Research Paper

Innovation model of firms in China: Evidence from automotive and semiconductor sectors

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ABSTRACT

There are several written articles about the rising innovation capabilities of Chinese firms and till date, however, this research treats Chinese firms in far too uniform fashion. In this study, we took a closer look at two leading innovation sectors of Chinese industry, automobiles and semiconductors. In these two sectors, we showed that the innovation model differs sharply between State-Owned Enterprises (SOEs) on the one hand, private-owned enterprises (POEs) and de novo start-up firms on the other hand. particularly, we find that the POEs and start-ups are valuable contributors for more radical technology innovations and new business models, while the former SOEs labor under a variety of constraints that make them slower to adopt these new innovations and business models. Relatedly, the former SOEs concentrate predominately on the Chinese market, while the POEs and startup firms utilize China as an export platform to sell products to the world. We empirically find that Chinese innovation model is very different from both mainstream catch-up model and the Western. This research has academic value and its also useful industrially. Our findings have implications for both Chinese policymakers (who tend to overemphasize the former SOEs in their policymaking) and for the Western firms operating in China (who pay insufficient attention to the start-ups as possible partners).

Keywords: Innovation model, State-owned enterprises, Private-owned enterprises, China.

INTRODUCTION

Due to significant difference in resources and technology base, innovation models between developed and developing countries are not same (Bell and Pavitt, 1993), which means that the innovation models from developed countries cannot be fully adapted by developing economies. Therefore, over the last 30 years, much progress has been made in the research on technological catching up in developing countries. Mainstream opinion on latecomer catch up is that technological innovation in developing countries was mainly realized through imitation, reverse engineering to advanced mature technology acquired from developed countries (Hobday, 1995; Kim, 1997), which is very different from that of developed countries (Bell and Pavitt, 1993). Although existing mainstream literature on catching up is useful and helpful to understand latecomers’ innovation models, there are several research gaps. First, these studies assume that latecomer firms are homogenous in initial resource and capabilities, which leads to less attention paid to innovation heterogeneities in the catching up process (Li and Kozhikode, 2008). Actually, trajectories of technological accumulation and capabilities vary in different countries, sectors and firms (Bell and Figueiredo, 2012; Lee and Malerba, 2017; Malerba, 2004). Secondly, mainstream catching up theory was developed from small economies like Korea, Hong Kong, Taiwan, and Singapore. It cannot reasonably explain the practice of catching up and innovation in larger geographical regions such as the BRICS countries (Brazil, Russia, India, China, and South Africa).
Thirdly, mainstream catch-up literature ignored institutional factors. Institution, especially its core-element ownership significantly influences firm innovation behavior and performance (Dacin et al., 2002; DiMaggio and Powell, 1983; Jiang et al., 2013; Peng et al., 2009). Very different from other economies, China, in a transition period has a large number of state-owned enterprises (SOEs) and privately-owned enterprises (POEs), which determines special institutional context of catching up and innovation. The mainstream catch-up literature pays little attention to the relationship between institution and innovation. Finally, previous research on latecomer catching up focuses too much on technology level, losing sight of two pivotal innovation factors, entrepreneurship and business model. Entrepreneurship is a crucial driver of economic growth for both developed and developing nations (Vivarelli, 2013), while business models are essential for converting ideas and technology into economic value (Chesbrough, 2006). In addition, most scholars in the research on latecomer catchup concern little about the market which is ultimate target of technology innovation. Their hidden assumption is that latecomer firms’ product is only sold in domestic market. However, in many large developing economies, the products are also sold to international markets. In the case of China, much has been written about the rising innovation capabilities of firms. To date, however, this research stream treats Chinese firms in a uniform fashion. There are three major features of these research. Firstly, the majority of them are descriptive studies on Chinese innovation systems or policies from macro perspective. Secondly, most are proving or simply revising and testing the mainstream catching up theories or innovation theories of developed countries based on public data or questionnaire survey of Chinese firms (example, Jin, 2008). Thirdly, the current innovation literature on Chinese firms lacks explorative multi-case studies across industries. It has not deeply investigated and looked into the differences between Chinese firms’ innovation models, mainstream catching up theories, and Western innovation theories. China, very different from Western countries and other developing economies, has many state-owned enterprises (SOEs) which dominates its industries and many private companies which have been developed in recent years.

In this study, we took a closer look at two leading innovation sectors of Chinese industry, automobiles and semiconductors. In these two sectors, we showed that the innovation models of the industry differ sharply between former State-Owned Enterprises (SOEs) on the one hand, private-owned enterprises (POEs) and de novo startup firms on the other hand. The evidence suggests that the role of governments is greater than entrepreneurs in SOEs than in POEs and startup firms. In particular, we found that the POEs and startups are particularly valuable contributors for more radical technology innovations and new business models, while the former SOEs labor under a variety of constraints that make them slower to adopt these new innovations and business models. Relatedly, the former SOEs concentrate predominately on the Chinese market, while the POEs and startup firms utilize China as an export platform to sell products to the world. We empirically find that Chinese innovation model is very different from the mainstream catch-up model for developing countries and from the Western. POEs and startup firms are more in line with Western innovation models, but the former SOEs have more unique Chinese characteristics. This research is valuable academically and useful industrially. Our findings have implications for both Chinese policymakers (who tend to overemphasize the former SOEs in their policymaking) and for the Western firms operating in China (who pay insufficient attention to the startups as possible partners).

THEORETICAL BACKGROUND

Innovation trajectory for Latecomer firms in developing economies

Innovation trajectory of latecomer firms in developing countries is the process of moving from imitation to innovation (Hobday, 1995; Kale and Little, 2007; Kim, 1997; Lee and Malerba, 2017), or from engineering to innovation capabilities (Bell and Pavitt, 1993; Bell and Figueiredo, 2012) through reverse engineering to advanced mature technology acquiring from developed countries. This process is very different from developed countries, where firms aim to sustain, renew, and deepen innovation capabilities that already exist in the firm. Previous researches (examples, Kim, 1997; Hobday, 1995) mainly stressed that latecomers achieve technology levels of existing firms in developed countries. Just like Bell and Figueiredo (2012) denoted, however, “catching up is not just a matter of achieving static levels of higher efficiency in established firms, it is about catching up in a technologically dynamic world and creating capabilities to innovate in latecomer firms.” Hence, in recent years, more and more scholars have been paying attention to approaching the innovation frontier and capabilities upgrading for latecomer firms that have international competitive advantage in some sectors, such as Samsung and Hyundai (Guo et al., 2019; Hobday et al., 2004; Kang, 2015; Landini et al., 2016). Innovation transitions to full leadership status probably necessitates a strategic ‘mindset’ quite different from that of a firm in a catch-up mode, international brand recognition, strong marketing capabilities, control over foreign distribution channels, and substantial R&D capabilities (Hobday et al., 2004; Landini et al., 2016).

Drivers of innovation for Latecomer firms

What drives innovation of firms? There are a huge number of literature on this topic. The traditionally focal concerning
it is that innovation is pushed by technology or pulled by
the market (Lee and Sung, 2005). However, since single
dimension is very hard to explain innovation (Nelson and
Winter, 1982; Clark, 1985; Crossan and Apaydin, 2010),
comprehensive research on the linkage or interaction of
technology and market came out. The initial work was done
by Clark (1985), who argued that the pattern of innovation
is influenced by “the interaction between the internal logic
of the product and the evolution of customer requirements”.
From systematical view, drivers of innovation can be either
internal or external. Internal drivers of the innovation
process can be, available knowledge, resources, or
competence, whereas external drivers would be market
opportunities or imposed regulations (Crossan and
Apaydin, 2010). Inside firms, entrepreneurs are key drivers
of innovation (Schumpeter, 1934; Peters and Waterman,
1982) or innovation is pushed by grassroots impetuses
(von Hippel, 2007; Tzeng, 2009). Entrepreneurship is a
crucial driver of economic growth for both developed and
developing nations (Koellinger and Thurik, 2012; Vivarelli,
2013). Entrepreneurship, however, is paid little attention to
by mainstream catching up literature. Outside firms,
affiliated institutions including, university and government
R&D laboratories, serve as the engines of innovation
(Corrocher et al., 2007) and play the role that is to stimulate
and enhance the power of industry, R&D industry. In
developing countries, the government is the important
promoter and supporter of firms’ innovation (Fan, 2006;
Lee & Lim, 2001; Narayanan, 1998). According to catching
up practice of firms in late industrializing East Asian tigers
like Hong Kong, Korea, Singapore, and Taiwan. Hobday
(1995) and Kim (1997) argued that governments played a
key role in the initial stages of catching up, which is similar
to government’s role from system of innovation theory.
Particularly, competitive pressure and rivalry play an
incentive role in technological accumulation from studies of
the origins of competitiveness to the west large companies
(Porter, 1990; Bell and Pavitt, 1993). Bell and Pavitt
pointed out; “Conversely, an almost complete lack of
competitive pressures was one reason why production
units in centrally planned economies had no incentive to
develop or adopt more efficient techniques.” This can
explain why POEs are more creative and innovative than
SOEs in China.

Integrating innovation and business model for
Latecomer firms

In the internet age, business models play a vital role in the
difficult task of converting technological potentials into
economic value, business model innovation and technology
innovation are of equal importance to society (Chesbrough,
2006; Teece, 2010). Unfortunately, catching up literature
pay little attention to this topic. Openness paradigm is one
of the most important features of today’s business model.

Any enterprise is unable to own all or rely solely on internal
knowledge resources that innovation needs in the
networked world (Chesbrough, 2003). The delivery of
product/process innovation requires the employment not
just of complements, but of many inputs/components up
and down the vertical chain of production (Pisano and
Teece, 2007). Therefore, a firm’s innovation is an interactive
process involving the innovative firm and its environment
(Lundvall, 1992), need to interact between internally
produced and externally acquired knowledge resources
(Chesbrough, 2003, 2006; Grimpe and Kaiser, 2010).
Innovation management requires a tight integration of
internal and external knowledge within the firm's
innovation process to capture the positive effects on each
innovative activity (Cassiman and Veugelers, 2006). The
combination of know-how within the enterprise, between
the enterprise and organizations external to it is important
(Teece, 2007). Integrative capabilities 'sharpen' the firm
management’s attention to recognize and deploy superior
resource combinations, and enable firms to tailor external
knowledge resources to firm-specific needs and to redeploy
them within the firm. As a result, the combination of
internal and external knowledge resources will be firm-
specific, unique, and hence valuable (Grimpe and Kaiser,
2010). Better absorptive capacity can combine a company's
old knowledge and new knowledge from outside, and
transform new knowledge to apply (Cohen and Levinthal,
1990; Minbaeva et al., 2003). Business model can also serve
as a construct that creates architecture for the business
through a blend of internal and external innovation
activities (Chesbrough, 2003; Osterwalderr and Pigneur,
2010).

Transition economy, ownership of firms and
innovation under Chinese context

Transition economy was originally called planned economy,
but committed to market mechanisms through
liberalization, stabilization, and the encouragement of
private enterprise (Hoskisson et al., 2000). Firms’ growth in
transition economies are limited by institutional
constraints (Peng and Heath, 1996; Peng, 1997), and
government institutions have negative impact on
enterprise reform (Suhomlinova, 1999). Hence, in recently
years, a dozen of scholars have paid more attention to
institutions relating to latecomer catching up, the
perspective of which is called institution-based view
(examples, Li and Kozhikode, 2008; Peng et al., 2009). The
mainstream latecomer catch-up literature comes from the
newly or early industrialized economies in East and South-
East Asia with relatively mature market system, where
effective market systems and institution arrangements are
working effectively. This stream of literature, however, is
inadequate to fully direct the transition economies, where
institutions and market systems are imperfect. In developed
economies, the regulative institutions are well developed and they facilitate firm actions (Li and Kozhikode, 2008), while in transition economies they are highly regulated, transient and interventionist in nature at least during the initial years of transition (Peng and Heath, 1996). As the largest developing countries and transition economy in the world, China has quite distinctive institutional characteristics (Child and Tse, 2001). There are two main features, one is the central government has been the primary driving force of economic reform (Child and Tse, 2001), the other is the ownership presents diversity with state-owned enterprises (SOEs), collectively owned enterprises (COEs), privately-owned enterprises (POEs), and foreign-invested enterprises (FIEs) (Jiang et al., 2013; Peng et al., 2004). In particular, SOEs dominate the industries in China, which are closely tied to governments, receiving direct financial subsidies and indirect preferential treatment (Hoskisson et al., 2000). Few studies paid attention to how ownership types influence Chinese firms' choice of innovation strategy and consequently, their performance (Jiang et al., 2013). SOEs are generally less likely to innovate or take risks (Peng et al., 2004; Tan, 2002) because government investment is usually the only source of innovation investment for SOEs (Jiang et al., 2013; Mascarenhas, 1989). In addition, the compensation of SOE management is often unrelated to firm performance, which led to less R&D activities and lower innovation performance of SOEs than non-state-owned firms in China (Jiang et al., 2011; Tan, 2002). The view point is also tested in this article.

METHODOLOGY

Since existing theories are unable to satisfactorily explain the innovation practice of firms in China, we employed the method of multiple case studies.

Research Design and Process

We selected eight emerging companies from leading innovation sectors of Chinese industry, automobiles and semiconductors. Table 1 describes the eight firms studied. Apart from FAWCAR found in 1958, others were all established after 1996. They are the fast-growing, big-scale, well-performed, and domestically-branded players in their respective sectors. The reason of selecting these two industries is to increase the study’s generalizability since the automotive industry represents traditional sectors, while the semiconductor represents emerging industry sector. On the other hand, the two Chinese industries from which we selected our cases are very representative. First, automotive industry in China is the fastest-growing in the world, wherein the scale of automobile production and sales surpassed 29 million units in 2017, far ahead of the traditionally strong economies such as U.S. and Japan. All automotive MNEs in the world, such as GM, FORD, Toyota, BMW, Mercedes, and so on, have entered the Chinese market and established joint ventures locally. Secondly, China is one of the largest markets and producers of semiconductor in the world, where almost all big semiconductor companies in the world, such as Intel, Philips, Fairchild, Vishay etcetera, have established production bases, or regional R&D centers. Hence, the eight companies selected from the two industries were set up and developed under global competitive environment. Among the eight sites, four are car companies, and four are semiconductor firms. In order to improve universalities of the research, the eight cases selected were divided into three categories namely, POEs, SOEs, and startup firms. Startup firms in this article means that time of establishment is short, and full of entrepreneurship and market-orientated rather than government-orientated. Hence, of the eight cases, apart from FAWCAR and Datang, all the others are startups.

The study lasted from April 2004 till December 2017, which is based on two research projects from USA and China. One project on China's semiconductor industry funded by the Alfred P. Sloan Foundation of New York (grant #2004-3-18), was assumed by UC Berkeley team. The other, on China's automotive industry funded by Nature Science Foundation of China (grant # 71172007), was taken by Tsinghua University team. At first, the two teams did research and field work separately. From February 2010, the core team members of the two teams started collaborative research to conduct a comparative analysis, and further collected and updated data. Therefore, in this study we grouped three research sub-teams step by step, the automotive team, semiconductor team, and collaborative team.

Data Collection

We collected data from three main sources, interviews, archival documents, and direct observations. Table 2 summarizes these sources.

Interview

We conducted interviews in four different forms, structured, semi-structured, through email and telephone. The research interviews grouped two parts, automotive team by Tsinghua and semiconductor team by UCB. In total, we interviewed 143 persons, including 35 respondents from case firms and 108 from other institutes (Table2). The other institutes include, Chinese central government, universities, other research units, industry associations, and American research universities. The reason we interview other institutes is to help us better understand the two industries and to validate some of our research
Table 1: Description of the Eight Companies Studies.

<table>
<thead>
<tr>
<th>Company</th>
<th>Sector</th>
<th>Revenue in 2017 (1000 US$)</th>
<th>Ownership/Entrepreneurship</th>
<th>Listed Corporation</th>
<th>Foundation year</th>
<th>Employees in 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geely</td>
<td>Automobile</td>
<td>14,263,024</td>
<td>Private, Startup</td>
<td>Yes/HKSE</td>
<td>1997</td>
<td>80,000</td>
</tr>
<tr>
<td>BYD</td>
<td>Automobile</td>
<td>8,706,615</td>
<td>Private, Startup</td>
<td>Yes/HKSE</td>
<td>2003</td>
<td>180,000</td>
</tr>
<tr>
<td>Cherry</td>
<td>Automobile</td>
<td>15,698,997</td>
<td>SOE, Startup</td>
<td>No</td>
<td>1997</td>
<td>130,000</td>
</tr>
<tr>
<td>FAWCAR</td>
<td>Automobile</td>
<td>4,290,272</td>
<td>SOE</td>
<td>Yes/SZSE</td>
<td>2003</td>
<td>7027</td>
</tr>
<tr>
<td>Vimicro</td>
<td>Semiconductor</td>
<td>345,962</td>
<td>Private, Startup</td>
<td>Yes/NASDAQ</td>
<td>1999</td>
<td>601</td>
</tr>
<tr>
<td>VeriSilicon</td>
<td>Semiconductor</td>
<td>165,007</td>
<td>Private, Startup</td>
<td>No</td>
<td>2002</td>
<td>600</td>
</tr>
<tr>
<td>Datang</td>
<td>Semiconductor</td>
<td>410,256</td>
<td>SOHC</td>
<td>Yes/SHSE</td>
<td>1998</td>
<td>2636</td>
</tr>
<tr>
<td>SMIC</td>
<td>Semiconductor</td>
<td>3,101,175</td>
<td>SOHC, Startup</td>
<td>Yes/HKSE, NYSE</td>
<td>2000</td>
<td>17967</td>
</tr>
</tbody>
</table>


assumptions/propositions. Semiconductor team interviewed 71 persons, of which, 18 are Professors at UC Berkeley or consultants and executives in the U.S. The main purpose of interviewing the USA experts is to understand the state and trend of the semiconductor industry so that we can research China's semiconductor sector better. The automotive team conducted interviews with 72 persons, of which 27 are executives or senior managers from our sample firms listed above, and the others are from Universities, national research institute, Ministries of central government in China. Each interview lasted typically 60-100 minutes in length. In addition, we interviewed 30 respondents by telephone and emails to expend on questions in details. After analysis and filtering, nearly 90 percent of interview data that are credible were transformed into the case study database.

Archival documents

For data triangulation purposes, we collected 80 internal archival documents from eight case sites. These documents include annual reports, corporate development strategies, business plans, CEO's reports, historical sales and avenue collateral materials. We also collected more than 120 public documents pertaining to the eight case firms or the two industries, including press releases, statistical yearbooks, industrial research reports, and journal articles. These documents are very useful and helpful for us to examine and retrospect the interviews to remove some bias.

DATA ANALYSIS FINDINGS

Innovation trajectory

Innovation is a process from idea generation to commercialization. Hence three measures served for this examination:

1. initial source of technology
2. innovation path
3. market performance.

Initial source of technology means: where to get technology during the start of a firm, that is, technology starting point. We evaluated it by acquiring mature advanced technology from the developed countries or self-owned technologies by R&D.

Innovation path was defined: as the way by which a company realized innovation, this is put into four specific questions, incremental or radical innovation, and from imitation to innovation, from in-house R&D, and collaborative development.

Market performance are: the results of a firm’s innovation activities, which is evaluated in this article by domestic and international market share of a firm products. The more international market share, the stronger the innovation capabilities. The data indicates that innovation trajectories show diversities between the two sectors. Table 2 summarizes the findings. Regarding initial source of technology, in automotive sector, apart from Geely, other firms got some or whole initial technologies through acquisition. Only FAWCAR obtained its technology through joint venture with Mazda, a Japanese car maker.
Table 2: Innovation trajectories.

<table>
<thead>
<tr>
<th>Company</th>
<th>Initial source of technology</th>
<th>Innovation path</th>
<th>Market performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geely</td>
<td>Technological decomposition learning, no any technology acquisition but senior skilled people</td>
<td>From imitation to innovation, in-house and joint R&amp;D, external collaboration, Merge to VOLVO</td>
<td>24.1% of market from foreign countries</td>
</tr>
<tr>
<td>BYD</td>
<td>M&amp;A to domestic low-end carmaker; R&amp;D on alternative energy vehicles</td>
<td>From imitation to innovation in mechanic system; in-house R&amp;D in EV.</td>
<td>4.9% of market from foreign countries</td>
</tr>
<tr>
<td>Chery</td>
<td>Acquisition from four foreign auto MNEs</td>
<td>From imitation to innovation; in-house and joint R&amp;D</td>
<td>31.3% of market from foreign countries</td>
</tr>
<tr>
<td>FAWCAR</td>
<td>Acquisition from Audi, Joint venture with Mazda</td>
<td>Outsourcing R&amp;D, less in-house R&amp;D</td>
<td>0.6% of market from foreign countries</td>
</tr>
<tr>
<td>Vimicro</td>
<td>Own technology embedded in Entrepreneurs and founders from Silicon Valley</td>
<td>Mainly in-house R&amp;D and external collaboration</td>
<td>70% of our chip (design) customers are from foreign countries</td>
</tr>
<tr>
<td>VeriSilicon</td>
<td>Merge a former American company, Celestry Design Technologies, Inc.</td>
<td>In-house R&amp;D, M&amp;A such as from Digital Signal Processor Division ZSP® of LSI Logic Corp. (NYSE: LSI)</td>
<td>90% of revenues come from abroad</td>
</tr>
<tr>
<td>Datang</td>
<td>From China Telecommunications and Science Institute, its largest shareholder</td>
<td>In-house R&amp;D and external collaboration such as Texas Instruments, Beijing University of Posts and Telecommunications</td>
<td>nearly 100% revenue from domestic market</td>
</tr>
<tr>
<td>SMIC</td>
<td>Acquisition and own technology embedded in its core engineers</td>
<td>In-house R&amp;D and external collaboration, M&amp;A to a Chinese firm and a factory of IBM</td>
<td>90% of revenues come from abroad</td>
</tr>
</tbody>
</table>

BYD, backed by American billionaire Warren Buffett, a leader of electronic vehicle in China, got traditional car technology through merging a small car company in China, while its EV product line by its own technology from in-house R&D. Geely, which acquired 100% of Volvo from Ford Motor Company in 2010, is very different in initial technology from other Chinese car companies, most of which through acquisition or joint venture. Geely got its initial technology through technological decomposition learning, just like learning model of Korean automaker Hyundai described by Kim (1997). Although initial source of technology of the four case firms shows diversity in semiconductor sector, compared to automotive sector, they depend on more of their own technologies. The topical firm is Vimicro, whose initial technologies were embedded in entrepreneurs and founders from Silicon Valley. Before returning to China to build Vimicro, these talented people had been working in Silicon Valley semiconductors companies for many years. Datang, a state-owned holding company, got its initial technology from its largest shareholder, China Telecommunications and Science Institute. SMIC’s technology started from both acquisition and own technology embedded in its core engineers, while Veri Silicon totally through merging a former American company, Celestry Design Technologies, Inc. As for the innovation path, automotive firms followed the path from imitation to innovation, step by step, and gradually mastered the automotive key technology. This fact is consistent with mainstream catch up model. However, BYD is a special case. The company meets this model in its traditional car on the one hand, for instance, the structural system of BYD F0 imitated the Toyota Aygo, while F3 imitated
Corolla. As for clean vehicle system, BYD does not meet this model, for instance, its EV integrated international advanced battery technology was made by its own in-house R&D and realized technologically radical innovation. Other three cases of car firms, apart from FAWCAR, have finished radical technology in engine and transmission after ten years of incremental innovation. FAWCAR has been mainly dependent on outsourcing R&D with less in-house R&D. While comparing the two sectors, we found a rule that firms whose initial technology come from itself and startups attached great importance to internal R&D activities. The typical example is Vimicro. Mastering the growing demand for mobile, networked, multimedia content and communications, Vimicro started from the research and development of advanced mixed-signal multimedia chips. The company has successfully launched a series of products into domestic and international markets, targeting fast-growing application fields such as computer, broadband, mobile communication, and consumer electronics. Vimicro's chip solutions have been adopted by multinational companies such as Sony, Samsung, HP, Philips, Fujitsu, Logitech, Lenovo, Bird and ZTE. On March 11, 2001, Vimicro released the first chip product, an advanced imaging processor for PC USB camera market. The chip was successfully adopted by Samsung and Philips in their system designs. In April 2002, Vimicro's second chip product, a new generation PC USB camera processor with integrated audio and video processing was released. It was later adopted by leading PC USB camera vendors such as HP, Creative and Logitech. Vimicro's forth chip product, Vimicro's mobile camera processor, successfully landed in US market in February 2003. It was adopted by Sprint PCS in their "Vision" handsets for mobile multimedia application. And on April 1, 2008, Vimicro announced that it has shipped more than 5 million VC0336 web camera embedded processors, the most advanced web camera processor in the market, for high-end notebook PCs. After analyzing market performance data, we found that SOEs are prone to domestic market, while POEs and startup firms to international or global markets. In automotive sector, Chery and Geely are the first two companies of China in car exportation, Chery exported 88,081 units and ranked first in China, its ratio of exports for total sales were 17.4%. Geely Auto sales in 2017 reached 1.24 million units, they exported only 6,500 cars in 2006 but increased to 100,000 cars in 2012 and also shows 164% year to year growth. Geely forecast vehicle sales of 1.58 million units this year, up 27 percent from 1.25 million vehicles in 2017. This would mark a slowdown from 63 percent growth last year. Geely’s export volume, however, dropped to 46 percent last year. BYD’s innovation embodies its clean energy vehicles, whose battery buses have been introduced into markets in developed countries such as the USA, Japan, England, and Australia, since 2014. In semiconductor sector, apart from Datang, revenue of other firms mainly comes from abroad. The CEO of Vimicro, John Deng, can supported this view with the quote “More than 70% of Vimicro's market is from international customers, Vimicro has an advantage in competing globally. In China, a lot of SOEs have government protected channels for their products, so it is not easy to enter that market. On the other hand, Vimicro does not feel the need to focus on the domestic market since it already has the power to race globally”. VeriSilicon’s Chairman and CEO, Wayne Dai has a different reason for his firm’s outward focus. "We have two kinds of customers, design and foundry. 70% of our chip (design) customers are from foreign countries. We wish we could have more Chinese firms as customers, but they not all mature enough". In particular, 90% of SMIC’s revenues come from abroad. Mr. Calvin, Chin of SMIC told us, "many of the company’s customers today are integrated device manufacturers (IDMs)! This includes Toshiba, TI, Infineon, Samsung and ST". Through comprehensive analysis of the eight case firms, we got four findings, firstly, that not all firms are consistent with mainstream catch up model, some of them did not acquire advanced technology form developed countries or followed by the path from imitation to innovation, they started innovation by their own technology and in-house R&D. Secondly initial technology come from itself and startups attach great importance to internal R&D activities. Thirdly, startup firms are particularly valuable contributors for more radical technology innovations, while the former SOEs labor under a variety of constraints that make them slower to adopt these new innovations, the fourth is that SOEs are prone to domestic market, while POEs and startup firms to international market. In formal terms, the findings suggest the following:

**Proposition 1a:** Latecomer firms in developing economies may start innovation without acquiring advanced technology from developed countries that is emphasized by mainstream catch up model innovation in China presents a hybrid model unlike Kim and Hobday’s ones.

**Proposition 1b:** The startup firms are particularly valuable contributors for more radical technology innovations, while the former SOEs labor under a variety of constraints that make them slower to adopt these new innovations.

**Proposition 1c:** The former SOEs concentrate predominately on the Chinese market, while the POEs and startup firms utilize China as an export platform to sell to the world.

**Drivers of innovation**

From previous research, we can conclude that drivers of firms’ innovation include four main elements, market, technology, entrepreneur, and government. However, there is a gap in the existing literature, which is whether the four driving forces have the same role to play in innovation, or which one is bigger? According to research questions of this
<table>
<thead>
<tr>
<th>Company</th>
<th>Absorptive capacity</th>
<th>Combinative capabilities</th>
<th>Value proposition/market scope</th>
<th>Key resources and capabilities</th>
<th>Innovation ecosystem</th>
<th>Openness paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geely</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 4.6%</td>
<td>Strong; both technological and organizational; international orientation of integrative management</td>
<td>Economic car; international market orientation “Let Geely cars run all over the world” (the company’s vision)</td>
<td>Entrepreneurship, quick market response; low-cost; management mechanism comparing with SOEs</td>
<td>International supply chain and collaborative network</td>
<td>Fully open</td>
</tr>
<tr>
<td>BYD</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 5.5%</td>
<td>Strong; both technological and organizational; international orientation of integrative management</td>
<td>Economic and environment friendly vehicle; Objective customers for EV is mainly group ones: taxi and public bus; Mostly domestic, but global orientation in EV.</td>
<td>Entrepreneurship, management mechanism comparing with SOEs; advanced R&amp;D in EV</td>
<td>International supply chain and collaborative network</td>
<td>Fully open</td>
</tr>
<tr>
<td>Chery</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 4.2%</td>
<td>Strong; both technological and organizational; international orientation of integrative management</td>
<td>Economic car, medium-size car; both domestic and international market orientation</td>
<td>Entrepreneurship, management mechanism comparing with the former SOEs</td>
<td>International supply chain and collaborative network</td>
<td>Fully open</td>
</tr>
<tr>
<td>FAWCAR</td>
<td>Mainly depend on outsourcing, inactive in-house R&amp;D efforts; R&amp;D intensity is 4.2%</td>
<td>Very weak; domestic orientation of integrative management</td>
<td>High-end car; Domestic market orientation</td>
<td>Government relationship</td>
<td>Domestic supply chain and collaborative network</td>
<td>Semi-open</td>
</tr>
<tr>
<td>Vimicro</td>
<td>Continuous and very active in-house R&amp;D efforts; R&amp;D intensity is 20.9%</td>
<td>Strongest; both technological and organizational; global orientation of integrative management; integrate external advanced knowledge and talent through its distinct advanced product platforms.</td>
<td>Global market orientation</td>
<td>Entrepreneurship, core team from Silicon Valley, core technology and R&amp;D; international-level management</td>
<td>Global supply chain and collaborative network</td>
<td></td>
</tr>
<tr>
<td>VeriSilicon</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 12.1%</td>
<td>Stronger; both technological and organizational; global orientation of integrative management; After merging at the beginning, absorb and integrate external advanced knowledge and talent through its distinct advanced product platforms.</td>
<td>Global market orientation</td>
<td>Entrepreneurship, core team from Silicon Valley, R&amp;D, global supply chain and collaborative network, international-level management</td>
<td>Global supply chain and collaborative network</td>
<td></td>
</tr>
</tbody>
</table>
Table 3:

<table>
<thead>
<tr>
<th>Company</th>
<th>Continuous and very active in-house R&amp;D efforts; R&amp;D intensity is</th>
<th>Relatively Strong; both technological and organizational; domestic orientation of integrative management; form absorptive capacity though its core technology TD-SCDMA.</th>
<th>Government relationship, core technology, R&amp;D</th>
<th>Mainly domestic supply chain and collaborative network; government orientation</th>
<th>Semi-open</th>
</tr>
</thead>
<tbody>
<tr>
<td>Datang</td>
<td>10.6%</td>
<td>Domestic market oriented</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMIC</td>
<td>11%</td>
<td>Strong; both technological and organizational; global orientation of integrative management;</td>
<td>Both global and domestic market orientation</td>
<td>Strong</td>
<td>Global supply chain and collaborative network</td>
</tr>
</tbody>
</table>


article and the fact that China is in the transition period from planned to market economy, we measured the driving force in three dimensions (see Table 3), entrepreneur, government and competitive pressure. We used numbers from one to five to express the magnitude that the four dimensions affect innovation. The higher the number, the greater the magnitude. Table 3 summarizes the findings from each studied site. The data indicates the degree of difference in their impacts on innovation. The entrepreneur is the strongest driving forces to POEs and startup firms such as Chery, while weaker to FAWCAR. This finding challenges Schumpeterian view that entrepreneur is the soul of innovation and other western belief that leaders create innovative culture by having a clearly stated, attainable, valuable shared vision (West, 1990). The best example that entrepreneur drive innovation is Geely, a first Chinese private automotive company that broke through the government regulation in auto industry. When Li Shufu, Chairman of both Geely and Volvo Car Corporation, planned to enter the car industry, his family and many friends opposed the idea. However, he still insisted saying: “I have decided it, even if it is bankruptcy, badly beaten, I will have a try!” Actually, as a successful entrepreneur, Li Shufu is very sensitive to market and industry change, just like he said: “We do everything that we can do.” In 1997, Geely was built and proposed its mission: “make cars that common people can afford, get Geely cars running all over the world.” Why did Geely propose the mission? In China at that time, cars were deified, and ordinary people were unable to afford a car. There was no traditional car company, just like FAWCAR, to think about making cars for ordinary people, but Li Shufu wanted to reduce the price sharply. That time, the lowest price of domestic car (Xiali) was $13,000, while the lowest price of foreign brand was $20,000. In 1997, GDP per capita in China did not reach $1,000. Thus, Geely priced its first car at $5,000. This is a price that made hundreds of thousands of ordinary people excited. From then, ordinary Chinese families were able to afford cars. Consequently, other brand cars followed suit by reducing their prices. Especially, foreign car price gradually returned to reasonable range of price. Among the eight sites, impact degree of competitive pressure is also different, which is very similar to the entrepreneur. POEs and startups pay much more attention to market competition and rivalry and respond to market much more quickly than the former SOEs. As the first carmaker and the biggest carmaker 20 years ago in China, FAWCAR lacked sense of market competition. As a result, its production scale and innovation capabilities have been surpassed by many newentrant firms such as Geely, Chery, and BYD. FAWCAR was founded in 1958, a total SOEs until 1997, when it became a listed company. Although ownership structure has changed, FAWCAR’S big shareholder is a whole SOE. In China’s today distinctly institutional environment, management system and regime of state-owned holding company (SOHC) has no difference from complete SOEs. This can also explain why Datang with SOHC system has less sense of market competition than other case firms in semiconductor sector. One of the reasons is
probably their revenues come from much more government purchasing. For instance, high-end cars used by central government top leaders and ministers are FAWCAR brand. The comment during interview from John Deng, CEO of Vimicro, can also support this view: “More than 70% of Vimicro’s market is from international customers, Vimicro has an advantage in competing globally. In China, a lot of SOEs have government-protected channels for their products, so it is not easy to enter that market. On the other hand, Vimicro doesn’t feel the need to focus on the domestic market since it already has the power to race globally.” The other reason probably is what Jiang et al. (2011) and Tan (2002) argued that the compensation of SOE management is often unrelated to firm performance, which led to less R&D activities and lower innovation performance of SOEs than non-state-owned firms in China. Regarding Datang, one of our interviewees, Mr. Xu Xiao Tian, general secretary of the Chinese Semiconductor Association, a high position under the Ministry of Information Industry (MII) said:

“Datang is number one (among Chinese design houses) at ¥1 billion RMB, but this revenue was provided by the central economy, not by global markets. For example, they receive government orders for SIM cards for cell phones, they are really very weak. Support of a weak player may not be the best investment to bolster the global competitiveness of Chinese industry in the long run, unless that weakness can be turned to strength”. As for Chery, a passenger car company with totally SOEs system, although its sense of market competition is lower than other POEs but higher than FAWCAR and Datang. This special phenomenon maybe comes from the company building background and different running mechanisms from other SOEs. The company was set up under the intention of the local government in Wuhu City, Anhui Province, who was actively committed to develop local economy and gave Chery’s CEO and executive team all kinds of autonomy from decision making to operation. Just like Yin Tongyao, Chery’s CEO told us: “the government only concern supporting us, other things are decided by us.” Chery surpassed FAW(a former SEO China’s No.1 automaker then) in passenger car sales in 2004 and became the largest domestic carmaker in China. This case maybe show us the role to firms’ innovation is different between local and central government in China. Chery’s example also presents a different role to firms’ competition and innovation from the west, in that case, the government plays a far more active role in China. Chinese government policies to innovation are not monolithic. There are differences at the national level between ministries, such as rivalry between the Ministry of Industry and Information, and the Ministry of Science and Technology. These ministries differ on the policies they promote and the companies they support. There are also differences between the national and local governments. So startup firms neglected by the national government have recourse to support from provincial bodies, even cities like Shanghai. Yin Tongyao described the cause of Chery growth: “From the very beginning till now, there has been no support from local government, there was no Chery. Several years later, we obtained the financial support of the Central Government, especially when we met business and financial crisis in 2004.”

The government’ drive for innovation not only reflected in SOEs, but also in private firms. For example, Vimicro, a China’s star design house, which has a 60% global market share in PC multimedia chips, was founded 1999 in Beijing by several entrepreneurs from Silicon Valley, an elder among the IC design firms. Although Vimicro is a listed company in Nasdaq, it gained initial supports from the Ministry of Information Industry (MII) of China and Beijing Municipal Government. The company’s “Star Chip Project in China” has acquired great grants from the Central Governments. Of course, the company also raised venture capital in Silicon Valley, and the majority of their sales are exported from China to global markets. In 2005, less than 10% of Vimicro's production was sold in China. When speaking of the success of Star Chip, John Deng, CEO of Vimicro, concluded thus: “Silicon Valley model + government support model is the key to success”. Notwithstanding, the government has active role in firm innovation in China, we should raise at least a couple of important points. First, Chinese government innovation policy in the 1990s utilized joint ventures between SOEs and Western companies to inject foreign technologies into the Chinese automotive and semiconductor industries. The Western companies were effectively trading market access to China for investing money and technology in China. By the early 2000s, it became however clear that many of these JVs were not at the leading edge of technology. By contrast, newly entering startup firms that lacked strong government support at the outset were achieving significant technological breakthroughs and gaining market strength. Only then did Chinese government policy begin to embrace startup firms like Geely and BVD as well as Chery. Geely and Chery had been planning to enter the car-making industry for five years, but not until 1997 did the central government approve their projects.

A comparison of the two groups of SOEs and POEs indicates three findings, which present a different role to firms’ competition and innovation from the west, in that the government plays a far more active role in China. First, the strength of the three drivers to innovation is very different between SOEs and POEs. One of reasons is that the two kinds of enterprises have different organizational regime and institutional system. Second, government support SOEs much more than POEs, which may lead to lack of entrepreneurship and sense of market competition in SOEs. Third, entrepreneur and competitive pressure play much greater roles in POEs than SOEs but Chery. Although Chery’s sense of market competition is a little lower than other POEs and startup firm, but much higher than FAWCAR and Datang. Table 3 summarizes the influence magnitude of innovation driving force. Chery’s case tells us that there are
### Table 4: Integrative innovation and business model.

<table>
<thead>
<tr>
<th>Company</th>
<th>Integrative capabilities</th>
<th>Business model</th>
<th>Key resources and capabilities</th>
<th>Innovation ecosystem</th>
<th>Openness paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geely</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 4.6%</td>
<td>Strong; both technological and organizational; international orientation of integrative management</td>
<td>Economic car; international market orientation “Let Geely cars run all over the world” (the company’s vision)</td>
<td>Entrepreneurship, quick market response; low-cost; management mechanism comparing with SOEs</td>
<td>International supply chain and collaborative network</td>
</tr>
<tr>
<td>BYD</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 5.5%</td>
<td>Strong; both technological and organizational; international orientation of integrative management</td>
<td>Economic and environment friendly vehicle; Objective customers for EV is mainly group ones: taxi and public bus; Mostly domestic, but global orientation in EV.</td>
<td>Entrepreneurship, management mechanism comparing with SOEs; advanced R&amp;D in EV</td>
<td>International supply chain and collaborative network</td>
</tr>
<tr>
<td>Chery</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 4.2%</td>
<td>Strong; both technological and organizational; international orientation of integrative management</td>
<td>Economic car, medium-size car; both domestic and international market orientation</td>
<td>Entrepreneurship, management mechanism comparing with the former SOEs</td>
<td>International supply chain and collaborative network</td>
</tr>
<tr>
<td>FAWCAR</td>
<td>Mainly depend on outsourcing, inactive in-house R&amp;D efforts; R&amp;D intensity is 2.3%</td>
<td>Very weak; domestic orientation of integrative management</td>
<td>High-end car; Domestic market orientation</td>
<td>Government relationship</td>
<td>Domestic supply chain and collaborative network</td>
</tr>
<tr>
<td>Vtimicro</td>
<td>Continuous and very active in-house R&amp;D efforts; R&amp;D intensity is 20.9%</td>
<td>Strongest; both technological and organizational; global orientation of integrative management; integrate external advanced knowledge and talent through its distinct advanced product platforms.</td>
<td>Global market orientation</td>
<td>Entrepreneurship, core team from Silicon Valley, core technology and R&amp;D, international-level management</td>
<td>Global supply chain and collaborative network</td>
</tr>
<tr>
<td>VeriSilicon</td>
<td>Continuous and active in-house R&amp;D efforts; R&amp;D intensity is 12.1%</td>
<td>Stronger; both technological and organizational; global orientation of integrative management; After merging at the beginning, absorb and integrate external advanced knowledge and talent through its distinct advanced product platforms.</td>
<td>Global market orientation</td>
<td>Entrepreneurship, core team from Silicon Valley, R&amp;D, global supply chain and collaborative network, international-level management</td>
<td>Global supply chain and collaborative network</td>
</tr>
</tbody>
</table>
differences in policies to innovation between the national and local governments. In formal terms, these findings can be summarized in three propositions:

**Proposition 2a:** The government plays a far more active role to firms’ competition and innovation in China than the West, which leads to different competitive behaviors and innovation performance between POEs, startups, and SOEs.

**Proposition 2b:** POEs and startups pay more attention to market competition and rivalry and respond to market quicker than the former SOEs.

**Proposition 2c:** POEs and startups are full of entrepreneurship, while the former SOEs lack it. This is mainly due to government supporting SOEs greater than private companies. We measured integrative innovation in two dimensions, integrative capabilities and business model. Integrative capabilities are evaluated by absorptive capacity (Cohen and Levinthal, 1990; Kim, 1997, 1999) and combinative capabilities (Kogut and Zander, 1992). We evaluated absorptive capacity of firm through prior knowledge base and intensity of in-house R&D. We insight to combinative capabilities from both technological and organizational dimensions, external and internal perspectives. synthesizing arguments of Chesbrough (2006), Johnson, Christensen and Kagermann (2008), Osterwalder and Pigneur (2010), and Teece (2010), business model assessment was based on customer value proposition and market scope, key resources and capabilities, innovation ecosystem, and openness paradigm. Considering open innovation is a process of outside-in and inside-out activities (Chesbrough, 2003; Chesbrough, 2012), we evaluate openness paradigm from fully open and semi-open perspectives. Most of latecomer firms in developing countries only implement and perform out-inside activities of open innovation, that is, semi-open innovation. This lead to the three firms having strong absorptive capacity and further strong combinative capabilities. By contrast, the R&D intensity of FAWCAR which has been mainly dependent on outsourcing is only 2.3% and its in-house R&D is very inactive. The main reason is that FAWCAR is a typically old SOE, running under the mechanism and regime of government management and lacking market system. This governmental-orientation system also leads to the combinative capabilities of FAWCAR which are much weaker with domestic orientation of integrative management than that of other case firms. The combinative capabilities of Geely, BYD, and Chery are very strong in both technological and organizational, internal and external with international orientation of integrative management. In contrast with automotive group cases, semiconductor firms have much stronger integrative capabilities. Their in-house R&D intensity all surpassed 10% on average from 2011 to 2017, having achieved the level of the automotive MNEs in developed countries products such as Ford, VW, BMW, and Toyota etc., the index of which ranges around 4.5%. This lead to the three firms having strong absorptive capacity and further strong combinative capabilities. By contrast, the R&D intensity of FAWCAR which has been mainly dependent on outsourcing is only 2.3% and its in-house R&D is very inactive. The main reason is that FAWCAR is a typically old SOE, running under the mechanism and regime of government management and lacking market system. This governmental-orientation system also leads to the combinative capabilities of FAWCAR which are much weaker with domestic orientation of integrative management than that of other case firms. The combinative capabilities of Geely, BYD, and Chery is 4.6%, 5.5%, and 4.2% respectively on average from 2011 to 2017, having achieved the level of the automotive MNEs in developed countries products such as Ford, VW, BMW, and Toyota etc., the index of which ranges around 4.5%.
knowledge through its distinct advanced product platforms technologically and organizationally with a global orientation of integrative management. Comparatively in this group, Datang’s R&D intensity is 11% and its combinative capabilities are relatively strong with domestic orientation of integrative management, while other three semiconductor firms are globally orientated. Just like FAWCAR, this comes from Datang’s system of SOE. As for business model, the two groups are different. Automotive companies business models are mainly based on vertical integration, while semiconductor firms’ are dominated by horizontal integration. This is largely caused by technological paradigm (Dosi, 1982). In general, of the eight firms, business model of FAWCAR and Datang are governmentally and domestically orientated, and less articulable than the other six. John Deng, Chairman and CEO of Vimicro described semiconductor companies in China, “A lot of these firms actually don’t know anything about business models. They do not have earlier (overseas) experiences”. Value proposition/ market scope and innovation ecosystems of FAWCAR and Datang are mainly domestic orientation, particularly in supply chain and collaborative network, while the other three auto car makers are international and the other three semiconductor firms are global. For instance, Geely has a DSI automatic transmission R&D center and manufacturing factory in Australia, one vehicle R&D center in Gothenburg, Sweden. It has vehicle manufacturing sites in Egypt, Uruguay, Russia, Ethiopia, Ukraine, Belarus and Sri Lanka with nearly 540 sales and service outlets in 43 foreign countries. Regarding openness paradigms, of the eight cases, both FAWCAR and Datang are semi-open, while others fully open. Particularly, the two firms lack entrepreneurship, while others are full of entrepreneurship and adventurous spirits. In particular, headquarter office in FAWCAR and Datang can hardly see foreign employees, while in other case firms, there are many top and senior managers and R&D faculty working with domestic employees. SMIC’s Calvin Chin offers an inside view into what it is like to work in China’s SI with the statement, “Our company has 7,814 employees as of May 2005, 14% are from abroad”. Two typical case firms are analyzed as follow, Vmircro, BYD and Chery. Vimicro is very open to companies who based itself on core technological competence. Most of the company’s founders and key employees have overseas working experience, typically in Silicon Valley. Six of seven members of the Board of directors ever studied and worked in the U.S, and so did five of six members of top management team. The company attaches great importance to external cooperation, building network or ecosystem of innovation. Only several months of its establishment, Vimicro launched its subsidiary in Silicon Valley in January 2000, followed with branch offices in Shanghai, Shenzhen and Hong Kong. In November 2000, Tsinghua-Vimicro Microelectronics Research Center was established in Tsinghua University which is on the top of universities in China. President of Chinese Academy of Science ,Zhou Guangzhao, was appointed as the honorary Director, with John Deng as Chairman and CEO of Vimicro, as the Director. In January 2002 Vimicro and Microsoft signed a memorandum in Beijing to collaborate on promoting digital multimedia technologies in worldwide market. Vimicro PC multimedia chips achieved WHQL certification for Microsoft Windows XP platform, the first among Chinese chip vendors. In September 2003 Microsoft-Vimicro Multimedia Technology Center was established in Beijing to develop next generation digital multimedia technologies and applications. The strategic partnership between the two companies entered a new era related government authorities /National standard committees. In February 2004, Vimicro joined Mobile Industry Processor Interface (MIP) Alliance as the first Chinese chip vendor. With its strategic vision and technology, Vimicro has successfully launched a series of products into domestic and international markets, targeting fast-growing application fields such as computer, broadband, mobile communication, and consumer electronics. Vimicro’s chip solutions have been adopted by multi-national companies such as Sony, Samsung, HP, Philips, Fujitsu, Logitech, Lenovo, Bird and ZTE. Vimicro successfully completed its initial public offering on the Nasdaq Security Market on November 15th, 2005, becoming the first fabless chip company from China listed in Nasdaq. The second typical example is BYD, a listed company in Hong Kong Stock exchange. The company has advanced technology of all-electric cars in the world. In April, 2010 in Los Angeles, BYD North American headquarters was established. This was the first Chinese company to build its headquarter in the U.S. On May 27, 2010, in Beijing, BYD and Daimler signed a 50:50 joint-venture agreement. The two sides will set up a R&D joint-venture that will engage in R&D of electronic vehicle (EV), planning to launch a new electric car by 2016, and to be the first Chinese company to market alternative energy-powered vehicles in Europe. Very different from other joint ventures in China, Mercedes-BYD joint ventures’ partners are both technology exporter, and the new products will be neither Mercedes-Benz nor BYD brand but a new brand. Before this, all the automotive joint ventures in China were producing and selling foreign-brand vehicles such as VW, BMW, GM, Ford, Toyota, etc. Currently, BYD has branches or offices in America, Europe, Africa, Japan, Korea, India, Taiwan and Hong Kong and has 6 oversea manufacturing sites (Lancaster, US; Rostov, Russia; Baghdad, Iraq; Cairo, Egypt; Khartoum, Sudan; Chennai, India) and 13 oversea offices or service centers. BYD set up R&D systems at the beginning of its establishment. In a few years, it exceeded the traditional big auto makers in China in many fields of R&D such as organizational structure, process, project management, and R&D input and output. In the year 2008, the R&D input intensity of BYD was 13.9%, while the intensity of traditional top three was, FAW, SAIC, and Dongfeng was 1.6%, 3.0% and 1.4% respectively. On May
12, 2010, Business Week released its latest annual Tech 100 List. BYD, for the first time, earned the Number 1 spot among tech’s top performing companies. Being the big winner, BYD even outperformed Apple, who is Number 2 on the list.

To summarize this part, apart from FAWCAR, the other seven companies paid more attention to in-house R&D, integrating internal and external knowledge. But unfortunately, Datang and FAWCAR are domestic-market- and government-oriented, particularly in supply chain and collaborative network, while Chery and Verisilicon lacked the support of capital market. The other three auto car makers are internationally orientated and the other three semiconductor firms are globally. Regarding openness paradigms, of the eight cases, both FAWCAR and Datang are semi-open, while others fully open. Particularly, the two SOE firms lack entrepreneurship, while others are full of entrepreneurs and adventurous spirits. In formal terms, the findings suggests the following:

**Proposition 3a:** startups and POEs pay more attention to in-house R&D, integrating internal and external knowledge with fully open innovation, while the former SOEs are inactive in in-house R&D with much less integrative capabilities and semi-open innovation.

**Proposition 3b:** startups and POEs are far more globally connected and more globally oriented with regard both to technology and to markets served, while the former SOEs are domestic-market and governmental orientation.

**Proposition 3c:** startups and POEs that show greater imagination and risk-taking behavior are particularly valuable contributors for new business models, while the former SOEs follow traditional approaches to defining their business model under a variety of constraints that make them slower to adopt new business models.

**DISCUSSION AND IMPLICATIONS**

**Innovation model of firms in Chinese context**

The method of theory building from cases emphasizes theory exploration (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 2009). Using this method, we got findings from interviews and secondary data presented in Table 2. These findings revealed different innovation model of firms in China from mainstream catch up model from NIEs such as Korea, Hong Kong, Taiwan, and Singapore, etc. as well the West. Mainstream catch-up model argued that latecomers from developing countries must start their business and build technology capabilities from acquiring mature technologies in developed countries through reverse engineering, rather than product innovation (Kim, 1997; Hobday, 1995). The trajectory of technology innovation of latecomers is a process from imitation to innovation (Kim, 1980, 1997). Our finding, however, shows that not all firms are consistent with mainstream catch up model, some of them such as BYD in EV, Viricom, and Datang, did not acquire advanced technology from developed countries followed by the path from imitation to innovation. They started their business from their own cutting-edge or core technology through in-house R&D rather than reverse engineering. This validates our previous judgment that mainstream catch up theory form eastern and south-east small-scale economies is inadequate to larger economies such as China. Another difference is the type of technology acquisition. Acquired technology in mainstream catch up literature refers to physical technology, while it also includes technology and knowledge embedded in talented people in China’s startups. For instance, in Chery, Geely, Vimicro, and Verisilicon founders, many expert staff and top managers are Chinese returning from Detroit or Silicon Valley in the U.S. This can explain why Chinese startup firms did not acquire advanced technology from developed countries to start up their business and innovation journey. In contrast to the Western innovation model, our findings also show that Chinese model is very different. On the one hand, the entrepreneur is the strongest driving force to POEs and startup firms, while weaker to the former SOEs. This finding challenges Schumpeterian view that entrepreneur is the soul of innovation and other western belief that leaders create innovative culture by having a clearly stated, attainable, valuable shared vision (West, 1990). On the other hand, the government plays a far more active role in firms’ competition and innovation in China than the West, which leads to different competitive behaviors and innovative performance between POEs, startups, and SOEs. POEs and startups are full of entrepreneurship and have stronger sense of market completion, as a result, they have obtained good innovative performances and entered global markets. This finding is consistent with Hobday (1995) and Kim (1997a) opinions that governments played a key role in the initial stages of catching up. It is excessive government support and rigid bureaucracy that makes the former SOEs in China lack innovation motivations and vitality, and competitive pressure. Government-orientated management generates two kinds of enterprises, have different organizational regime and institutional system. This finding follows and develops catch up literature of institution based view emerging in recently years, which was paid less attention by mainstream catch up scholars. This kind of literature argued that SOEs are closely tied to governments, receiving direct financial subsidies and indirect preferential treatment (Hoskisson et al., 2000), and generally less likely to innovate or take risks (Peng et al., 2004; Tan, 2002). In addition, the compensation of SOE management is often unrelated to firm performance, which led to less R&D activities and lower innovation performance of SOEs than non-state-owned firms in China (Jiang, Gong, and Wei, 2011; Tan, 2002).

This article, different from mainstream catch up
literature, analyzed and discussed business model and open innovation in the eight case firms. The two theories originated from the West, but ignored by mainstream catch-up literature. Business models commercialized new ideas and technologies through their business models (Chesbrough, 2010), which play a vital role in the difficult task of converting technological potentials into economic value, business model innovation, or new business models and technology innovation are of equal importance to society (Chesbrough, 2006; Teece, 2010). Teece (2010) denoted that, “Increased understanding of the essence of business models and their place in the corpus of the social and organizational sciences should help our understanding of a variety of subjects including market behavior, competition, innovation, strategy and competitive advantage.” Our findings from the eight case firms validate the importance of business model. Startups and POEs that show greater imagination, risk-taking behavior and better innovation performance embrace new business models, while the former SOEs follow traditional approaches to define their business model under a variety of constraints that make them slower to adopt new business models.

Our findings also shows that open innovation is important to latecomer firms in developing countries, which is consistent with Chesbrough (2003, 2012). We have developed the explanatory power of open innovation theory in this study. In order to explain the reason why most of Chinese traditional big automotive makers which are all SOEs have been very open to acquire developed countries’ technology for more than half century but their technology capabilities are still very weak, we divide openness paradigm into two parts namely, fully open and semi-open. These firms only implement and perform out-side activities of innovation, that is, semi-open innovation. Regarding the eight cases firms, both FAWCAR and Datang are semi-open paradigms with weak absorptive capacity and combinative capabilities, while others are fully open with strong integrative capabilities. In addition, startups and POEs are far more globally connected and more globally oriented with regards to both technology and markets served, while the former SOEs are domestic-market and governmental orientation.

**Toward a new catch-up model for transitional economies**

This research, based on Chinese firms, has revealed the truth that different countries or economies have different innovation models. The findings shows that some of the firms in China follow the mainstream catch-up models and the Western innovation models on the one hand, but some do not follow on the other hand. The mainstream catch-up literature originated from the newly or early industrializing economies in East and South-East Asia with relatively mature market system, where effective institution arrangements are working. However, this stream of literature is inadequate to fully direct the transition economies, where institutions are imperfect. In developed economies, the regulative institutions are well developed and they facilitate firm actions (Li and Kozhikode, 2008), while in emerging economies, they are highly regulated, transient and interventionist in nature at least during the initial years of transition (Peng and Heath, 1996). Bell and Pavitt (1993) pointed out that the accumulation activities of firms in the early industrializing countries have been similar to patterns in the earlier experience of the currently developed countries, but very different from the most common patterns in other developing countries. Of all the developing countries, very special group is transition economy, which is badly in need of innovation model related to its institutional context. Transition economy was originally planned economy who pursue socialism, but committed to market mechanisms through liberalization, stabilization, and the encouragement of private enterprise (Hoskisson et al., 2000). Firms’ growth in transition economies is limited by institutional constraints (Peng and Heath, 1996; Peng, 1997), and government institutions have negative impact on enterprise reform (Suholminova, 1999). Hence, in recent years, a dozen of scholars have paid more attention to institution relating to latecomer catching up, the perspective of which is called institution-based view (examples, Li and Kozhikode, 2008; Peng et al., 2009; Peng, Tan, and Tong, 2004; Tan, 2002). Institutions impose rules for legitimacy, serves as a source of knowledge, and allocate incentives and resources for innovation (Lu et al., 2008). This new stream of research has enriched the literature of mainstream technology catch up and is helpful to innovation of firms in transition economies. However, innovation is a comprehensive and integrative process with environmental context. Only from institution based view or technology based view cannot build innovation capabilities as well as from mainstream catch up theory or the Western theories. Hence, Innovation model of firms in transition economies is a hybrid model just like China. This model will integrate mainstream catch up model and the Western model associated with their economy development stage, technology and knowledge base, culture, and especially political regime and system. This need further research in the future.

**Practical implications**

There are several practical implications deriving from the empirical study on innovation model of firms in China’s automotive and semiconductor sectors. This research mainly discusses the differences between innovation trajectories in China and newly industrialized economies, differences between innovation systems in China and the West, differences between innovation models in SOEs and POEs, and the roles of entrepreneurs and government to
innovation in China. For China and other transition economies, three implications should be followed. Firstly, they need to establish perfect a market system, reform current political regimes, weaken the excessive roles of government to innovation, which do not distort the competition structure and decrease innovation performances. More importantly, the number of SOEs should be reduced to the greatest degree. Particularly, China does this job because that is where there are larger amount of SOEs. Our finding has presented that the government plays a far more active role to firms’ competition and innovation in China than the West, which leads to different competition behavior and innovation performance between POEs, startups, and SOEs. POEs and startups are particularly valuable contributors for more radical technology innovations, global market and new business model, while the former SOEs labor under a variety of constraints that make them slower to adopt these new innovations and business models, more inactive to expand global markets. One of the most important reason is that compensation of SOE management is often unrelated to firm performance, which led to less R&D activities and lower innovation performance of SOEs than non-state owned firms in China (Jiang et al., 2011; Tan, 2002). Bell and Pavitt (1993) also pointed out, “Conversely an almost complete lack of competitive pressures was one reason why production units in centrally planned economies had no incentive to develop or adopt more efficient techniques”. Secondly, firms in transition economies acquire advanced technology from developed countries, at the same time, go in for active in-house R&D activities. Only acquiring read-made technology from more technologically advanced countries are likely to hinder rather than hasten industrial catching-up, which has led to many of the industrializing countries to some kind of enormous ’technological desert’ (Bell and Pavitt, 1993). In-house efforts play a key role in absorptive capacity as well as technology capabilities to latecomer firms in developing countries (Kim, 1997). Complementarity between technology imports and local capabilities is very important to latecomer firm, and this type of complementarity was matched by intensive efforts to improve and develop what was initially acquired (Bell and Pavitt, 1993). Particularly firms in transition economies should learn from BYD, Chery, Verisilicon, and Viricom as cases studied in this studio, they started their businesses from their own cutting-edge or core technology through in-house R&D rather than reverse engineering. They pay more attention to acquiring knowledge, skills, and idea embedded in people, returning Chinese from Detroit or Silicon Valley than physical technology. This is why Chinese startup firms did not acquire advanced technology from developed countries to start up their business and innovation journey. Thirdly, firms in transition economies should understand well that innovation process is a series of comprehensive, connected, interactive, and integrative activities. Most of latecomer firms in developing countries often pay much more attention to technology innovation, with ignoring management innovation and business model innovation. Teece (2010) denoted, “To profit from innovation, business pioneers need to excel not only at product innovation but also at business model design, understanding business design options as well as customer needs and technological trajectories.” Building innovation capabilities depend not only on technological dimension but also organizational dimension (Dutre’nit, 2000; Bell and Figueiredo, 2012). It makes good business sense especially in the internet age, for companies to develop the capability to innovate their business models (Chesbrough, 2010). This research finds that firms that have strong integrative capabilities and innovate business models with full openness paradigms have built their stronger technology capabilities and more competitive advantage. These firms pay more attention to in-house and joint R&D, rather than only outsourcing R&D just like FAWCAR. Companies can build stronger business models if they assess their own capabilities and the context for a co-development partnership (Chesbrough and Schwartz, 2007). Therefore, firms in transition economies as well as other developing countries should be committed to integrative innovation rather than only production and technology innovation.

CONCLUSION

This Study has been continuously researched by Berkeley and Tsinghua team for nearly ten years to avoid the adverse effects of circumstantial eventualities. It was experienced for a long time, in order to get a qualitative case study with eight sites in two sectors which is indeed uncommon and uneasy, it increases the time to test and validates our findings and make our conclusions more reliable. Through this study, we provided evidence for innovation model, two in Chinese leading sectors. Our qualitative empirical study does not support some aspects of mainstream catch-up model mainly derived from Kim (1997, 1999) and Hobday (1995, 2005). We empirically found that latecomer firms in developing economies may start innovation through in-house R&D without acquiring advanced technology from developed countries. Our findings also show that Chinese innovation model is also very different from the Western. The entrepreneur is the strongest driving force to POEs and startup firms, while much weaker to the former SOEs. This finding challenges Schumpeterian view and other western belief on entrepreneurship. The government plays a far more active role to firms’ competition and innovation in China than the West, which leads to sharply different competition behavior and innovation performance between POEs, startups, and SOEs. In particular, we find that POEs and the startup firms are valuable contributors for more radical technology innovations and new business models, while the former SOEs labor under a variety of constraints that make them slower to adopt these new innovations and
business models. Relatedly, the former SOEs concentrate predominantly on the Chinese market, while the startup firms utilized China as an export platform to sell products to the world. This research develops and enriches catch-up theory literature that makes it go to general. Firstly, we connect two catch-up perspectives of technology based view focused on mainstream catch up literature and institution based view emerging in recently years. Secondly, we introduced business model and open innovation into this research. The two theories originated from the West, yet are largely ignored by mainstream catch up literature. We have developed the explanatory power of open innovation theory in this study with the taxonomy of fully open and semi-open paradigm. The finding shows that former SOEs are semi-open paradigms with weaker absorptive capacity and combinative capabilities, while POEs and startups are fully open with stronger integrative capabilities. Finally, we developed innovation models of latecomer firms in developing countries, especially for transition economies.

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