
Towards an Innovation-driven Nation: The ‘Secondary Innovation’ Framework in China[†]

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Abstract

The rise of latecomer countries across the world directs academic attention to their catching-up and innovation processes of seizing technological opportunities and combining internal and external knowledge. Different from the developed economies as well as the newly industrialized economies, China presents a special innovation environment, wherein its technology regime, market opportunities, and institutions are complex and the globalization trend affects competition in a broader way. In this context, we clarify and extend the framework of “secondary innovation”. This framework describes the dynamics of those with relatively poor resources and capabilities in their efforts to capture the values of mature/emerging technology or business models by acquiring them from across borders and then adapting to catching-up contexts. Such processes, differentiated from original innovation that involves the whole process from R&D to commercialization, has become a prevailing regime during paradigm shifts. In particular, unlike the traditional catch-up literature that focuses more on technology, the secondary innovation framework inclusively contains both technology and business model innovation, and puts forward the co-evolution between the two elements, which is more applicable to China’s context. In accordance, we also provide implications towards fulfilling the goal of building an innovation-driven nation.

Keywords

latecomer catching-up, secondary innovation, China context

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1. INTRODUCTION

It is widely accepted that innovation is a social process, and one of strategic and endogenous driving force in economic development (Alcouffe & Kuhn, 2004; Schumpeter, 1934). For the past several decades, a number of studies have been done on the theme of innovation processes (Gassmann, 2006; Terziowski, 2010; Tushman, 1977). Increasing attention has been paid to the context of emerging countries (EC), given the dilemma that EC firms as latecomers are trapped by the liabilities of the developing countries' home base - such as low resource munificence, capabilities constraints, and special institutional context (Yiu, Lau, & Bruton, 2007) - while still managing to achieve great technological leaps and competitive advantages (Contractor, 2013; Li, 2007; Mathews, 2002). In order to be internationally competitive, latecomers' entries into the global business are largely concerned with catching up to multinational corporations (MNCs) based in developed countries with higher technological capabilities (Mudambi, 2008). Scholars attached increasing importance to the latecomers' advantages' impact on economic growth and explored the possibility of building these advantages under an emerging economy setting (Fu, Pietrobelli, & Soete, 2011; Kim, 1997). The cases of earlier latecomers, especially successful ones within Korean, Taiwanese, and Singaporean contexts, enrich latecomer catch-up literature (e.g., Hobday, 1998; Mathews & Cho, 1999; Wong, 1999). These latecomer firms are characterized as "utilizing state agencies to engineer their entry into export markets and then into high technology sectors" (Mathews, 2002, p. 470), which highlights the importance of state power, export orientation, and access to advanced technology in the catch-up pattern. Some Korean scholars link the technological regime to catch-up (e.g., Lee & Lim, 2001; Lee, Lim, Song, 2005), emphasizing the impact of technological regimes; others suggest that a latecomer country or firm could also be motivated by market changes (Cho, Kim & Rhee, 1998; Kerin, Varadarajan, & Peterson, 1992), national innovation systems (Nelson, 2004 ; Wong, 1999), or learning capacity (Kristinsson & Rao, 2008; Li & Kozhikode, 2008; Mathews & Cho, 1999). Kim (1980) also drew on Utterback and Abernathy's (1975) innovation model to identify the innovation processes in latecomer countries within a 3-stage model, starting from the acquisition and learning of mature technologies from developed countries, proceeding to indigenous assimilation in the development process and product design capabilities, and ultimately leading to innovation capability improvement. Later, Lee, Bae, and Choi (1988) extended this model to include both mature and growing technologies to describe firms with relatively higher capacities that target higher-level technology. Recently, Choi (2010) summarized three sequential phases in the Korean innovation model, namely, "path-following," "path-revealing," and "path-creating," following the three types of catching-up development (Lee & Lim, 2001; Lee, Lim, & Song, 2005).

China currently presents a unique context for firm catching-up and innovation. Its context - possessing the interactive characteristics of mixed technology regimes, diverse market segmentation, transformed institutions, and globalization - is different from any other country in the world. While the influence and interactions among the above four facets matter in understanding the firms' catching-up progress, the innovation models that apply to western firms have never suited the latecomer firms, and the catch-up model grounded in the Korean or Japanese experience also has lost its explanatory power. Consequently, the innovation and catch-up processes of Chinese firms call for a more fine-grained model

towards demonstrating their dynamics (Liu, 2005).

Among the firm-level models of latecomer innovation, the conceptual model of “secondary innovation” is regarded as a particularly appropriate framework in figuring out innovation in Chinese firms. Secondary innovation differentiates the underlying assumptions from the processes of acquisition, assimilation, and improvement in traditional models, as it stresses continuous innovation throughout every step of the process rather than initiating innovation from R&D processes. Consistent with the comments of Mathews & Cho (1999) that latecomer firms and latecomer nations “are able to exploit their late arrival to tap into advanced technologies, rather than having to replicate the entire previous technological trajectory” (p141), secondary innovation provides a dynamic logic to latecomers in the catch-up process by seizing opportunities and by passing the potential organizational inertia that were obstacles for their more established competitors.

This paper highlights the Chinese context through reviewing and clarifying the theoretical framework of secondary innovation and its evolution in order to enrich the catch-up and advantage literature on latecomers. Grounded in such context, the catch-up process for Chinese firms shows a different pattern from those in newly industrialized economies (NIE). Thus, the secondary innovation framework provides a systematic perspective to look into the innovation and catching-up of Chinese firms, and helps firms to improve their capacities and leapfrog. In addition, the secondary innovation framework looks into the dynamism of innovation along technological trajectories, as well as business model innovations, rather than statically describing import-assimilation-innovation in the same paradigm, taking into account more influential factors.

This paper is organized as follows: section 2 delimits the current China context and the influential factors that may cause changes. Section 3 summarizes the research on the dynamics of secondary innovation in technological innovation, and touches upon the relatively new concept of secondary business model innovations and the interactions between the two dimensions. The last section clarifies the implications for both entrepreneurs in reorganizing their business and catch-up strategy, and policymakers in designing a harmonious business development system.

2. AN OVERVIEW OF THE CHINESE CONTEXT

2.1. Facts of the Rise of Chinese Firms

Nowadays, several prominent Chinese firms show high potential for catching-up and outperforming their foreign counterparts, achieving prominent reputations, and gaining significant market share. Also in the past five years, the working lives of Chinese citizens have changed greatly due to high-speed railways. The extension of the Chinese high-speed rail network shortened distances between cities, enabled better connections among the general population, increased economic activity (Amos, Bullock, & Sondhi, 2010), and influenced resource allocation and exploration, resulting in further economic development. The year 2014 witnessed the operational mileage of China’s high-speed railway reaching 16,000 kilometres with its total operational mileage ranking first worldwide.

With the influence of this widespread railway, the economic zones where the destination cities are geographically proximate can also evolve, and more cities could radiate out from the focal cities of Beijing, Shanghai, and Guangzhou. The development of cities would accelerate to some extent. Moreover, though the first generation technology was imported from developed counterparts, iterated improvements and indigenous innovations will allow the rise of a new generation of technologies enabling the label “created in China” in only one decade. Now with the world’s largest high-speed rail network and highest rail speeds (Wang, Hong, Kafouros, & Wright, 2012), China has secured agreements with several nations on the export of its high-speed railway technology and products, involving other countries such as Thailand, Romania, and Turkey. In 2015, China’s two largest train makers are moving forward in a merger to be more competitive and R&D-efficient, which would establish prevailing advantages in technological innovation as well as increase market power.

The success of China’s high-speed railway puts forward the question of how the high-speed rail achieved such rapid growth and significant market share. Firstly, China has a large population but also bears the problem of uneven distribution of economic activities and resources, causing frequent population shifts between the western and eastern areas of the country. Such demand could not easily be met by conventional railways or limited airlines. Hence, the expansion of their high-speed rail network is called for by such demand, as well as by their national advantage in their low construction costs in terms of land and labor force. Their large amount of governmental infrastructure investments as well as the exclusivity of operations by state-owned companies allows the nation to pay more attention to and support the development of their high-speed rail network.

Besides the leading firms in national pillar industries, changes also take place in those firms from the service and digital industries. Relying on the booming trend of the Internet and big data, the e-commerce company, Alibaba creatively adapted Western models in China and built a large business empire. As China’s biggest online commerce company and one of the most valuable public companies in the country, Alibaba - together with its three major sites Taobao, Tmall and Alibaba.com - attracts hundreds of millions of users, and keeps pace with the changing requirements of users and the business environment (Guo, Lam, Lei, Guan, Iong, & Jeong, 2006). Moreover, with lower barriers-to-entry and better access to the market, Alibaba enables thousands of farmers to find ways to sell their agricultural products directly to consumers without any broker fees. Recently, the company also began undertaking cross-border transactions, thus involving more foreign customers and entrepreneurs. For example, in May 2015, several countries including Spain, Italy, Japan, and Korea in line with the heated trend of cross-border trade became suppliers for 1688.com, which is expected to become one of the world’s largest platforms for importing and distribution. Since the global e-commerce market is still going strong, the potential for Alibaba expansion keeps growing. There is no doubt that Alibaba was established with a global perspective towards successfully taking over the world e-commerce market. However, at the outset, it also thrived in niche markets overlooked by offline shops, and managed to meet consumers’ low-end demands (Wu, Ma & Shi, 2010). Noticing different demands and targeting accordingly was a key to its success, or as the founder Jack Ma put it, Alibaba owes its success to women and youth as well as entrepreneurs.

Founded in 1987, Huawei is another textbook example representing the Chinese firms’ march into

the global market. This privately held company is now a leading world networking and telecommunication equipment manufacturer and services provider. Huawei is also the only Chinese company to make the Thomson Reuters list of “2014 Top 100 Global Innovators”, together with other firms such as Apple and 3M, a presence indicating the global position of this growing Chinese innovator. It is anecdotal knowledge that Huawei had to start with rural areas under the competitive pressure of both foreign counterparts and state-owned enterprises (SOEs). At the time, the rural market brought in less profit than urban ones, the latter of which attracted powerful multinationals. The less competitive but significant rural market then was captured by Huawei, paving the way for capital accumulation. It turned out to be an effective strategy, as the capital, innovation capabilities, and marketing strategies developed during the rural market exploration enabled Huawei to gain more advantage into the urban competition. In light of such “best practice,” Huawei acts within the same philosophy in the global market, understanding that developing countries are ideal markets in the early stages of the internationalization process. After a certain level of experience is attained, developed markets are targeted and successfully captured.

Unlike their western counterparts with their superior innovation capabilities and initial monopoly advantages (or the newly industrialized economy firms supported by government and targeting foreign markets), Chinese firms are mostly grown from the Chinese market. Since national differences would affect technology development patterns (Katz, 1984), the modus operandi for them is to rely on the domestic market to accumulate achievements before striking out globally as industry leaders rather than largely relying on export and exploiting the foreign market. In other words, the domestic market allows the firm to develop advantages before eventually scaling up. Is this, however, a myth?

2.2. The Myth of the Rise of Firms: China Context

China has undergone great changes in recent years, changes bringing both social and economic transformations in the institutional and market environment (Luo, Zhou, & Liu, 2005). Such changes present new opportunities as well as challenges to firms rooted in the context, calling for capacity development in order to cope with the complex environment and dynamism.

2.2.1. Technological and Market Opportunity

Originating from intrinsic characteristics of technology as well as the state of the scientific environment, technological opportunity indicates “exogenous variations in the cost and difficulty of innovating in different technological areas” (Jaffe, 1996, p. 3). The paradigm shift and mixture of technology regimes in Chinese society opens windows to technological opportunity (Lee & Kim, 2001), reinforcing the technological capacity development of firms. Information now acts as effective tools for reducing transaction costs and improving efficiency in the economy. The popularity of the Internet and ICT (information and communication technology) in China also update the network-based competition in the business environment, leading to an attitude of collaboration and complementarity. For example, the group of so-called BAT firms (Baidu, Alibaba, Tencent) are now famous worldwide. Benefiting from widespread Internet technology, they have innovated to establish a well-served platform where individuals and SMEs can join the business ecosystem (Liu, Tian & Guan, 2013). Furthermore, the ICT power of the nation supports the development of strategic

emerging industries, leading these pillars of national economy to intelligent systems and becoming environmentally friendly. In addition, the disruptive technologies of note have emerged to play an important role in economic transition, such as the Shanzhai products and PAS system. They might not be at the final frontiers of technology, but they have emphasized unmet demand and niche markets as their focus (Christensen, 2006; Christensen & Rosenbloom, 1995), fitting the situation of the Chinese transition context.

On the other hand, since the touchstone for innovation is no doubt “commercialization”, innovation must serve a stimulus of economic growth and must be market-oriented, paying much attention to market opportunities. Korean companies such as Samsung show a typical pattern of overseas market-seeking and high export dependence due to Korea’s limited domestic market. Given China’s enormous population and its vast territory, the magnitude of China’s domestic demand is inevitably an outstanding feature of its context, inspiring potential entrants to step into profitable industries to compete for a share. At the same time, the differences among regions and classes (according to social stratification) results in dramatic market diversity (Cui & Liu, 2000) and customer group complexity, requiring tailored marketing strategies (Wu, Dou, Gao, & Huang, 2014).

The demands in the northern and southern parts of China are at variance due to sub-national cultures, habits, and states of development, while the needs of the middle class would differ from the lowest of the economic strata or from rural areas in terms of income inequalities. An interesting and often discussed case is the effort made by the Haier Group, how they continue to investigate the different demand from various groups and market their washing machines accordingly, ranging from the “Xiaoxiaoshentong” designed for washing summer clothes to a specialized vegetable-and-fruits washing machine for the countryside, pivoting from function improvement to function transition. With such market diversity and industry upgrading, the demand for technicians has also increased significantly. Compared to the world average, the cost of Chinese technicians is relatively lower, laying the foundation for better labor quality and lower production cost.

2.2.2. Institutional Change and Policy

According to certain empirical findings and examination of political economies, institutional change and policy exert influence upon the innovation system within emerging economies (Choi, Lee & Williams, 2011). China is also experiencing such changes in transforming from a central planning system to that of the competitive market (Li & Zhang, 2007). To begin with, ownership presents significant challenges to firms. For private firms, the privatization process forces certain state-owned firms to transition into private ones, with the allocation of technology and human resources also shifting from the state-owned or large firms to these newer incarnations (Child & Lu, 1996). On the other hand, the weak legal environment, especially concerning intellectual property rights, undermines the effectiveness of innovation (Li & Atuahene-Gima, 2002; Xiao, Tylecote, & Liu, 2013), and so do opportunistic behaviors (Li & Zhang, 2007). Among the many different kinds of organizations involved, universities and research institutions generally outperform firms in innovation (Li, 2009). Therefore, in supporting the development of firms’ productivity and innovation efficiency, Chinese SOEs, SMEs, and university and research institutions seek ways to develop cooperative relationships or establish platforms, and attempt to create strategic alliances in emerging industries,

such as the TDS-CDMA alliance (Gao & Liu, 2012). In view of national policy, the enactment of the National Indigenous Innovation Strategy (2005), the Strategic Emerging Industry Policy (2010), as well as systematic law and regulations on fiscal support, tax, government purchase, and IP institution encourages innovation activities in all walks of life. The industries and the technology are then legitimized and have the potential to flourish (Guennif & Ramani, 2012). As pointed out by Li (2009), there exists a dual innovation system in the transitional stage, with the upper level setting developed countries as benchmarks and emphasizing advanced technology, while the lower level tends to be more relevant locally. Hence, the local or lower level government always makes an effort to nurture local clusters or high-tech parks where the firms with high growth potential can locate themselves in. Such arrangements inspire firm innovation but also could compensate for the uneven distribution of resources and technological innovation and foster regional competition.

2.2.3. Globalization

Since the twenty-first century, the rise of globalization has brought about many changes in firms' competing environment through interactions and factor exchanges between the home country and host country (Mathews, 2006). China was initially treated as a desirable attraction for foreign direct investment (FDI) due to its low production and labor costs, its raw materials, and market size (Cheng & Kwan, 2000; Friedman, Gerlowski, & Silberman, 1992). FDI in general results in production and technology spillovers (Liu, 2008; Tian, 2007), leading to impact positively on local technological innovation. Globalization encourages Chinese firms to embed themselves into the global manufacturing network (GMN) and benefit from knowledge diffusion among GMN members (Ernst & Kim, 2002). For example, plenty of Chinese hidden champions have come to light showing the proactive attitudes of Chinese SMEs joining the GMN and achieving prosperity. They specialize in certain products - such as gears, nailclippers, gas valves - and keep innovating, finally to become industry leaders. This sort of knowledge varies from general information and advanced technology to complex know-how, which could be acquired and integrated to facilitate organizational effectiveness and efficiency. At a later stage, Chinese firms' OFDI activities enter a new phase as the firms accumulate knowledge step by step. The financial crisis in particular provided a golden opportunity for bargain hunting. Up-to-date studies and statistics found that firms in emerging economies usually expand overseas to acquire strategic resources and reduce their home country's institutional and market constraints (Luo & Tung, 2007; Rui & Yip, 2008). With the motives to capture the profit from acquiring strategic assets, many emerging economy MNCs not only leverage their existing resources, but also augment knowledge sought from advanced sources, which could leave reverse effects from OFDI in building and maintaining the new competence of investing firms (Kafourous, Buckley, Sharp, & Wang, 2008; Kedia, Gaffney, & Clampit, 2012; Sanna-Randaccio, 2002). Hence, the globalization trend involves all kinds of players in the competition landscapes as well as their reciprocal impact on each other, with the acquired advanced technology and valuable brands ranking as prominent benefits to Chinese firms.

In summary, the Chinese context provides infinite possibilities for the firms' catching-up in four main aspects. In the technological aspect, the existing paradigm is inadequate for further development, with declining profit extracted from it. Emerging industries, collaborating with ICT, begin to determine and shape their environment with emerging intelligent paradigms, through the interac-

tions between government policy, firm actions, and industry dynamics. It opens a wide window for domestic firms to flexibly generate and improve technologies, whether acquired or by in-house R&D (Liu, 2005). And the new environment, with more network-based businesses, modularity, and governmental support, is more open to the new entrants. From the market side, the opportunity for accessing the market is sometimes challenging to latecomers (Amara, Landry, Becheikh, & Ouimet, 2008), while changes in consumer tastes may also act as stimuli in disrupting an incumbent's leading position (Cho, Kim, & Rhee, 1998; Kerin, Varadarajan, & Peterson, 1992). Additionally, market segmentation and the special needs of customer groups in emerging markets may also change the latecomer's technology trajectory (Hobday, Rush, & Bessant, 2004; Wu et al., 2014). Institutional changes also restructure constraints and incentives in the environment for certain technologies, firms, and industries, which may leave promising paths for countries to catch-up (Perez & Soete, 1988). On the other hand, as in globalization, whatever choice is made - being embedded into GMN or organizing one's own GMN, or investing abroad - technology and knowledge flux arecarried and transferred by the network, building aknowledge base for the innovations that follow.

The developing context of Chinese firms are different from the innovation or catching-up environment in developed countries or the NIEs such as Japan, Korea, and Singapore. Along with Schumpeterian economics, Western companies thrive on a stable institutional environment, a relatively perfect market system, and strong indigenous innovation capabilities, while in the NIEs the government provides strong support with the limited domestic market in mind (Mathews, 2006). As a result, the Chinese context offers abundant opportunities for realizing different types of innovations, differentiated from Korea or Japan. The secondary innovation pattern stands out with its theoretical framework deeply rooted in China. Its dynamic process accurately captures this new practice of innovation.

3. SECONDARY INNOVATION FRAMEWORK FOR LATECOMERS' CATCH UP

Derived from a global model including both first-movers and latecomers, the construct of "secondary innovation" came into sight since the 1990s with a conceptual framework developed by Xu & Wu (1991), and was further enhanced by a series of empirical work grounded on industrial practice (e.g, Wu et al., 2010; Wu, Ma & Xu, 2009). By definition, secondary innovation is a sequential process containing technology acquisition, assimilation, improvement, and the crisis stage as a firm's proactive response to technology acquired from foreign firms. Aimed at capacity upgrading and breakthrough on the basis of imported technology rather than rejecting the external technology or being trapped by the import-stagnate-lag behind-import cycle, it acts as the primary pattern adopted by Chinese firms in achieving potential advantages. Moreover, the secondary innovation framework not only covers technological innovation but also concerns business model innovation, deepening the understanding of catching-up whilealso being differentiated from traditional models.

3.1. An Introduction to Framework

Dosi (1982) introduced technological paradigms and trajectories that established the foundations

for the development of “secondary innovation”. With original innovation stemming from the technologies and products from lab R&D and determining the dominant design and technological trajectory, “secondary innovation” highlights the starting point of technology acquisition as being from developed countries or advanced technology sources, thereby indicating the common initial step of secondary innovation, that adapts to the imported technology or products, as a process of innovation. According to the development stage of acquired technology, technology acquisition is categorized into two types, where “acquisition I” importing mature technology shapes further innovative efforts following established trajectories, and “acquisition II” with emerging technology or lab technology acquisition allows possible in-house R&D conducted at an early stage of technology development and offers more potential for original innovation under a fluid stage of undefined dominant design (Wu et al., 2009).

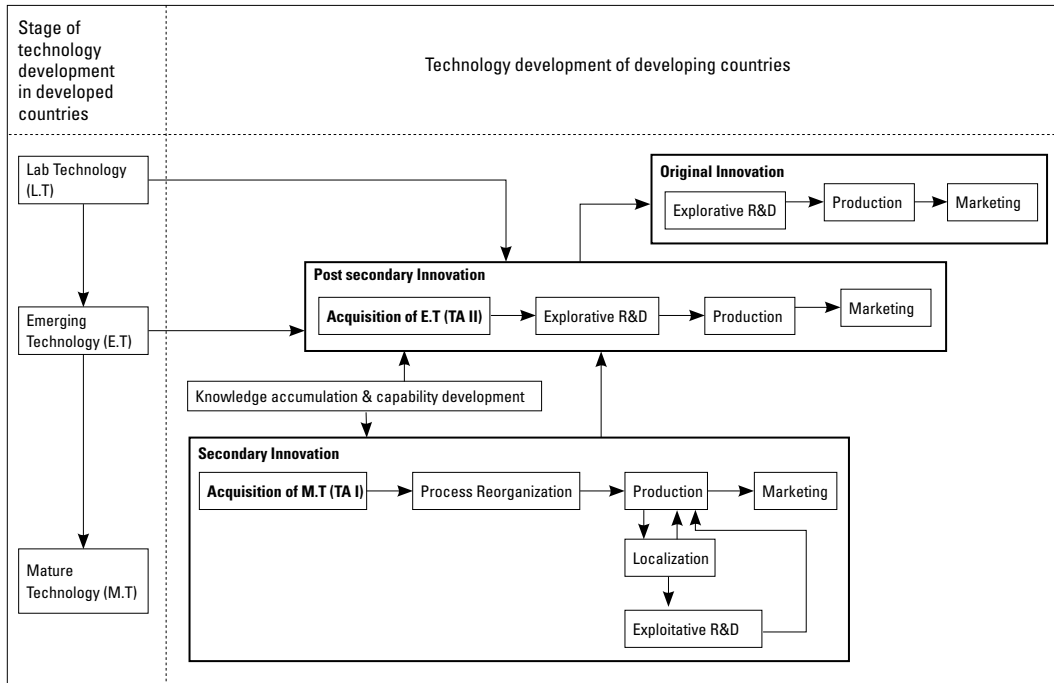
Secondary innovation provides new channels for latecomer firms to find opportunities to catch up, even though the incumbents might determine the trajectories. It is also distinguished in that the framework regards secondary innovation as a nonlinear process in its description of the dynamics of technology development. According to the source of acquired technology, secondary innovation can be divided into two parts, namely “standard secondary innovation” (acquisition I with mature technology) and “post-secondary innovation” (acquisition II with emerging technology). Generally, standard secondary innovation consists of the three sub-processes of imitative innovation, creative imitation, and improvement innovation, with every sub-process describing how firms use acquired technology to achieve higher production and market share. Of the sub-processes, imitative innovation denotes the path from acquiring mature technology to equipment/process reorganization, and production and marketing, while creative imitation requires the adaptation of acquired technology to existing technology to accomplish localization and realize capacity improvement and better production. Though both sub-processes are doing imitation, the latter has made a difference to the technology. With the imitation processes enabling the firm to better understand the acquired technology and stronger capabilities, improvement innovation takes advantage of these capabilities to undertake indigenous R&D activities such as reverse engineering. From that point, firms do not rely on the acquired technology and pave their own way to realizing innovation. This model also lays much emphasis on the R&D process during secondary innovation, which maybe neglected in the previous model. R&D activities not only take place during the assimilation of emerging or lab technology, but also in that process of mature technology assimilation. That means, for developing countries, R&D activities are necessary for mature technology adaptation, and such exploitative activities are embedded in the whole process in order to improve production as well as internal capacities.

Post-secondary innovation is when the technology acquired is emerging technology or lab technology. A latecomer firm may not quickly get to acquisition II in seeking for emerging technology until the firm has gone through several rounds of acquisition I and established a considerably strong technological capacity base. Latecomer firms thereby could improve their competence step-by-step through several rounds.

With Chinese firms growing to domestic leaders by adopting acquisition I, this might also force latecomers into the pre-existing paradigm and trap them in the lag-behind or technology lock-in sit-

uation. The emerging paradigm could provide opportunities for a flexible shift for latecomers without worrying about “incumbent inertia” and switching costs (Wu & Zhang, 2010). Therefore, such firms could take advantage of the opportunity window, catch up to the new trajectory, and leapfrog with strong nonlinear features. It is necessary for Chinese firms to acquire emerging technology or lab technology, and combine or organize it into current technology with market focus, in order to break through the limit of the current paradigm and accelerate innovation capability accumulation.

FIGURE 1. The Dynamics of the Secondary Innovation Mode



Source: Wu (1995)

3.2. Organizational Learning and Secondary Innovation

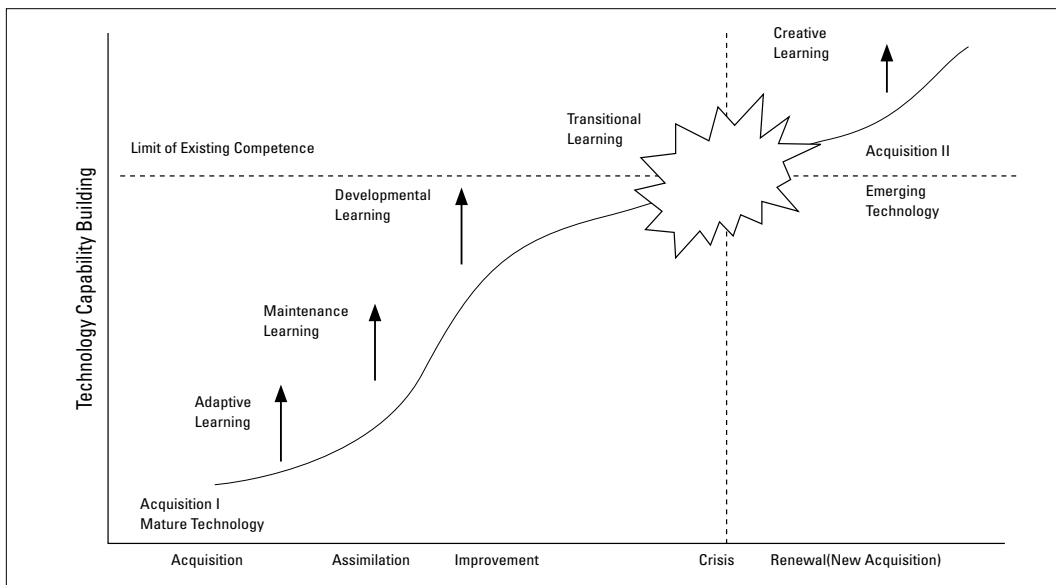
Technological catch-up could be understood as the accumulation of technological capabilities through organizational learning. As mentioned, the secondary innovation framework in contrast to traditional catch-up models focuses on continuous learning and upgrading activities throughout the whole process, involving the interactions between the acquired technologies and the local technological and market environment, termed as “understanding” (Wu et al., 2009).

As learning enables firms to improve capacity accumulation and sustain competitive advantages (Barkema & Vermeulen, 1998; Hatch & Dyer, 2004), the current literature presents a different perspective on technological learning (Carayannis, Popescu, & Stewart, 2006; Forbes & Wield, 2002; Kim, 1997). For instance, Hitt, Ireland and Lee (2000) present a system for distinguishing learning into lower-level, higher-level, and meta-level in terms of the environment’s complexity. With the

catch-up process, Korean scholars tend to be forefront. Based on Kim (1980) and Lee et al. (1988) present a three-stage development model from the global perspective, and Kim (1999) relates the U-A model together with the pattern of latecomers' technology development, showing a reverse direction from the developed countries. However, few studies have explicitly delineated the learning modes respectively matched to certain stages of technological development.

Conforming to the secondary innovation stages, the learning modes of the new paradigm also vary from adaptive, developmental, transitional, to creative learning (Wu et al., 2009). Since the knowledge embedded in the technology is to some extent tacit, it is also the same for latecomer firms (Kim, 1999). For each stage, the main task of learning is to reconstruct the organization process, or routines, and reveal and combine the tacit knowledge of the technology and firm's existing knowledge base in order to adjust the newly acquired technology into mass production and accumulate sophisticated technological capabilities.

FIGURE 2. Organizational Learning Mode along with the Secondary Innovation Stages



Sources: Wu, Ma & Xu (2009)

To summarize briefly, secondary innovation is initially a type of innovation based on acquired technology, building technological capabilities during the assimilation and improvement on that core-technology. Hence, latecomer firms can accumulate experience and knowledge under environmental turbulence, and make efforts to catch up. Later on, it becomes critical to push latecomer firms into original innovation.

3.3. Technological and Business Model Dimensions

Generally, the barriers keeping people from obtaining a particular solution may include insufficient

wealth, access, skill, or time (Johnson, Christensen, & Kagermann, 2008), which is potentially linked to disruptive innovation as well as the facts of China's context (Hwang & Christensen, 2008; Wu et al., 2010). In this regard, latecomer firms have obtained a different perspective for seeking opportunities into the whole value-related process, beyond just technological capabilities. To perform such innovative activity, these firms have to distinguish market structures as well as demand ladders based on "market understanding," and then offer a consumer-appealing value proposition, along with a unique value network and revenue/cost structure (Wu et al., 2010). Therefore, business models carry great importance. Since the underlying logic of business models is a strategic representation for creating, delivering, and capturing value to customers, or in other words an integrated representation of all the elements of business (Amit & Zott, 2001; Chesbrough & Rosenbloom, 2002; Johnson, Christensen, & Kagermann, 2008; Teece, 2010; Zott, Amit, & Massa, 2011), business model innovation is a critical driving force in firm transformation (e.g., Demil & Lecocq, 2010; Johnson, Christensen, & Kagermann, 2008) and competitive advantages (Teece, 2010).

In terms of the theoretical framework, it is clear that secondary innovation can be conceived as a value-creation process for mass customers in developing countries, but the early dimension of technological or product innovation cannot explain the question of how latecomer firms create, deliver, and capture value for customers (Wu et al., 2010). Also, the economic value of a technology will not be revealed until it is commercialized via a business model, and an unfit business model will cause less value in the technology (Chesbrough, 2010). Therefore, an updated framework with a new dimension of business model innovation is suggested for obtaining reliable and in-depth findings. In light of Fagerberg (2005), secondary business-model innovation can be introduced to provide a tailored business model from advanced economies, with a value network adapted especially to local requirements and latecomer economies (Wu et al., 2010). Mature business models from developed countries need to be adapted to local requirements in order for productive interaction with local systems. In practice, several Chinese firms with relatively weak technological capabilities have changed the rules of the game by successfully accomplishing secondary business model innovation.

Taking into account both the technology and business model dimensions, this business model acts as a mediating construct between technology and economic value so that new product development efforts are coupled with a clearly defined business model (Chesbrough & Rosenbloom, 2002; Teece, 2010), indicating a potential synergy effect between the two types of innovation. But this business model could subsequently limit the search for new and alternative models for other technologies after unlocking the latent value of a technology (Chesbrough & Rosenbloom, 2002), reflecting the interaction of technology and business innovation. Regarding the impact of technological innovation on the business model, technological change often but not always triggers the shaping of business models for newer and better ways of satisfying customer needs (Teece, 2010). Beyond interaction, technological innovation and business model innovation co-evolve within the secondary innovation framework. Alibaba initially introduced e-commerce to China and experienced such a process. Initially imitating the business model of eBay, Alibaba now does business in cloud computing, big data, and finance, all of which requires advanced technology to accomplish (Wu et al., 2013). The introduction of business models from abroad initiates the development of technology that enables further adaptation of secondary business model innovation (Wu et al.,

2013). With improving capacity and the technological innovation network, the necessary resources for shifting business models could be provided for leading an original and local business model innovation (Calia, Guerrini, & Moura, 2007). With such a process, the technological gap is also effectively narrowed.

Hereby we present and clarify the theoretical framework of secondary innovation, revealing its content, dimensions, evolutionary path, and learning types embedded into the dynamics. This framework can provide insight for latecomers catching up in both technological and business model innovation, and lay a foundation for building competitive advantage.

4. POLICY IMPLICATIONS

After discussing the secondary innovation framework from both the technological and business model dimensions, we have delineated the general evolutionary process and learning process of latecomer firms undertaking secondary innovation. Such framework depicts dynamic technology upgrading, illustrates a new pattern of catch-up in emerging countries, and goes beyond the conventional wisdom of latecomer firms that attempt to achieve technological capability improvement by simply repeating the linear process of technology acquisition-assimilation-innovation. Despite being initially put forward in the 1990s, the secondary innovation framework is far from being outmoded, taking China into account. As such, we could draw following implications and provide new insights for policymakers as well as entrepreneurs.

Organizational Learning & Unlearning

In secondary innovation, the organizational learning mode is key to technological capacity building; otherwise, catch-up cannot be achieved at all. Latecomer firms must improve by organizational learning their technological know-how during the sub-processes embedded in secondary innovation. In fact, learning capabilities and absorptive capabilities enable diverse knowledge to be properly transmitted for technological leapfrogging and increased innovative capacity. Though the breadth or the speed might vary, such technological accumulation processes could support the firm to become a fast follower. At the same time, absorptive capacity determines the extent to which a firm can learn. Within the new technology, entrepreneurship must acquire the necessary experience for identifying the market, which conforms to the learning process (Gruber, Macmillan, & Thompson, 2008). Latecomer firms suffer a chaotic period during paradigm shifts, requiring them to unlearn or in other words undertake “organizational restructuring to cut out the existing routines and rigidities in order to create new capabilities and synergy” (Lee & Lim, 2001). Unlearning in this sense is important during the crisis stage or paradigm shift since it is essential to cope with environmental changes (Akgün, Byrne, Lynn, & Keskin, 2007; Li & Atuahene-Gima, 2001; Starbuck, 1996). Understood as changes of beliefs and routines in the organization (Akgün et al., 2007), unlearning is also an assumption of continuous learning (Starbuck, 1996) and sustained competence (Prahalad & Hamel, 1994). In this regard, unlearning could help latecomer firms to facilitate an effective scrutiny process on the learned knowledge and organize flexible ways to attain new knowledge as the environment evolves.

Co-evolution Between the Business Model and Technological Innovation

Based on the study on the co-evolution between technological innovation and business model innovation, a system was developed that integrates internal firm status quo, the external competitive environment, stage-specific situations, and the dynamic evolutionary path. Such findings remind us that technological capacity is not the only thing that improves a firm's competitive advantages. Business models also carry great importance, and provide other breakthroughs advancing the firm's technological capabilities. Hence, both dimensions in the secondary innovation framework and their interactions could be regarded as a sound solution for latecomer firms.

As Secretary Xi in 2014 proposed officially with a strategy of innovation-driven development aimed at accelerating the transformation of China's growth pattern, innovation by latecomer firms has become a novel driving force in tandem with that of the traditional labor-intensive or capital-intensive, enabling not only their own uplift but the ascension of their entire industry. In this nation driven by innovation, latecomer firms can bear the driving force of innovation and realize technological leapfrogging by applying an upgraded secondary innovation framework for organizing resource allocation as well as technology-market balance.

Upgrading Secondary Innovation to Original Innovation

Within the Chinese context, local firms have accomplished thousands of innovative projects, but most of them belong to the "secondary innovation" category originating from foreign countries. This means that while fulfilling the goal of sustainable growth backed by technology accumulation, most Chinese SMEs generally adhere to the given technological paradigm/dominant design and find it difficult to surpass the forerunners. Yet, opportunities exist. Considering the dynamic evolution of secondary innovation, capable firms shall be encouraged to take advantages of paradigm shifts once the accumulation of technological capabilities are adequate, upgrade to leapfrogging, and realize original innovation and finally catch up. In the meantime, certain technological progress increases productivity and upgrades industry structure. Firms at the innovation stage can also lead in related fields (such as product development or marketing) and build competitive advantages, which in turn stimulates innovation activities as well as knowledge diffusion. Practicing an innovation pattern that combines imported technologies and in-house R&D is a good way to improve the technology base, firm-to-firm, industry-to-industry, and country-to-country. As discussed in section 2, the world and China are both stepping into a new era where information technology takes the position of the traditional manufacturing technology and attacks the earlier paradigm. The modularity of production as well as the weak innovation system calls for a transformation from secondary innovation to original innovation, and an enrichment of domestic knowledge stock.

From secondary innovation to original innovation, Chinese firms strive to transform from the role of followers to leaders, which requires more in-depth understanding of Chinese contexts. This involves the interaction and co-evolution of technology, the market, and institutional and global network embeddedness. As the secondary innovation framework developed on the basis of Chinese firms' practices, the continually updated framework can provide more insight into Chinese firms' innovation processes and capacity development, which in turn can contribute to the long-term growth of the nation.

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