrator in mobile telecommunications represented another technological path beyond Fenghua's competency, and the dominant position of IC designers in the value chain seemed very difficult to be broken down.

It was also during this critical period of time that Fenghua lost its key clients, in face of fierce competition in electronic components from foreign and Taiwanese companies such as Chuntian, Guoju, TDK, and Taiuyotai, etc. One key client lost was INTEL, the leading company of micro-processor in the world. The multinational had identified Fenghua as a qualified supplier and even created joint R & D programs with it. However, Intel had nearly 150 Chinese suppliers. In the beginning of 2008, INTEL made an internal decision to break the contract with Fenghua. This loss of relationship with a key customer was fatal for the firm, because the pulling force of its particular MLCC technology, whose technical performance ranked far behind the Japanese and Korean competitors, suddenly disappeared. The break-up with INTEL imposed a dead-end on Fenghua's MLCC technology. In fact, to attain a global level and approach the technological frontier as Samsung, Fenghua should have invested much more in R & D, and continuously improved the method of manufacturing. Its relationship with INTEL was particular, because INTEL was Fenghua's key client and key technology source at the same time. Staying in an ecosystem is vital if a firm wants to maintain and improve the high-level technological capabilities. Fenghua, despite of its significant internal technology efforts, ongoing State support, and good financial and credit conditions,

was eventually not able to insert itself into such a small and closed circle composed of global producers of multilayer components. The loss of key market relations left Fenghua perplexed in overall development direction. It hesitated between the ideas of integrating in a system integrator and finding a comfortable place in the new industrial chain, or localizing the production to strengthen its industrial structure of transistor, capacitor and resistor production, or implementing own-brand strategy through investing more in indigenous R&D. In 2007, Fenghua started searching for strategic investors since the financial support from the State was almost exhausted. The government's plan was also selling Fenghua to foreign groups. In 2008, it decided to stop production abruptly.

The rise of Fenghua was due to its enormous inputs in R&D with the government's supportive corporatization reform of organization. The technologies developed through R&D were innovative for Fenghua, but in the electronic components industry they were mostly catching up to the technology frontier. Fenghua could sense the technological opportunities and invest in developing them. But it had difficulty in transforming and exploiting the developed technologies to attain and maintain competitive advantage in the market. Every time it worked out a new technology closer to the frontier, the technology became obsolete quickly. This difficulty of building up market competitiveness seems to be due to the weakness in technological capabilities - Fenghua was always one step lagged behind the most advanced technology. But the real cause is the absence of dynamic capabilities to manage the market change. Fenghua was not able to project market trends and sense threat from market. Its over-dependence on a limited number of clients seriously reduced their power to negotiate technology change process with its clients in the market (who were its key technology sources). In terms of market linkages, Fenghua was in the same situation as the Chinese private OEM producers of jeans or garments, whose relationship with foreign customers was essential because these customers were also technology providers. This situation was very different from those of Taiwanese companies or Japanese and Korean companies some twenty to thirty years ago. These East Asian companies strategically leveraged their technologies and production capacities to diversify customers and markets. They actively searched for new market opportunities, invested in market development, and maintained strong customer relations. In turn, they negotiated better commercial and technological cooperation conditions with their foreign clients (Ernst, D. and Kim, L., 2002). Their good mastering of market change supported the technological change process with strength. With no capability on market change, Fenghua was not able to articulate between technological progress and market development, despite its significant investment in technology and production. And the reason why Fenghua was lack of "feeling and sense" of market change may be due to the heavy intervention of government: on one hand, Fenghua's market was almost "guaranteed" by the government; on the other, Fenghua's management team had only limited control over the organizational change process. The corporate governance, project financing structure, and even personnel allocation were all arranged by the government: the dynamic capabilities of making organizational change were weak in Fenghua. Without strong supports from active market management and effective organizational change, its technological adventure eventually fell to a dead end.

The problem of integrating effectively changes of market and customer needs to lead choice of technological paths can be found in other electronic firms. For example, the television producer TCL launched its overseas expansion after strong growth in the domestic market. In 2002, TCL bought the

television division of Schneider, but stopped the production in 2004. TCL also bought the mobile phone business unit of Alcatel and the colors TVs division of Thomson. At that time, TCL was already the world leader of cathode television, occupying 11% of the global market. It planned to reduce the selling price of TVs by controlling Thomson's manufacturing technologies and supply chains through acquiring the weak Western brand. However, there was a sharp decline of demands in market, especially in Europe. TCL underestimated the speed of market changes and the fastness of technological change. When TCL Thomson launched its new LCD product in 2005, TCL found itself fall behind its competitors in the European market, in terms of knowledge of LCD technology. Its organization and collective expertise exclusively in cathode technologies were of little help to meet the new demand of flat screens TVs. Though TCL finally didn't miss the technological transition to LCD[2], its way of managing innovation was problematic. TCL's aggressive international acquisition represented a dynamic organizational development triggered by the needs of exploiting existing technologies, but its relative inactive market change management made TCL difficult sense and seize the technologies a step ahead of market. It followed passively emerging technologies in the market. Like many other reputed Chinese firms (Lenovo, Galanz, Medea, etc.), TCL became eventually important market player, thanks more to its productive capacity of large scale, than to the dynamic capabilities of orchestrating technologies, markets and organizations to make innovation.

If the problem of dynamic capabilities in Fenghua and TCL is on managing of market change in relation to technological change, the problem of most Chinese firms' efforts to upgrade to innovation is still more related to absence of appropriate management of imported technology itself. Beijing Oriental Electronic Company (BOE), a factory of CRT (CRT) in Beijing, is such an example. In the eighties, BOE established a joint venture with Matsushita to produce electronic tubes for color TVs, but the technology was still managed and controlled by Japanese companies. BOE wanted to change from the cathode technology (CRT) to liquid crystal display (LCD) monitors. So BOE chose to acquire technology through organizational acquisition of foreign companies. It bought the STN-LCD divisions of Hyundai Group (Hynix) and the business unit producing TFT-LCD. Then BOE bought the distribution company of Hynix liquid crystals and invested in constructing production lines of the fifth-generation TFT-LCD in its own factories in China. To get the key technology, BOE singed turn-key contract with Hyundai Group for constructing three complete production lines of TFT-LCD, including the patents of the TFT-LCD of second and third generation, buildings, workshops, fixed assets, and the entire global distribution network. In short, BOE's acquisition covered all the operations necessary for the acquisition of hardware technologies, access to information sources and methods of commercial distribution: it bought everything that was tangible and believed in this way it mastered the complete technology and, more important, could become the market leader. However, after the accomplishment of turn-key contract, when BOE began producing liquid crystals displays (LCD), managers discovered that the manufacturing process needed a lot of tacit knowledge and know-how. For example, the production of screens actually depended on the temperature and humidity. But this tacit knowledge, only based on the experience of workers on the production line, was not included in the purchase contract and obviously not transferred to BOE.

2 In 2009, it was the third biggest brand of LCD TV in China and the 7th biggest worldwide. It was a bigger LCD TV exporter than any of its Chinese rivals.

BOE had to invest more for acquiring the tacit knowledge on LCD technology, such as training and exchanges with workers in Korean and Japanese firms. When it finally mastered the whole process, the imported technology had already become obsolete in the market. Moreover, operating costs were too high compared to competitors because of the additional investment required for technology transfer. To catch up with technological change, BOE decided to import the fifth-generation TFT-LCD. However, after losing a lot of money in the acquisition of Korean production chains, it had not enough resources to ensure the new technological leap forward. BOE eventually lost control of upstream suppliers, as well as its downstream distributors, due to the increased costs of production.

*4.3. Cases in Automobile Industry*

Similar to BOE, many Chinese State-owned automobile firms also tried to move closer to innovation frontier through transferring and absorbing foreign technologies, supported by the national policy which encouraged large Chinese corporations to invest directly in foreign companies. A typical case was the acquisition of the car company MG Rover by two Chinese groups: SAIC (Shanghai Automotive Industrial Corporation), China's largest auto company, and Nanjing Automobile Corporation (NAC). The process of acquisition of MG Rover Group was complicated and two very different Chinese companies were put together without a successful dialogue. The technologies of MG Rover were split into two packages: SAIC spent 67 million British pounds to purchase the technologies of two patented car models (Rover 25 and 75) and two patented engine models (KV4 and KV6). SAIC acquired no assembly line or physical production assets, neither the brand of Rover. NAC, on its side, spent 53 million British pounds to buy MG and Austin brands, the technologies of four patented car models (MGZR, MGZS, MGZT, MGTF) and three engine models, as well as all assembly lines for manufacturing those car models and motors. When the deals were completed, the two Chinese firms started to compete with each other in the Chinese market, instead of cooperating.

In late 2005, SAIC created an imitated Chinese brand "Roewe" in domestic market by using the technologies it had acquired from MG Rover. It was virtually a legal copy of the Rover 75. Three years later, SAIC sold totally 5,300 cars under the brand "Roewe 750". With no equipment and no production line, SAIC encountered difficulty in reproducing exactly the Rover car model. For example, the engine manufacturing required advanced equipment. SAIC produced some engines by itself, most of engines were still bought from its traditional Chinese suppliers. SAIC sensed the coming opportunities in Chinese automobile market and would like to catch it as soon as possible. But it would not wait for a high quality Roewe car to launch. NAC has the same attitude of rush into the domestic market, except that the initial situation was a little different: NAC bought the MG brand, so it has all the legality of using this brand. Owning the properties of the brand, technology, production equipment and assembly lines, NAC also decided to launch as quickly as possible the car production and marketing it on the domestic market. NAC dismantled all the engine production lines and the most important car production lines of Rover, and transported them from UK to China. As a result, NAC spent more than four months to re-install all the lines on their production site in China. The dislocated lines, mainly for manufacturing more than 40 key engine components, were composed of more than 600 equipment. In July 2007, without R & D activities on the imported lines, NAC launched its car model MG ZT, the Chinese version of MG7. Later, NAC used these lines to reproduce other MG car models for the Chinese market.

The above three State-owned firms, BOE, SAIC

and NAC, like many other Chinese State firms, identified the emerging Chinese market opportunity and intended to catch it by imported foreign technologies. After overseas M&A deals, they all dismantled the tangible assets, relocated them to China, and sell products to domestic market, instead of continuing the operations abroad or re-export to foreign markets. They couldn't fully absorb, assimilate, and transform the bought technologies because there was no dynamics to create new internal and external organizational arrangements to carry on further technological change, such as JV or alliance which could facilitate transfer of tacit knowledge. The purchase of high technology and advanced equipment cannot assure upgrading to innovation of firms. As a result, these firms counted on their old tactics of large production scale, low sales pricing, and short lead time to market, to survive the competition in domestic Chinese market.

### *4.4. More Examples: Chinese Emerging Transnational Corporations*

Nevertheless, better innovation management practice with stronger dynamic capabilities now can be found in Chinese automobile industry. The acquisition of Volvo by Geely, a private car maker only entering the automobile industry in 1997, is an example. Geely kept almost all the organizational structures of Volvo outside China and triggered further development of Chinese market for Volvo cars. Two new Volvo factories were constructed in Chengdu and Daqing to produce new models for Chinese market. Geely established a joint R&D platform with Volvo to develop CMA models, but the program was dominated by Volvo R&D team. Geely integrated the procurement systems of the two companies and reduced enormously the production cost of Volvo for both Chinese and international markets.

A similar example is Chinese Bluestar Company, a subsidiary of largest Chinese national chemical group ChemChina. In 2007, after acquiring the French Rhoda Silicon, Bluestar kept the French R&D center with 130 researchers in Lyon almost intact. Over years, Bluestar continued to invest in the R&D projects in France, but also created internal training and personnel exchange programs with manufacturing factories in China. Bluestar later bought upstream activities through acquiring Elkem, a Norway chemical company, and downstream activities through acquiring Adisséo, a French animal nutrition and sulfur producer, whose business were linked to former Rhodia Silicon. By these organizational and managerial arrangements, Bluestar progressively assimilated the core technologies as well as the know-hows of Rhodia Silicon and diffused them across the whole group.

Generally, those few Chinese firms that succeed in internationalization development are those that deviate from strategy of large quantity and lower prices. The management characteristics of their more successful innovative activities appear again and again: firstly, by learning and absorbing foreign technology, they establish close interactions with customers in domestic market, as well as the branded foreign clients; they become more and more sensitive to market demands; then, through creation of new organizational frameworks such as overseas R & D centers, alliances, or mergers & acquisitions, they approach further foreign sources of knowledge; normally they will restructure the internal and external organizations, and leverage the Chinese production capacity with newly acquired technological capabilities for global markets (Zahra, S. A., R. D. Ireland and M.A Hitt, 2000). Huawei may be the most typical case of such dynamic management. It tested its production capacity and management of wireless networks in China's Xinjiang region first before seeking to export to developing markets such as Zimbabwe, Kenya and Thailand. It then established R&D centers in Europe (Stockholm), Texas and Silicon Valley, and recently

in India and Russia to detect the most advanced technologies. Note that Huawei created its first R & D centers abroad very early, well before its production line of server network was fully finished and when it was under legal attack of CISCO who accused Huawei of plagiarizing its server technology. Of course, overseas R&D Centers of Huawei were not for adapting its research already conducted in China, but for learning, acquiring and repatriating foreign technologies, to both overseas market and later Chinese market. As for the appliance manufacturer Haier, when it established operations in the U.S., it smartly targeted the specific market segments in North America, such as dormitory refrigerators, wine refrigerators, and TV sets in children's room, etc., things they were able to produce easily in mass with their standard technologies. Based on market feedbacks, Haier launched more sophisticated R&D projects to further develop the North American market.

But not all Chinese emerging multinational firms manage well the innovation dynamics all the time. Lenovo, which has made a series of international acquisitions, might be an example of problematic dynamic capabilities. The acquisition of PC business from IBM reinforced Lenovo's technological progress in laptop computers, but Lenovo did not reconfigure and transform the emerging market of mobile phones, even though it already sensed it early and try to seize it by investing in production in 2002. Lenovo bought out Motorola Mobile in 2014, but this seizing action was too late. Lenovo neither seized the opportunity of internet business, even it was fully aware of the transformation of IBM. After acquisition of IBM, Lenovo spent huge energies and resources to transform the internal organization to focus on embedding IBM's market sales system and PC technologies in the group, while neglecting to large extent the market dynamics. Now it has world-class production scale, cost control and supply chain system, but its R&D budget was below 1.9% during 2006-2014. The firm seems to stop sensing.

## 5. Discussion and Implication

The firm cases in this paper show that Chinese firms have been technology learners. In terms of linking market needs with commoditized technologies, most of Chinese firms have huge potential of growth and improvement, which is still under-utilized and can be exploited through more investments in in-house R & D and partnering with external research institutions. In terms of dynamic capabilities, we synthesize the analysis of each firm's innovation management practice in the Table 1.

**Table 1.** Assessments of innovation management of case firms

| | Sensing, seizing and transforming of technological change | Sensing, seizing and transforming of market change | Sensing, seizing and transforming of organizational change | "Orchestration" skills of strategic integration |
|---|---|---|---|---|
| Firms in Dachong (private SMEs) | Weak in sensing (technologies were brought in by foreign clients) Strong in seizing and transforming (mass production capacity) | Very weak (no access to final market) | Very weak (keeping the simple factory structure) | Weak (Owners not able to leverage technological capabilities to change market positioning and business models.) Weak technology sensing due to absence of market access |
| Yishion (large private firm) | Strong (buying the public center and pursuing fashion designs) | Very strong (recognizing children's clothes and segments; local brand building; franchising) | Very strong (creating the franchising system; upgrading IT system; improving QC system, etc.) | Very strong (integrating design, suppliers, franchise stores, etc. in its Show Center system) |

| | | | | |
|---|---|---|---|---|
| Fenghua (large State-owned firm) | Weak in sensing the most advanced technologies<br>Strong in seizing (investing in technology development)<br>Medium in transforming (technology became obsolete before fully exploited) | Very weak (depending on a few foreign clients; government endorsement) | Weak (most of organizational change was arranged and directed by government) | Very weak (Since there was no market prediction, there was always technological "surprise" to the firm. No market input in technological change.)<br>No organizational motivation to trigger market development |
| TCL (large joint-stock company) | Weak in sensing the most advanced technologies<br>Strong in seizing and investing<br>Strong in transforming and exploiting acquired technologies through manufacturing system | Strong in Chinese market but weak in European market | Strong in sensing and seizing (overseas mergers and acquisitions of Thomson)<br>Medium in transforming (difficulty in cultural integration) | Problematic (did not take maximum use of foreign acquisition to trigger market change process in Europe and then the technological change process) |
| BOE (large State-owned firm) | Medium in sensing the most advanced technologies in the world<br>Strong in seizing, investing in and exploiting acquired technologies | Strong in Chinese market but very weak in foreign market | Very weak (problems of managing personnel and employees) | Very weak (only concentrating on managing technologies as tangible commodities) |
| SAIC & NAV (large State-owned firms) | Strong in sensing foreign advanced technologies<br>Medium in seizing and transforming (buying the equipment and technologies without further development and investment) | Strong in sensing and seizing the Chinese market<br>Very weak in foreign market | Very weak (no organizational change since only the acquired assets were moved to China) | Medium (somehow combing the Chinese market opportunities with imported technologies through overseas assets take-over) |
| Geely, Bluestar, Haier, Huawei (emerging Chinese MNCs) | Strong or every strong in detecting foreign technologies<br>Very strong in investing in overseas R&D<br>Very strong in exploiting the developed technologies | Strong in exploring and developing foreign markets<br>Medium in transforming and reconfiguring foreign markets | Very strong in sensing and seizing organizational change through aggressive M&A<br>Strong in transforming overseas organizations and structure (relative successful cultural integration) | Strong (managing the market, technology and organization changes simultaneously to create positive feedbacks among them; leveraging Chinese production capacities with foreign technologies in both foreign and domestic markets) |
| Lenovo (emerging Chinese MNC) | Weak in sensing (mobile and internet technologies)<br>Medium in seizing (investment in mobile was light and then late)<br>Strong in transforming and reconfiguring (for matured PC technologies) | Strong in sensing (having a strong tradition of selling and customer service)<br>Medium in seizing the new market trends<br>Strong in transforming (setting and managing distribution system; branding) | Strong in sensing and seizing (buying IBM PC business; moving head-office to US, etc.)<br>Weak in transforming (not creative in organizational change; difficulty in cultural integration) | Problematic (strong in sustaining the existing business but weak in orchestrating in creating new business; typical incumbent syndrome.) |

The table illustrates some main problems of innovation management in Chinese firms. At the most basic level, many Chinese firms still confuse "innovation" with "invention" and replace innovation by technological breakthrough, patent registration, or R&D investment. Innovation management is thus heavily biased to technology management and is regarded as technical matters to be handled by product designers, engineers, and technicians. Even in terms of managing technological change itself, Chinese firms, especially large State-owned firms, still give more importance to hardware and information of technology than to knowledge and human skills in technology acquisition, as the cases of BOE, SAIC and NAC demonstrated. Some others just focused on technical advancement rather than changing market and competition situation, as the case of TCL.

For those who built up large productive capacity through strong technological learning and accumulation with customers, including foreigners as their technology providers, either they are kept too distant from the final consumers (as the firms in Dachong Cluster), or they become too much dependent on key foreign client in technology (as Fenghua). Sensing, seizing and transforming the market is absent in their innovation management. The counter-example is Yshion, which began to forge ahead in innovation thanks to its development in domestic market and avoided too much technological path dependency on foreign clients.

Merely managing R&D or marketing is not enough for innovation. The dynamics of technological, market and organizational changes are inter-linked and reinforced each other. Theories on innovation management, particularly the approach of dynamic capabilities, emphasize the importance of integrating strategically the technological, market and organizational changes to successful innovation. As shown by the cases, the integration, articulation, or "orchestration" skills are often the weak points for managing innovation in Chinese firms. Firms like Geely, Huawei, Haier and Blustar have been skillful in integrating and articulating simultaneously and appropriately the different dimensions of change in innovation, but the firms having this type of dynamic capabilities are still rare to find in China.

In this respect, China differs dramatically from the competitive challenge to Western companies that Japan presented 30 years ago. Japan's secret sauce was management; but that is China's weakness (Lieberthal, K. and G. Lieberthal, 2003). Maybe it will take decades for them to overcome the ingrained management weaknesses that prevent them from mastering the dynamics of innovation. Knowing the importance of management to innovation, Chinese managers can start by asking some basic questions when facing a potential innovation project:

How do we choose the technology? Do we have a clear technology strategy and a suitable roadmap for technological capability development? Is technological innovation the core part of project?

Do we have a corresponding market strategy for the technological innovation? What relations and interactions with customers or clients should we have to support the coming technological change? How will we change the market with the innovation?

Should we change correspondingly our internal and external organizations of people and business to meet the technological innovation? What way of organizing people and activities is suitable to achieve the innovation goal of project?

Most importantly, how can we coordinate and integrate the above changes in three domains? Can we articulate and leverage these three processes to create sustainable dynamics of innovation of the firm? Do we have such dynamic capabilities in management?

By nature, the rampant problem of weak dynamic capabilities in managing innovation in China is the shortage of high-level human resources of managers. China will need a whole new generation of managers

to upgrade. In fact, innovation management as a specialized major can only be found in several top business schools in China. Entrepreneurial and forward looking managers are difficult to find in existing corporations, since the strategic development divisions of large firms or strategy consultants are mainly oriented to financial strategies or IT operations. Some innovation managers may be employed in financial sectors (policy-leading funds, industrial investment funds, venture capital firms, specialized technology banks, and business angels, etc.). Chinese government shall understand the importance of these intangible assets and capabilities and reform its education and training system to form a new generation of managers. On the other side, they shall free the firms to find their own strategies and cultivate their endogenous capabilities of managing innovation.

## 6. Concluding Remarks

When Chinese firms, like catch-up firms in other developing countries, try to innovate closer to the frontier, specific management skills can be vital, among others factors. Through some empirical cases, this paper highlights how Chinese firms manage the technological, market and organizational changes for innovation activities in terms of sensing, seizing and transforming them. If the Chinese firms are more or less strong in managing technologies, markets or organizational changes separately, the most innovative firms are also strong in a kind of dynamic capabilities: management skills of strategically orchestrating and integrating the change processes in different fields. In this sense, the weak capability of strategic integration is the main problem of innovation management in China. This conclusion supplements the literature on catch-up firms and has implications for practice and policy.

One of the limitations of this research is the case "stories" are old, though their timing can reflect more intensively the problematic of innovation management. Further research shall be done to follow the recent situations of the case firms or other emerging E-commerce companies in China, in order to observe whether Chinese firms have evolved in their way of managing innovation. Besides, quantitative data and econometric method can help clarify the complicated cause-effect relations among innovation process, dynamic capabilities, innovation outcomes, and business performance of firms.

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