ICTs in the transformation of rural enterprises in China

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ICTs in the transformation of rural enterprises in China: a multi-layer perspective

Abstract

This paper investigates the methods by which firms take advantage of information and communication technologies (ICTs) to achieve transformation. The research results advance current knowledge on the mechanism of ICT-faciliated firm transformation. Based on the literature, we propose a conceptual framework that describes firm transformation occurs at three interrelated layers: 1) operation mode / technological capability layer, 2) open innovation layer, and 3) actor network layer. It argues a firm can leverage ICTs to practice open innovation and accordingly form a supportive actor network, which will help the firm build its ccapability and upgrade the operation mode. We further use this framework to analyse cases of non-farm rural enterprises (REs) in a coastal region of China. The case study demonstrates that, on the condition that the government has ensured the availability of ICTs infrastructure, a latecomer firm from a disadvantaged context such as a RE in China can take advantage of ICTs to transform itself and advance in the industry value chain mainly with its own indigenous efforts. Researchers can use our proposed framework as an analytical tool in future research on ICTs in firm transformation. The framework offers reference for firms to design their strategies for leveraging ICTs to promote the transformation.

Keywords:
China, firm transformation, information and communication technology (ICT), open innovation, rural enterprise (REs), technological capability

1 Introduction

Global value chain cross countries comprises firms from different countries. Historically, multinational corporations (MNCs) from developed nations owned the product brands and controlled the product design and distribution, and dominated the global value chain. Firms from developing economies traditionally were at the low-end position in the value chain, with the role of manufactures under other firms' branding (Gereffi, Humphrey, & Sturgeon, 2005). In recent decades, the global business landscape has undergone dramatic change. Some firms from disadvantaged backgrounds (i.e., firms with comparatively poor capability usually from developing countries) have transformed their operation mode, i.e., whether they operate as an original equipment manufacturer (OEM), original design manufacturer (ODM), or original brand manufacturer (OBM), and become an important player in the international market (Chen, Wei, & Hu, 2015; Eng & Spickett-Jones, 2009). In this paper we explore this phenomenon. Specifically, we focus on how rural enterprises (REs) in China have transformed themselves and caught up with leading firms in the global value chain.

The term RE emphasises rural characteristics. REs play an important role in the local economies they serve. They employ local people, use and provide local services and products, and generate income for the rural environment (McElwee & Smith, 2014). REs may incorporate a wide range of businesses such as farming, commerce, services, and small and medium-sized industries (Pato & Teixeira, 2018). In this paper, we focus on non-farm REs in China that rural entrepreneurs (i.e., entrepreneurs who live in a rural environment) operate. China's administrative division system comprises five levels (from the lowest to highest): province, city, county, town, and village. China officially defines the town and village levels as rural areas.

Looking back the recent history of the global market and value chain re-structuring, we have seen three waves of firm transformation and catching-up. The first wave started in East Asia. By the 1950s, Hong Kong, Singapore, South Korea, and Taiwan - the so called "four little dragons" - began their quest to catch up with

developed countries in economic development and market competition. Firms in these areas achieved remarkable business upgrading (Hicks, 1989; Vogel, 1991). A typical path for a firm to upgrade its operation mode is from the OEM to ODM and to OBM (Lee, Song, & Kwak, 2015). An OEM makes products that bear another firm's brand name. ODM resembles OEM, but the producers also design products for their clients. Finally, an OBM produces and sells products with its own brand (Hobday, 1995). In Hong Kong, to optimise the value-creation process and increase profit levels, many entrepreneurs invested in manufacturers that their relatives in mainland China ran, and they focused on research and development (R&D) and branding. As a result, the joint ventures transformed from OEMs into OBMs (Chyr, Taylor, & Hui, 2008). Some firms in Singapore initially ran on an OEM mode but eventually established their own brands by relying on foreign direct investment (Brown, 1998). The South Korean government helped a small number of large conglomerates to produce some successful global brands. For example, in the 1990s, Samsung started to pursue R&D-intensive and own-brand strategies and switched away from the OEM mode (Chu, 2015). In Taiwan in early 1970s, most firms operated at the OEM mode. By the late 1980s, some firms, such as Acer, transformed into OBMs, which meant they became global enterprises with their own proprietary brands (Chiang & Yan, 2011; Chu, 2009).

The second wave involved China and other emerging economies. From the early 1980s, China entered into an era of economic reform and firm transformation. It opened its door for Chinese firms to access to foreign capital and technologies and the international market (Gao & Yu, 2010). Major MNCs have come to rely on Chinese OEMs to access the huge market of China, but the Chinese industry has not remained only as a low-end OEM economy. Some Chinese OEMs progressed to ODMs. For example, Lenovo merged with IBM's Personal Computer Division and acquired design capability (Luo & Chang, 2011). Some Chinese OEMs upgraded to OBMs. For example, Konka started as an OEM contractor but then successfully upgraded its capabilities to produce its own branded products for the domestic market and became a major player in diverse consumer electronics goods (Lee, Jee, & Eun, 2011; Mathews, 2008; Xie & Wu, 2003).

From the mid-1990s, the Internet boomed and businesses began to widely use information and communication technologies (ICTs), which has lead to the third wave of firm transformation and catching-up. Internet applications have transformed the business landscape in different industries across the world. Internet technology provides firms with better opportunities than before to establish distinctive strategic positioning in the market (Porter, 2001). The adoption of Internet-based ICTs lowered the physical barriers for market entry in certain regions and thus promoted inclusive development. It gave the small and medium-sized enterprises (SMEs) with a disadvantage in the market competition a better opportunity to transform their business and enter into the global market (Fuller-Love et al., 2006). For example, through case studies, Grimes (2000) demonstrated how rural SMEs leveraged ICTs to access market information so as to develop innovative products, improve effective marketing, and enhance the learning capacities; No and Kwak (2018) observed how some SMEs used e-commerce as a marketing channel and achieved branding success in the overseas market.

In recent decades, we have witnessed the fast economic growth and dramatic change in market structure in China. The economic system reform and market competition started from coastal regions such as Guangdong Province near Hong Kong and Fujian Province neighboring Taiwan, which developed close relations with overseas market and attracted foreign investment (Berger & Lester, 1997). In these regions, REs that cover a broad range of business, such as shoes, garments, and so on have benefited from the open-door national strategy and developed quickly (Long et al., 2011). Meanwhile, as early as a decade ago, all administrative villages in China were already connected to Internet infrastructure (Gao & Yu, 2010). As a kind of SMEs, some REs have leveraged ICTs to upgrade from the traditional OEM to ODM and to OBM. In general, the entrepreneurship literature contains little research on REs in developing countries and emerging economies (Pato & Teixeira, 2014). In particular, we poorly understand how REs in China have transformed and, in particular, the role that ICT has played in this process. As such, our research objective in this paper is to explore this topic given its significant academic and practical relevance.

Specifically, we examine the methods by which Chinese REs leverage ICTs to achieve transformation, or the mechanism of ICT-facilitated firm transformation in Chinese REs. We consider cases of REs in Jinjiang, Fujian Province. As we show in our literature review, existing work focuses on particular aspects of firm transformation from specific perspectives, for example technology acquisition from the resource-based view (Poon & MacPherson, 2005), OEM strategy from a global value chain perspective (Chen, Wei, & Hu, 2015), and technological and design capabilities from a capability-based view (Ho, Fang, & Lin, 2011). Analysing one specific aspect of firm transformation from a particular perspective has its strengths but offers only one view of the reality of the transformation phenomenon. Indeed, we need to integrate multiple perspectives to understand a complex phenomenon (Crowston & Myers, 2004). Thus, we propose an analytical framework of multi-layers that integrates several perspectives: operation mode / technological capability, open innovation practices, and actor networks. The case study demonstrates that, by leveraging ICTs, a latecomer firm from disadvantaged context (e.g., a RE in China) can transform itself and catch up in the global value chain mainly with its indigenous efforts not necessarily with the local government's intervention. REs can leverage ICTs to practice open innovation and, accordingly, form a supportive actor network, which help the firm build its capability, transform itself, and advance in the global value chain.

This paper proceeds as follows. In Section 2, we conduct the literature review from which we identify research gaps and justify our research topic. In Section 3, we develop a theoretical framework that we use as a guide to collect and analyse data in the case study. In Section 4, we discuss our research methods and, in Section 5, present our case study. In Section 6, we discuss theoretical contributions and practical implications of the case study. Our findings verify the proposed framework and generate theoretical propositions. Finally, in Section 7, we conclude the paper.

2 Literature review

Firm transformation is an ambiguous concept without a generally recognised definition. In this paper, we refer to firm transformation as a process that a firm upgrades its operation mode and improves the skill in activities such as design, product development, branding, and marketing (Ernst, 2002; Kadarusman, 2010). In the literature, researchers have approached firm transformation as a complex phenomenon from diverse perspectives. In this section we review literature relevant to our research objective in this paper. With this literature review, we focus on 1) outlining the research perspectives that will be used as the theoretical bases for developing a multi-layer research framework in the next section of this paper and 2) identifying research gaps so as to justify our research objective and define research questions.

2.1 Paths for upgrading operation mode

Many researchers have considered the process by which firms upgrade their operation mode, which represents a basic issue in firm transformation. To survive ever-increasing market competition, firms from developing countries that manufacture products for MNCs receiving only marginal levels of profit must themselves acquire the capability of independent designing and branding (Chiang & Yan, 2011; Lee, Jee, & Eun, 2011). A typical transformation path for latecomer firms is from the OEM to ODM, and then to OBM (Lee, Song, & Kwak, 2015). Eng and Spickett-Jones (2009) presented cases of low-cost labour-intensive OEMs progressing to ODMs and OBMs, which possessed a competitive advantage based on product design, and proprietary technology and brand equity, respectively. Miao et al. (2018) reviewed 17 journals from 1995 to 2018 and focused on how East Asian firms have caught up in technology. From the 76 articles they have reviewed, they concluded that few firms from developing contexts have successfully transformed from OEM into OBM. For example, in Taiwan, most firms remained as OEMs or ODMs (Chu, 2009), especially in the ICT industry (Lu & Yang, 2004). Understandably, the literature concentrates on OEM or ODM and few case studies examine the complete upgrading process. For example, from the perspective of the global commodity chain, Chyr, Taylor and Hui (2008) explored the implementation challenges for export-oriented clothing OEM firms in Hong Kong

when upgrading; Huang and Lo (2003) investigated firms' transformations from the OEM to ODM against the background of supply chain reconfiguration in the personal computer industry in Taiwan; Lu and Chang (2011) found that, in China, MNCs helped OEMs that had direct contact with Chinese customers increase their capability to compete in the market and leap forward to ODMs.

In conclusion, few firms from disadvantaged contexts have completely transformed from the OEM to ODM and to OBM, and the literature lacks studies on firms that have made the complete transformation in the path of OEM-ODM-OBM. It is of both academic and practical interests to dissect successful cases of latecomer firms that have successfully made the transformation and understand the methods they have used to upgrade their operation mode stage by stage.

2.2 Technological capability building and firm transformation

The innovation efforts in accumulating knowledge and building capabilitiy that disadvantaged firms undertake have a critical role in their transformation (Humphrey & Schmitz, 2002). In concluding the literature review on studies of technology catching up in East Asian, Miao et al. (2015) called for firm-level studies on the strategic choice for catching up, which should focus on how firms build capabilities, especially technological capability. Technological capability of a firm refers to its ability to effectively use technological knowledge (Kim, 1999) - an intangible asset in product development and an essential source of competitive advantage (Nelson, 1991). A latecomer firm that conducts low value-added activities needs to build up its technological capability so as to move up in the value chain.

The technological capability literature offers useful insights on the factors that impact firms to upgrade their operation mode. Chu (2009) observed that firms in China, South Korea, and Taiwan transformed based on building up their technological capability. Lee, Song, and Kwak (2015) observed firms in South Korea developed technological capability in the transformation process. They argued that, before starting transformation to the next stage in the path of OEM-

ODM-OBM, and depending on the nature of target technologies, a firm must build technological capabilities in one of the two approaches – conduct in-house scientific R&D-based or acquire proprietary knowledge. Jin and von Zedtwitz (2008) conducted four in-depth case studies in China's mobile phone industry to illustrate the relationship between technological capability and whether firms successfully upgrade their performance, which confirmed the development of technological capability is critical for manufacturing firms in high-tech industries. Yan, Chiang, and Chien (2014) demonstrated that some Taiwanese firms could transform into OBMs because they have created the required capabilities. Zhou and Wu (2010) considered the roles of technological capability in product innovation. Wang and Wu (2012) suggested that, when selecting the technological learning approach, firms need to consider their position in the industry value chain as OEMs, ODMs, and OBMs since such firm types have different capabilities.

In conclusion, we agree with Eng and Spickett-Jones (2009) who have called for more studies that examine the methods by which OEMs have developed their capabilities, especially technological capability, to transform their operations and upgrade to ODMs and OBMs.

2.3 Open innovation and firm transformation

Firms need to engage in open innovation in order to build technological capability and upgrade their operation mode. Theoretically speaking, one can view innovation from two extreme perspectives: the closed view and the open view. The closed view assumes that innovation is a closed process that involves little interactions with the external environment. A closed firm would develop knowledge based on its internal sources with minimal external input (Petersen, Pedersen, & Lyles, 2008). In contrast, the open innovation concept stresses that a firm should apply external innovation sources in designing products and innovating its production processes (Chesbrough, 2003). Situated in a rapidly changing environment and the globalisation context, a firm must be able to take advantage of emerging external opportunities to stay competitive (Huston &

Sakkab, 2006). One needs to consider the open innovation perspective to understand firm transformation.

To upgrade to an ODM and OBM and catch up in the global value chain, a latecomer OEM in developing countries often needs to acquire key product knowledge and production skills from firms in knowledge-rich countries (Chyr, Taylor, & Hui, 2008; Poon & MacPherson, 2005) and engage in learning toward knowledge frontiers (Li et al., 2015). The disadvantaged firms when adopting open innovation practices, especially for start-ups when starting to collaborate with large firms, will meet different challenges, e.g. lack of resources, risk of misappropriation of technology, little to no market reputation and credibility (Usman & Vanhaverbeke, 2017). When transforming from the OEM to OBM, a firm needs to reconfigure its internal resources and re-coordinate with the external resources in order to adopt new operation mode and compete in the new position in global value chain (Yan, 2012). Firms may have to alter their organisational structure to reduce open innovation barriers (Karim & Kaul, 2015).

The business transformation literature has recognised open innovation characteristics in building technological capability but has not mentioned the open innovation concept explicitly. For example, Miao et al. (2018) argued that latecomer firms need to learn and acquire technological capabilities to transform from the OEM to OBM stage. Using a learning mechanism framework to analyse a case in Malaysia, Hansen and Ockwell (2014) found that firms could gain technological capability through a combination of external learning from technology partners and internal learning via planned experimentation. Kadarusman (2010) examined the external-learning process that Indonesian manufacturing firms followed to gain technological capability in their attempts to upgrade. To conclude, in case studies of firm transformation, we need to draw on the open innovation concept and frameworks so as to systematically examine open innovation practices, and strategy in technological capability building.

2.4 Actors and the actor network in the transformation process

A firm's network represents a key factor that enables it to transform from closed to open innovation (Chiaroni, Chiesa, & Frattini, 2011). Researchers have noticed the roles of specific actors and the actor network in open innovation and firm transformation. For example, Sun and Grimes (2016) were interested in how Chinese OEM, ODM, and OBM firms in high-tech industries competed in the global value chain. They argued it is necessary to examine the complex interconnected network of the firms involved, and the changes in the value chain arising from the ongoing search for greater levels of competitiveness. Berger and Diez (2006) compared the innovation systems that underpin OEM-ODM-OBM transformation in Singapore, Malaysia, and Thailand. The quality of the innovation system was found highly important for a firm's learning and innovation. Yang and Hsia (2007) positioned some Chinese OEM firms in the trans-border production network. They found that foreign brand-name firms have played a key role in propelling foreign investment in these Chinese firms. Hsu, Chen, and Jen (2008) examined the various resource linkages that ODM and OBM firms sought in Taiwan. One interesting finding is that marketing know-how was not a resource commonly sought by ODM firms, nor by OBM firms. They called for longitudinal in-depth case studies on the co-evolution of resource linkages and manufacturing capabilities (OEM-ODM-OBM). Usman and Vanhaverbeke (2018) argued SME managers should orchestrate the ecosystem of innovation partners. Lee, Jee, and Eun (2011) investigated the technological catching-up strategies that Chinese firms follow to gain access to a foreign knowledge base, which include the acquisition of technology and brands through international mergers and acquisitions, and parallel learning from foreign direct investment to promote indigenous firms etc. Huang, Zhang, and Zhu (2008) considered how SMEs in one of the poorest regions in eastern China entered into a competitive market. They found that clustering deepens the division of labour in the production process and makes it possible for SMEs to enter the industry by focusing on a narrowly defined stage of production.

In particular, the government represents an important actor in a firm's network. Much literature has examined how governments in different countries have intervened to help firms upgrade their capabilities. For example, the Chinese government required state-owned telecommunications operators to deploy Internet infrastructure to every village, which has created a better business environment for

farmers to transform from farming to e-commerce and participate in the international market (Leong et al., 2016; No & Kwak, 2018). In Taiwan, based on the national innovation system that offers strong government support to SMEs to help them transform, some SMEs have moved from OEM into ODM. Firms have learned to design products from their own concepts, and provided their overseas buyers with cost efficiencies and good quality. They further transformed into OBMs and learned to develop their own brands and marketing systems to compete in international market (Siu, 2005). In Taiwan, in the late 1980s when the OEM practice matured in most industries, the government promoted the movement of branding that involved many firms. Consequently, some domestic firms started to compete in the international market with their own brands. Supported by strong nationalism in China and Kortea, the governments in both countries adopted an innovation champion strategy and corresponding industrial policies (Chu, 2009). Specifically in China, the indigenous development of proprietary technologies has been taken as national pride, and the government took strong measures to support national firms to develop their technological capability (Gao, 2015).

In the transformation process, by stage the innovation tasks vary. Accordingly, in different stages, different actor networks should be formed. While researchers have recognised that firms' actor network plays a role in their transformation and some actors such as the government play a particularly important role, we require a dynamic perspective that focuses on the changing actor-network's components in different transformation stages.

2.5 ICTs' role in firm transformation

Many information systems scholars have investigated the role that ICT plays in firm transformation (Crowson & Myers, 2004). Veugelers, Bury, and Viaene (2010) observed that using ICT tools such as LexisNexis, Dialog, Google Alerts, Twitter Alerts, and so on could help a firm track new technology developments and prepare for designing its own products. Dodgson, Gann, and Salter (2006) presented a case that a suite of new ICTs for data mining, simulation, prototyping, and visual representation supported open innovation. No and Kwak (2018) found

recent advances in ICT infrastructure has facilitated some private firms in China to actively use e-commerce as a marketing channel and transform from subcontractors (OEM) to their own brands (OBM) in the global market. Li et al. (2015) noticed that an intra-firm communications platform has helped latecomers engage in learning and catch up with forerunners. Pacauskas, Durgam, and Fomin (2014) reported specific ways for firms to use information from social media to develop new products and demonstrated that moving from traditional closed to open product development affected its R&D performance.

However, there is still a paucity of research on ICT for firm transformation. This argument is supported by the findings from the systematic review on extant literature of technological catching-up by East Asian firms by Miao et al. (2018). From the literature, they have drawn some internal factors and external environment for the catching-up processes, which however don't include ICTs. We specifically lack research on how ICT can help firms address specific innovation tasks in different transformation stages from the OEM to ODM and to OBM.

2.6 Types of studied cases

In terms of types of the studied cases, the present research on firm transformation focuses on MNCs and big firms (Chen, Wei, & Hu, 2015; Laufs & Schwens, 2014). For example, Yan, Chiang, and Chien (2014) examined how Taiwan's top 20 global brand firms transformed themselves. Yang and Hsia (2007) concluded that, while many researchers have studied the OEM-ODM-OBM model of firm transformation in large firms in a city context in China, we need case studies about successful transformation from the OEM to OBM in non-farm REs as a special type of SME. Not one among the 76 papers on technological catching-up of East Asian firms that Miao et al. (2018) reviewed covered SMEs.

Pato and Teixeira (2014) conducted a bibliometric analysis on the rural entrepreneurship literature, which covered 181 papers from 1996 to 2013 in journals indexed in Scopus. The authors found that "the bulk of the empirical research on rural entrepreneurship focuses on high-income (74%) or upper middle-

income (13%) countries. Low-income countries are seldom studied in the period considered" (p.19). In particular, we lack knowledge on the role that ICTs play in RE development in a disadvantaged context.

Further, open innovation represents an important aspect in firms' transformation, but most case studies on this topic focus only on large, high-tech firms. As such, we need to expand empirical research on the process by which firms apply external innovation sources in product design and production to traditional industries (Chesbrough & Crowther, 2006; Chiaroni, Chiesa, & Frattini, 2011). In particular, we need case studies that examine OEM-ODM-OBM transformation of non-farm REs in developing countries or emerging economies from an open innovation perspective. An open innovation perspective stresses that firms achieve transformation by exploring external innovation sources to improve their capability in product design and production (Chesbrough, 2003).

2.7 Synopsis of the literature and the research question

To conclude the literature review, firm transformation constitutes a multifaceted phenomenon. To transform, a firm may upgrade its operation mode, develop its technological capability, engage in open innovation activities, and form an actor network. ICTs affect these activities directly or indirectly and play a fundamental role in firm transformation. In the present literature, each study mostly considers only one kind of activity (i.e., one aspect of the transformation). The overall mechanism of firm transformation, and especially the role that ICT plays in how SMEs from disadvantaged contexts achieve transformation, is underresearched.

With this paper, we move one step towards filling this gap. We integrate these perspectives into one framework to describe the mechanism of ICT-facilitated firm transformation, and then use the proposed framework to analyse cases of non-farm REs in China. Specifically, we investigate the following research question:

RQ: How can firms leverage ICTs to successfully transform themselves and advance in the industry value chain?

3 Analytical framework of ICTs-facilitated firm transformation

Based on the literature review, we develop an analytical framework (see Figure 1) of ICT-facilitated firm transformation. The framework assumes that firm transformation occurs at three layers: 1) operation mode / technological capability layer, 2) open innovation layer, and 3) actor network layer. Specifically, on the top layer, a firm upgrades its operation mode in three stages, i.e., from the OEM to ODM and to OBM. In each stage, the firm will meet different challenges; in the middle layer, to address these challenges posed on the top layer, the firm needs to engage in open innovation practices; on the bottom layer, to support open innovation in the middle layer, the firm needs to collaborate with relevant external actors with specific sources to form a supportive actor network. ICTs affects the activities that occur in and between layers. Specifically, the firm can take advantage of ICTs to form an efficient actor network for performing open innovation practices. The firm can also use ICTs to support open innovation directly, which underpins its activities to build its technological capability and, thus, to upgrade its operation modes.

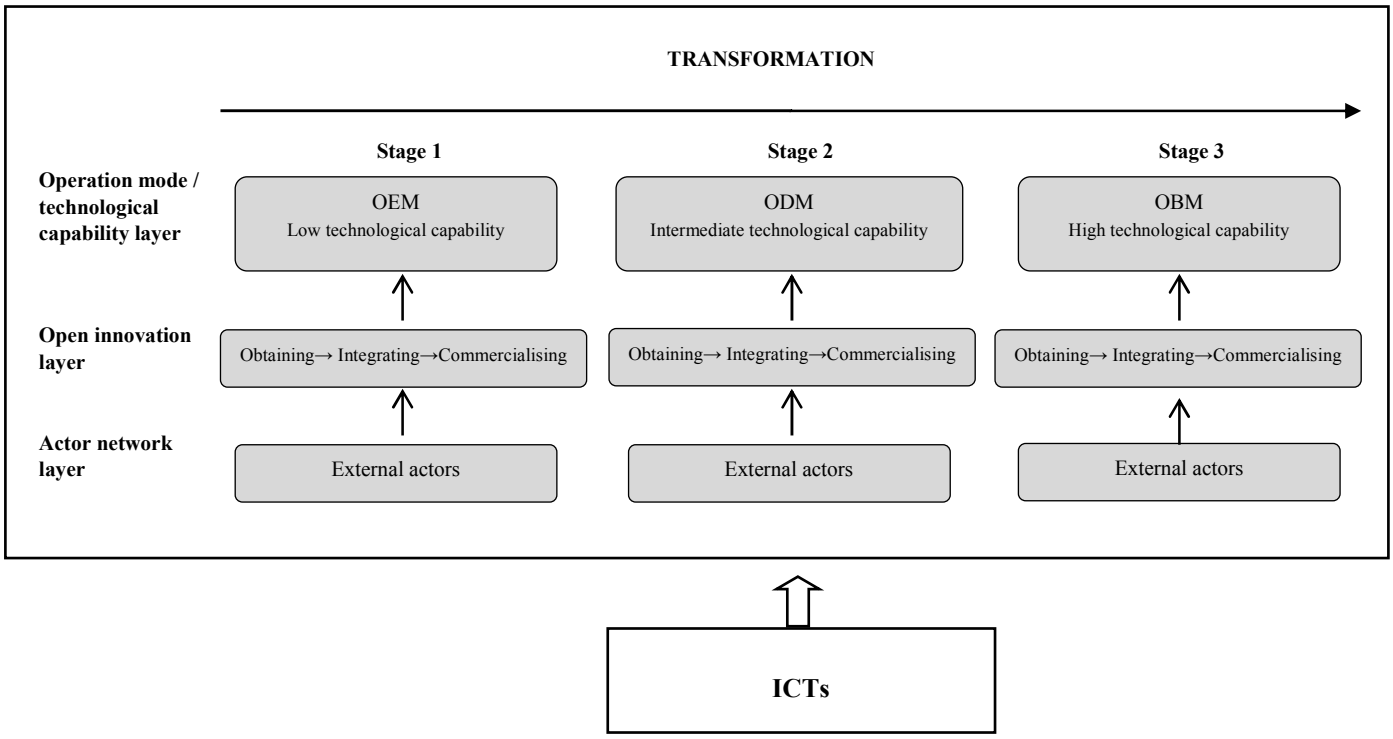

Figure 1 Analytical framework of ICTs-facilitated firm transformation

3.1 Operation mode and technological capability layer

The top layer of the framework describes the process that firms undergo to build their technological capability and upgrade their operation mode. Firm transformation and industrial development represent a process whereby a firm acquires technological capabilities and translates them into product and process innovation amid continuous technological change (Pack & Westphal, 1986). The OEM-ODM-OBM path represents the typical path that latecomer firms in developing countries follow to upgrade their technological capability (Lee, Song, & Kwak, 2015). Thus, we combine operation mode and technological capability into one layer placed on the top of the framework. In this layer, the tasks for research are to describe the characteristics of product and process innovation and to clarify the levels of technological capability in different operation modes.

The three operation modes (i.e., OEM, ODM, and OBM) represent different levels of technological capability (Chu, 2009). Specifically, OEM represents the initial stage of technological capability (Kim, 1980). Operating in the OEM mode, a firm concentrates on implementing imported technological packages and manufacturing products using client firms' design (Hobday, 1995). OEMs care about understanding the broad market and their competitors' products; however, with low technological capability, they can put only little indigenous efforts into product and process innovation. The indigenous efforts of a firm refer to its independent input in production (Fu, Pietrobelli, & Soete, 2011).

When implementing imported product designs and production technologies at its production units, an OEM has increasingly accumulated experience in production and become familiar with product-design characteristics. Finally the OEM will get the technological capability of upgrading to an ODM. In the ODM stage, except for manufacturing, the firm will focus on designing products by exploring imported products and technologies (Hobday, 1995).

The relative success in acquiring general production technology will gradually improve a firm's technological capability through indigenous efforts in production (Kim, 1980). Consequently, the firm will own its own brand and be able to deliver proprietary products, which means it has transformed to the OBM stage (Hobday, 1995).

3.2 ICT-facilitated open innovation layer

In the middle of the framework lies the open innovation layer that helps a firm build its technological capability and, thus, upgrade its operation mode on the top layer. Firm transformation is in the direction of having more access to broader external innovation sources and market (Huston & Sakkab, 2006). In pursuing open innovation, firms will meet various challenges, which they can overcome by using ICTs (Dodgson, Gann, & Salter, 2006). Given that the Internet's explosive growth has led to a dramatic increase in knowledge sources, firms should explore

the potential of using ICT tools to gather and analyse these sources to create knowledge (Veugelers, Bury, & Viaene, 2010).

From the literature, West and Bogers (2014) developed an open innovation model that describes the process from closed to open innovation with three stages: obtaining, integrating, and commercialising innovations from external sources. This model focuses on the dynamic characteristics of open innovation that ICTs facilitate. We refer to this model in our framework since it suits our research objective. It posits that firms use ICTs to obtain, integrate, and commercialise external information and knowledge in supporting different production, design, and marketing tasks across all operation modes (i.e., OEM, ODM, and OBM). In this layer, the tasks for research are to observe, stage by stage, key activities of open innovation – obtaining, integrating, and commercialising, and the roles of ICTs to support these activities.

In the obtaining stage, firms focus on sourcing new ideas externally. Traditional SMEs like REs in particular need to source such ideas since they generally exhibit limited technological capability in comparison to big high-tech firms (von Tunzelmann & Acha, 2005). A firm can use different kinds of ICTs, such as social media, as an intermediate for it to reach external sources of ideas and to include the useful ideas in the firm's knowledge base (Pacauskas, Durgam, & Fomin, 2014).

In the integrating stage, firms identify valuable innovations from external sources (West & Bogers, 2014). In this process, firms evaluate and then filter sources (Soukhoroukova, Spann, & Skiera, 2012). Firms need to evaluate external knowledge and technologies to ensure they select the correct ideas (Ozer, 2005). ICTs can help firms efficiently engage in these activities (Badii & Sharif, 2003). For example, Veugelers, Bury, and Viaene (2010) analysed a case that used ICT tools to collect and process data from different information sources, identify multiple new technologies of interest to the firm, and screen technologies to form technology intelligence profiles for the firm. The firm analysed primary raw data for its usefulness, filtered the data, and transformed it into actionable technology intelligence. The firm applied several ICT tools including software packages and databases to mine data, retrieve and classify text, conduct semantic analysis,

summarise documents, track webpages, and monitor the Internet. These ICT tools allowed the firm to download, categorise, integrate, and visualise texts in an automated manner.

In the commercialising ideas stage, firms harvest from innovations (West & Bogers, 2014). ICTs have proven useful in helping firms to exchange ideas for commercialisation purposes. For example, Nokia installed active wikis on both open-source and proprietary platforms, which helped it save time and effort in distributing and storing corporate intelligence; Lego implemented Web-based collaboration between Lego and its partners. It allowed for each partner to focus on core competences and ensure Lego would get the best innovations in products and services to use (Awazu et al., 2009).

3.3 ICT-facilitated actor network layer

The fundamental layer, the actor network layer, underpins open innovation process in the middle layer that includes the obtaining, integrating, and commercialising stages (West & Bogers, 2014) and impacts the process by which firms develop their technological capability and upgrade their operation mode on the top layer. The tasks for research are to identify the roles of ICTs in enrolling actors with specific knowledge sources into the actor network, and facilitating actor interconnections.

The successful experiences that firms in some emerging economies such as China have experienced demonstrate that interactions between local and foreign innovation efforts determine firms' technological capability building (Fu, Pietrobelli, & Soete, 2011). Specific external knowledge sources may include suppliers (Emden, Calantone, & Droge, 2006), customers (especially lead users) (Ozer, 2009; Piller & Walcher, 2006), business competitors (Leiponen & Helfat, 2010), public institutions and government (Pittaway et al., 2004), and so on. ICT systems can serve as an intermediatory for a firm to efficiently connect with these sources. For example, a firm can rely on social media to obtain customers' ideas and preferences when developing new products (Pacauskas, Durgam, & Fomin,

2014). Recent ICT-facilitated practices related to firm collaboration with customers in pursing innovation include idea and innovation crowdsourcing (Simula & Ahola, 2014), co-creation based on online platforms (Rayna, Striukova, & Darlington, 2015) and social media (Pacauskas, 2016), online communities (Gebauer, Füller, & Pezzei, 2013), virtual communities (Mahr & Lievens, 2012), and so on.

4 Research methods

4.1 The case

To reveal how ICTs facilitated firm transformation, we adopted a case study approach, which suits research that addresses "how" type research questions (Yin, 2009). We applied the "retroduction" technique, which allows one to explain events "by postulating (and identifying) mechanisms which are capable of producing them" (Sayer, 1992, p.107). Specifically, we developed a conceptual framework (Figure 1) from the literature. We then tested this framework via a case study of RE transformation in China and further exposed new theoretical findings by applying the framework to the phenomenon (Strauss & Corbin, 1994).

To select cases, we considered how well it represented the phenomenon of RE transformation in China and data availability. We selected the rural area of Jinjiang located in the south-eastern coast of Fujian Province in China as the case study setting. According to Jinjiang Statistics Year Book, in 2016, this area had 2.092 million residents over 721.7 square kilometres. With a GDP of CNY ¥174.424 billion, REs dominate the local economy at present due to hundreds of well-known national trademarks. Most REs in this area were family-run business operating in traditional industries such as garments, shoes, and zippers. They have experienced the transformation from the OEM to ODM and to OBM, during which ICTs played a vital role. We focused on three towns in particular: Longhu, Chendai, and Yinglin. We studied 24 representative REs in these towns (eight garment REs, eight shoe REs, and eight zipper REs).

4.2 Data

We used the analytical framework in Figure 1 as a guide to collect and analyse our data. We collected data from multiple sources. First, in 2016, we conducted two rounds of semi-structured interviews with 56 informants. Specifically, from 1 July to 15 August, we interviewed one owner and one ICT executive from 24 case REs. In addition, from 1 to 15 October, we interviewed eight governmental officials from the Jinjiang Municipal Bureau of Commerce in order to understand the government perspective of RE transformation and its supportive initiatives. We interviewed each person individually, and the interviews lasted for 1.5 to 2 hours. With informants' permission, we audio-recorded and transcribed the interviews. Following the analytical framework in Figure 1, in one interview, we tried to clarify such issues: ICT tools in use; the individual and organisational attitudes toward ICTs adoption; main sources of innovation; key external actors interacting with the REs via ICTs; information gathered and knowledge generated via ICTs usage; and so on. Second, from 15 August to 10 September, we made onsite observations to better understand how currently the case REs used ICT in business. We selected one RE as the observation site in each industry (garment, shoe, and zipper) to observe (thus, we observed three REs in total). In one site, the observation lasted for a week during its working time. Third, we referred to the REs' Internet homepages and annual reports and government policies' official documents to familiarise ourselves with background information about RE transformation in China. We validated data from different sources via triangulation before we used it. One author of this paper was responsible for conducting the interviews and onsite obvservations, but other authors participated in designing interview guidance and interpreting data. Such a triangulation of viewpoints among authors with different academic and personal backgrounds – originally from China or a different country with an expertise in ICT in China or rural development - ensured the collection of proper data and unbiased interpretations of the data.

We first analysed the data by writing thick descriptions. We repeatedly read the interview transcripts to capture the informants' meanings and contrasted them with data from other sources. Consequently, for each firm, we established a storyline for

how it developed its technological capability stage by stage and, in each stage, the underpinning paradigm shift from closed to open innovation with the help of ICTs. Further, for each firm, we identified the actors involved in the shift to open innovation and the interconnections among the actors, facilitated by ICTs. Consequently, we could describe the ICT-facilitated RE transformation, which presents as a process in which technological capability, open innovation, and actor network co-evolve.

5. Case study: ICT-facilitated RE transformation in China

In this section, we draw on the analytical framework in Figure 1 to investigate ICT-facilitated transformation in the case REs in Jinjiang, China. Specifically, we will examine how the REs improved the technological capability and transformed the operation mode based on ICT-faciliated open innovation practices; how the REs leveraged ICTs to form an actor network to support open innovation practices. We summarise the findings are in Table 1.

Table 1 Case findings

	Stage 1	Stage 2	Stage 3
Operation mode / technological capability layer	• OEM • Low technological capability	• ODM • Intermediate technological capability	• OBM • Low technological capability
	• Assembling products by referring to overseas clients' specifications • Using clients' brands	• Limited indigenous efforts in innovating differentiated products • Imitating competitors in product design	• Competing in the market with proprietary brands • Translating customers' demands into innovative product development
ICT-facilitated open innovation layer			
Obtaining	• Efficient mobile communications with clients	• Searching for latest market trends, competitors' products, market information, etc.	• Timely obtaining information in a large volume online via different channels (e.g., social media apps WeChat, e-commerce platforms Tmall, Jingdong, Ali Wangwang, etc.)
Integrating	• Not evident	• Evaluating absorbed information via Web-based applications of 3D shoe design • Evaluating and Diffusing information via ICT tools such as email and instant messenger QQ	• Micro innovation thinking approach: integrating customer feedbacks and preferences via ICT solutions • Creating online discussion boards on WeChat and e-commerce platform for customers to vote for new products • Providing personalised services via ICT applications
Commercialising	• Not evident	• Not evident	• REs started to sell online • E-commerce finally became the dominating channel • Online transactions widely used
ICT-facilitated actor network layer			
Key actors	• Foreign clients	• Foreign clients • Business competitors	• Customers • Local government

5.1 Stage 1: OEM mode and low technological capability

The first stage of RE transformation in Jinjiang was initiated in early 2000s. Operating as OEMs, all of the studied REs had low technological capability and displayed only the obtaining activities in open innovation. Specifically, these REs received orders from foreign clients along with product specifications and assembly instructions that they needed to follow in production. The REs had only few suppliers and retailers, and the REs' staff contacted the representatives of the suppliers and retailers directly face to face to exchange ideas about business operation. As the owner of one shoe RE told us, at that time when the business just took off, the firm concentrated on how to obtain orders and deliver on time using the traditional methods. Most REs did not know about the potential benefits from using ICTs in production and other works. One garment RE was exceptional. It was aware of the potential for ICTs to allow efficient communication but complained that they were unaffordable. The hardware, software, operation, and maintenance costs were high. Further, this garment RE could not rely on any local technicians but it cost too much money to recruit ones from cities. In this context, and due to low indigenous technological capability, all the REs that we studied did not care about using ICTs in operating their businesses.

This situation started to change in the later period of this OEM stage - the first stage of RE transformation. The Chinese government kept pushing hard on rural development and decided to further open the domestic market to foreign investment. The supportive measures to REs included preferential policies like offering REs loans with privileged interest rates, financial subsidy, and tax deduction (even exemption). Jinjiang had an advantage of benefiting from these national policies and achieving quick industrial development due to its geographical location. It resides only a sea strait away (about 200km) from Taiwan. Consequently, alongside our case firms, more and more REs emerged in Jinjiang, operating as OEMs (Interview with a governmental official). A lot of families in Jinjiang had wealthy business relatives in Taiwan. As several informants noted, close Chinese overseas ties attracted foreign investment in OEMs in this area. Their overseas contacts in Taiwan served as trade companies that referred orders to REs in Jinjiang. These REs focused on coping with these overseas orders but did not care about product or process innovation. They

competed with each other locally within few traditional industries like garment, shoe and zipper. To win in market competition, the REs had to make efforts to improve productivity. In this context, all of our studied REs started to recognise that the traditional face to face contacts with clients were inefficient. They used ICTs to facilitate them to communicate with their business partners in Taiwan.

5.2 Stage 2: ODM mode and intermediate technological capability

Driven by market competition and ICT innovation, RE transformation in Jinjiang entered into stage two, when they operated in the ODM mode with intermediate technological capability. In particular, the REs faced challenges from increasing number of new OEMs in the market. To achieve sustainable development, the REs had to develop their design capability and transform their operation mode from the OEM to ODM which meant they would be able to design their own products. As the Internet started to become an integral part of business and society, the REs started to recognise the roles that ICTs could play in their business. Due to their family owned nature, a RE owner normally appointed one relative to take charge of ICT use in the firm. Taking shoe RE2 as an example, the owner asked his son to go for training in Jinjiang City. Today, his son, a qualified ICT executive, oversees the firm's ICT-related duties. In interviewing the son, he said that he drafted the firm's ICT strategy and helped it implement information systems that relevant employees could access via mobile handsets. He also supervised the ICT training and the operation and maintenance of information systems.

In this stage, all of the studied REs focused on designing and producing differentiated products. For example, a garment RE differentiated its products from its competitors' products by changing its products' print, collar, cuff, and neckline designs to other styles. Due to their limited capability of indigenous innovation, the REs had to rely on external knowledge sources to develop products. They adopted an open innovation strategy and made efforts to learn from the market. The REs recognised ICTs' advantages in compensating for their disadvantage in operating in remote rural areas. They commonly used ICTs to practice open innovation, such as to access and evaluate innovation sources. For example, the product

development team at shoe RE3 followed the latest market trends via browsing its competitors' websites. The firm used a Web-based, 3D shoe-design application to evaluate and filter information that it obtained from the Internet. Consequently, the firm developed useful knowledge about product design, which staff members quickly diffused throughout the firm via different ICT tools, such as email and the instant messenger QQ. It integrated valuable knowledge into its existing knowledge base for product development. As different informants said:

> *Along with growing market competition, we faced stronger and stronger challenges for producing better products than our competitors. To get rid of the constraint by our remote location and improve our capability in product design and production, we then decided to rely on ICTs to obtain valuable product information from the market*. (Owner of zipper RE1)

> *When browsing the Internet if we found a shoe model in the market was selling well, we normally would go to the website of the seller and explore its properties in depth. We then would consider reconfiguring our own models but targeting on differentiated products. The Internet was a cheap solution for us to quickly respond to the market requirements and learn from the market.* (Owner of shoe RE3)

> *In our firm, you can often find people as a group of two or three sitting in front of a desktop to discuss how to use information obtained in the Internet for our production design and production. They search and evaluate information online together, and new ideas would be generated in this process.* (ICT executive from garment RE7)

5.3 Stage 3: OBM mode and high technological capability

In the OBM stage, the REs operated in an open mode and acquired the technological capability to explore the market with their own brands. The REs used ICTs in all their open innovation activities, which included obtaining, integrating,

and commercialising. The REs had a close connection to the external actors and, thus, the firm formed an efficient open innovation actor network.

In this stage, in general firms adopted e-commerce business model. Specifically to our case REs, during our onsite observations we found that each observed RE traded in several popular online platforms - typically Taobao, Tmall, Jingdong, and Ali Wangwang, and so on. Each platform contains abundant information about products, sales, purchases, markets and so on. By using ICTs, the REs could obtain such information in a large volume quickly as long as it was available online, which the REs relied on as an essential input to innovate their products.

Informants mentioned that such changes happened from 2014. The onsite observation with three representative REs indicated that more than 90 percent of the employees working on marketing and design used several mobile apps in their smartphones for business purposes. For instance, they used WeChat, one of the most popular socialising mobile apps in China for communications, sales and purchasing, payment, and after-sale service purposes. They received order notifications or alerts about new products in other e-stores that they followed via mobile phones. One informant from shoe RE8 said: “our firm will be unable to function smoothly without ICTs in place”.

The use of ICTs, especifically the adoption of e-commerce, greatly improved the open-integrating process. Specifically, ICT applications enabled effective interactions between the REs and customers and, consequently, facilitated this process. Customers represented key players of innovation throughout the entire OBM stage. Each RE regarded lead users as the most crucial source of innovation and made efforts to apply ICT-based solutions to involve these users into their innovation process. Different informants mentioned the “micro innovation thinking” approach several times. At its core, this approach produces a small volume of products for customers to experience and test at first hand in order to acquire their feedback for further improvement. All of the case REs created their online discussion boards on their e-commerce platforms and WeChat for these customers to discuss, comment, and vote for new designs. Customers could directly comment on or exchange their opinions about new products. Their ideas

reflected their preferences, which the REs found highly valuable in designing products. In contrast to the traditional mass production in a closed setting, this approach brought in innovative ideas to the REs' knowledge bases and minimised both cost and risk for new product development. Several REs offered personalised services for VIP customers. Two informants said:

> *We have adopted a bespoke business model allowing customers to propose their preferences and expectations to us via our virtual fitting room. In this way we could design their ideal products.* (Owner of shoe RE2)

> *Customers are essentially participating in our new product design. It would be impossible to make this happen if we did not have those online platforms to use.* (Owner of garment RE3)

We have learnt about the role that ICTs played in open commercialising in the OBM stage. Taking garment RE8 as an example, from 2009 when just starting OBM operation, it operated an online store in Taobao, an Alibaba platform. But, in the beginning, the traditional sale channel remained the dominant one, and it achieved few sales online. After a few years of operation, this situation changed. More and more people started to use smartphones, which allowed them to complete online transactions anytime and anywhere. In this technological background and through sophisticated Web-based marketing, the online commercialising channel dominated this RE's sales. As the owner of garment RE8 said, in 2015, the profits via its e- commerce store accounted for 87.2 percent of its total profits - a sharp growth compared to the 15 percent it achieved in the OBM stage initially. Most REs in the shoe and zipper industries we interviewed also confirmed an increase in their online commercial profits.

In our interviews in Jinjiang Municipal Bureau of Commerce, informants said that the Jinjiang Government actively helped the REs adopt e-commerce. On 7 August 2009, the Jinjiang Government issued Decree No. 87[1], which provided guidance

[1] Available at the website of Jinjiang Municipal Bureau of Commerce, http://www.jinjiang.gov.cn/zfshow.aspx?ctlgid=48774272&id=1556, recently accessed on 06.10.2018.

for the REs to implement ICTs in business and run e-commerce. It has also announced specific government-support measures. For example, the local government offered training to residents, including RE employees, on fundamental ICT knowledge. It provided subsidies to the REs to cover the membership fees of opening e-commerce accounts. In China, an e-commerce platform such as Taobao normally would charge very low account fees, but the Jinjiang Government's gesture encouraged hesitating REs to start e-commerce. Informants from all of the 24 REs acknowledged that government supports were more or less helpful for them in the initial e-commerce period.

6 Discussion

6.1 Reflections of the cases and framework: mechanism of ICT-facilitated RE transformation

Our framework (Figure 1) shows that ICT can help firms transform, which occurs in three layers (i.e., operation mode / technological capability layer, open innovation layer, and actor network layer) and three stages (i.e., OEM, ODM, OBM). We have used our framework to analyse traditional REs in China and, thus extended the extant literature, which mostly focuses on transformations or open innovation in large high-tech firms in developed countries. When in the OEM stage, the REs had a poor knowledge base and low technological capability. They simply assembled products for client firms by following their production specifications. The REs did not care about designing their own products and did not learn from the external sources. In terms of open innovation activities, the REs used ICTs only as tools to obtain information about products and production from clients and to communicate with them.

With ICTs' support, the REs transformed from the OEM to ODM, and they could operate efficiently in the ODM mode. In the ODM stage, the REs needed to develop differentiated products to cope with competition from new market entrants. The REs developed technological capability through obtaining and integrating external knowledge. Specifically, the REs sourced innovative

knowledge online from the market. Once they obtained external knowledge, the REs evaluated and filtered it via specific ICT platforms, such as a Web-based application. Finally, the relevant knowledge about production and design quickly diffused throughout the REs via ICT tools such as email and the instant messenger QQ. The REs integrated the new knowledge into their knowledge base and applied it to designing new and innovative products. Compared to the OEM stage, the REs relied on ICTs more in ODM stage to cope with the demands of open innovation.

In the ODM stage, the REs accumulated knowledge and gradually built up technological capability. Moving to the OBM stage, the REs could further improve their knowledge base and acquire the technological capability that they needed to develop their proprietary brands and deliver competitive products to the market. The REs used ICTs to pursue open innovation (in which they obtained, integrated, and commercialised ideas) and built an actor network for these activities. For example, some studied REs provided online discussion boards for their lead users to comment on new designs. The REs also received feedbacks from customers about their expectations and preferences after experiencing products in online virtual fitting rooms. Such ICT-facilitated interactions enabled the REs to reach out to external information in a timely manner and translate customer demands into innovative product ideas effectively. Consequently, with ICTs' help, the REs in OBM stage built a knowledge base that supported them to develop new products and implement innovative marketing strategies.

Based on the above analysis, we can draw the mechanism of ICT-facilitated firm transformation in the studied cases, which was characterised by an co-evolving process, in three layers. Specifically, technological capability co-evolved with the ICT-facilitated open innovation practices and the ICT-facilitated actor networks. In the OEM stage, the REs only obtained ideas and used ICTs to contact clients as the key actors of their actor networks. In the ODM stage, the REs used ICTs to both obtain and integrate ideas. Key actors also included competing firms. In the OBM stage, the REs obtained, integrated, and commercialised ideas. Firms used ICTs to approach customers with valuable knowledge on the market and products. The government support helped the REs when they began to run e-commerce.

The case study verifies the three-layer framework developed from the literature (Figure 1). This framework describes the mechanism of ICT-facilitated firm transformation. Specifically, to transform from the OEM to ODM and to OBM, firms need to leverage ICTs to engage in open innovation activities to build the required technological capability. Further, firms need to form an appropriate actor network to support open innovation practices, and use ICT to ensure the efficient collaboration of actors.

When using this framework to analyse a case of firm transformation which happens in three layers, in each layer there are specific research points for the researcher to explore. The findings will explain the mechanism of ICT-facilitated firm transformation in the studied case. Specifically, on the top layer, what are the characteristics of product and process innovation, and what are the levels of technological capability in the OEM, ODM, and OBM stages? In the middle layer, in each stage, what open innovation activities does a firm need to perform? How can the firm use ICTs to support these activities? In the fundamental layer, in one stage responding to open innovation requirements, what kinds of actors with specific knowledge sources should the firm enroll into their actor network? How can the firm leverage ICTs to help form their actor network and facilitate actor interconnections?

6.2 ICT-facilitated open innovation process

The case study demonstrate the process whereby technological capability building and open innovation practices co-evolve. On the one hand, to build their technological capability and upgrade their operation mode, firms need to engage in open innovation practices. On the other hand, technological capacity is the pre-condition to open innovation, and the technological capability level improvement from low to high level underpins the shift from closed to open innovation (Spithoven, Clarysse, & Knockaert, 2010). Further, open innovation requires that a firm values the innovative knowledge beyond its boundaries (Chesbrough, 2003; Huston & Sakkab, 2006). The extent to which a firm searches for innovative

sources determines how well it performs open innovation (Katila & Ahuja, 2002; Laursen & Salter, 2006), which it can achieve by using ICTs.

In the OEM stage when the REs had a poor knowledge base and low technological capability, the REs were rather satisfied with simple assembling operations. They could not cope with intensive learning and open innovation. They used ICTs only to contact their clients to obtain product and production information.

In the ODM stage, the REs accumulated a limited knowledge base and gained intermediate technological capability. The REs began to be interested in designing products but did not desire to compete in the market with their own brands. The REs leveraged ICTs to obtain external innovative knowledge, which they integrated into their knowledge bases so that they could develop differentiated products in order to stay competitive in the market. To do so, they searched for new market trends by browsing their competitors' online websites to approach their new designs. We saw such ICT-facilitated external-sourcing practices across the selected garment, shoe, and zipper REs.

To sustain a competitive advantage, the REs had to move from the ODM to the OBM stage in which they possessed the technological capability and knowledge base to compete in the market with their own brands. The whole open innovation process (i.e., obtaining, integrating, and commercialising stages) unfolded. Different from in the ODM stage, the REs in the OBM stage used socialising mobile apps such as WeChat and e-commerce platforms such as Taobao to perform broad and deep searches for information and knowledge. The REs could obtain feedback from customers about market trends and integrate their ideas into product design. The REs started adopting e-commerce which finally became the dominant commercialising channel for the REs. We may have

> *Proposition 1: in firm transformation process, open innovation should co-evolve with technological capability; as the firm's technological capability develops and the operation mode upgrades, the underpinning open innovation practices should become more open, which requires the firm to*

use ICTs in a more sophisticated way allowing them to more broadly and deeply search for innovation sources and access a broader market.

6.3 ICT-facilitated external actor network

From the OEM to ODM and to OBM stages, the REs' open innovation activities have involved different external actors. In the OEM stage when the REs focused on the obtaining activities in open innovation, foreign clients represented the dominant information source. The REs used ICTs only to have smooth connections with their overseas clients. In the following ODM stage, the REs engaged in open obtaining and integrating to build up their technological capability. Business competitors represented the key external actors. The REs employed ICTs to understand popular products in the market via surfing the Internet and referred to such kind of information in designing differentiated products in order to compete with emerging OEMs in the market. In the OBM stage, the REs relied on different ICT tools such as the socialising application WeChat and e-commerce platform Taobao to implement the micro innovation thinking approach and closely involve customers in product development and marketing. ICTs supported the REs in interacting with customers and incorporating customer needs and feedbacks into designing products under their proprietary brands.

Given globalisation and ICTs' pervasiveness, OEMs in latecomer countries now have an opportunity to transform their operation modes to ODMs and OBMs and upgrade their positions in the global value chain (Chen, Wei, & Hu, 2016). The extant wisdom posits that firms can only achieve such a transformation under MNCs' control (Humphrey & Schmitz, 2002). In examining traditional small-sized non-farm REs in China, we found that SMEs from disadvantaged contexts can control their catching-up process by leveraging ICTs to optimise their business actor network, which supports their open innovation activities and allows them to build their technological capability and upgrade their operation mode. The national government made ICTs infrastructure universally available across the country, including in rural areas. Further the local government was involved in REs' open innovation practices, but only when they began adopting e-commerce

by offering subsidies and trainings. Our findings support Pittaway et al.'s (2004) arguments that a firm's network relationships with its suppliers, customers, and intermediaries such as the government affect its innovation performance. We may move further to propose:

> *Proposition 2: in firm transformation process, actor network should co-evolve with open innovation in order to support the firm building its technological capability and upgrade its operation mode. As innovation practices become more open, firms need to use ICTs in a more sophisticated way to help the firm collaborate with external actors more closely. The government should ensure the availability of ICT infrastructure but does not have to intervene in helping firms adopt ICTs.*

6.4 Practical implications

The competitive environment and emerging ICTs offer both opportunities and challenges for firms with limited technological capability and poor knowledge base to upgrade their operation mode from the OEM to ODM and to OBM. The Chinese experience reflects how disadvantaged firms may rely on their own efforts to catch up and sustain competitive in the market by using ICTs. Firms can reference our empirical findings to design their transformation strategies.

Open innovation efforts drives a firm's transformation - a gradual process in which the firm accumulates knowledge, improves its knowledge base and builds technological capability. Latecomer firms should take advantage of different kinds of emerging ICTs, especially public socialising applications and open e-commerce platforms, to form an actor network for open innovation and ensure the efficient interconnections among actors. The actor network may include a different set of actors (e.g., clients, suppliers, competitors, customers, government, etc.) in different firm transformation stages.

6.5 Generalising beyond the cases of REs in China

For theoretical generalisation, Tsang (2014) suggests arguing a point based on similarities between relevant attributes of items in a sample and in other settings and asserts that broad claims based on the sample will likely to hold true in those other settings. We developed our framework (Figure 1) from the literature and verified it by examining Chinese REs. Considering that its components also exist in other settings, this framework will also likely apply to those other settings (i.e., to many different kinds of latecomer firms in different industrial and country contexts).

6.6 Limitations and future works

This paper has limitations that readers and future research should consider. First, the proposed framework can be improved. We consider only the typical business transformation path (i.e., OEM-ODM-OBM). In reality, for latecomers to catch up to leading firms and upgrade their position in the industry value chain, they do not have to go through this usual growth path. For example, some firms may leapfrog from OEMs to OBMs (Chiang & Yan, 2011; Chu, 2015; Jin & von Zedtwitz, 2008). Moreover, we simplify the framework by considering only the comparative levels of technological capability according to the stage (i.e., low, intermediate, and high level at the OEM, ODM, and OBM stages, respectively). Future research may treat technological capability as one separate layer and consider the core activities of technological capability development in each transformation stage. Second, future research can deepen understandings on the mechanism of ICT-faciliatiated firm transformation. Researchers can conduct case studies to categorise ICTs and map their types with the transformation tasks by stage. Last, we analyse only some non-farm REs in Jinjiang, China. The studied Chinese REs operated in traditional industries such as shoes, garments, and zippers. Unlike high-tech firms and big firms, these REs, a kind of SMEs, generally were not knowledge intensive and did not require high technological capability to operate. Researchers need to test our framework and empirical findings with case studies on different kinds of firms in different industries, other provinces with different

opportunities in terms of oversee business connections and government support, and other countries.

7 Conclusions

ICT-facilitated firm transformation presents a co-evolution process over three interrelated layers: 1) operation mode / technological capability layer, 2) ICT-facilitated open innovation layer, and 3) ICT-facilitated actor network layer. Specifically, based on the technological capability, a firm may upgrade its operation mode from the OEM to ODM and to OBM. In each stage, the firm must leverage ICTs to engage in an appropriate level of open innovation practices and, accordingly, form a supportive actor network. In principle, as the firm develops its technological capability and upgrades its operation mode, the firm should expand the open innovation practices (i.e., obtaining, integrating, and commercialising external knowledge) it conducts. Meanwhile, as the transformation moves forward, a firm's actor network becomes more complex, and accordingly the firm needs to use ICTs in a more sophisticated way to support the firm to collaborate more efficiently with other actors.

The proposed framework describes the mechanism of ICT-facilitated firm transformation. Specifically, operation mode and technological capability co-evolve with the ICT-facilitated open innovation and the ICT-facilitated actor network (Table 1). Future researchers can use it as an analytical tool in case studies of ICTs in firm transformation. Moreover, firms can refer to our framework in designing their ICT-facilitiated transformation strategies. This case study demonstrates that, on the condition that the government has ensured the availability of ICTs infrastructure, a latecomer firm from a disadvantaged context can take advantage of ICTs to transform itself and advance in the industry value chain mainly with its own indigenous efforts. The firm should improve its technological capability and upgrage its operation mode stage by stage, and in each stage the firm should use proper ICTs to promote open innovation practices, and accordingly form and effectively operate a supportive actor network.

References

Awazu, Y., Baloh, P., Desouza, K.C., Wecht, C.H., Kim, J., & Jha, S. (2009). Information-communication technologies open up innovation. *Research-Technology Management*, 52(1), 51-58.

Badii, A., & Sharif, A. (2003). Information management and knowledge integration for enterprise innovation. *Logistics Information Management*, 16(2), 145-155.

Berger, M., & Diez, J. R. (2006). Do firms require an efficient innovation system to develop innovative technological capabilities? Empirical evidence from Singapore, Malaysia and Thailand. *International Journal of Technology Management,* 36(1/2/3), 267-285.

Berger, S., & Lester, R. K. (1997). *Made by Hong Kong.* Oxford, UK: Oxford University Press.

Brown, R. (1998). Electronics foreign direct investment in Singapore: A study of local linkages in "Winchester City". *European Business Review*, 98(4),196-210.

Chen, D., Wei, W., & Hu, D. (2016). Survival strategy of OEM companies: A case study of the Chinese toy industry. *International Journal of Operations & Production Management*, 36(9), 1065-1088.

Chesbrough, H. W. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Press.

Chesbrough, H., & Crowther, A. K. (2006). Beyond high tech: Early adopters of open innovation in other industries. *R&D Management*, 36(3), 229-236.

Chiang, C., & Yan, H-D. (2011). Entrepreneurship, competitive advantages, and the growth of the firm: The case of Taiwan's radio control model corporation - Thunder Tiger. *Journal of Small Business & Entrepreneurship*, 24(4), 513-530.

Chiaroni, D., Chiesa, V., & Frattini, F. (2011). The open innovation journey: How firms dynamically implement the emerging innovation management paradigm. *Technovation*, 31(1), 34-43.

Chu, W. W. (2009). Can Taiwan's second movers upgrade via branding? *Research Policy*, 38(6), 1054-1065.

Chu, W. W. (2015). Latecomer upgrading in Taiwan. *Journal of the Asia Pacific Economy*, 20(3), 369-384.

Chyr, S. Y., Taylor, G., & Hui, C.L.P. (2008). Transition from OEM to OBM: A case study of Fenix. *Research Journal of Textile and Apparel*, 12(3), 77-85.

Crowston, K., & Myers, M.D. (2004). Information technology and the transformation of industries: Three research perspectives. *Journal of Strategic Information Systems*, 13(1), 5-28.

Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: The case of Procter & Gamble. *R&D Management*, 36(3), 333-346.

Emden, Z., Calantone, R. J., & Droge, C. (2006). Collaborating for new product development: Selecting the partner with maximum potential to create value. *Journal of Product Innovation Management*, 23(4), 330-341.

Eng, T. Y., & Spickett-Jones, J. G. (2009). An investigation of marketing capabilities and upgrading performance of manufacturers in mainland China and Hong Kong. *Journal of World Business*, 44(4), 463-475.

Ernst, D. (2002). Global production networks and the changingg geography of innovation systems: Implications for developing countries. *Economics of Innovation and New Technology,*11(6), 497-523.

Fu, X., Pietrobelli, C., & Soete, L. (2011). The role of foreign technology and indigenous innovation in the emerging economies: Technological change and catching-up. *World Development*, 39(7), 1204-1212.

Fuller-Love, N., Midmore, P., Thomas, D., & Henley, A. (2006). Entrepreneurship and rural economic development: A scenario analysis approach. *International Journal of Entrepreneurial Behavior & Research*, 12(5), 289-305.

Gao, P. (2015). Government in the catching-up of technology innovation: Case of administrative intervention in China. *Technological Forecasting & Social Change*, 96, 4-14.

Gao, P., & Yu, J. (2010). Has China caught up in IT? *Communications of the ACM***,** 53(8), 30-32.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy*, 12(1), 78-104.

Gebauer, J., Füller, J., & Pezzei, R. (2013). The dark and the bright side of co-creation: Triggers of member behavior in online innovation communities. *Journal of Business Research*, 66 (9), 1516-1527.

Grimes, S. (2000). Rural areas in the information society: Diminishing distance or increasing learning capacity? *Journal of Rural Studies*, 16 (1), 13-21

Hansen, U. E., & Ockwell, D. (2014). Learning and technological capability building in emerging economies: The case of the biomass power equipment industry in Malaysia. *Technovation*, 34(10), 617-630.

Hicks, G. (1989). The Four Little Dragons: An enthusiast's reading guide. *Asian-Pacific Economic Literature*, 3(2), 35-49.

Ho, Y-C., Fang, H-C., & Lin, J-F. (2011). Technological and design capabilities: Is ambidexterity possible? *Management Decision*, 49(2), 208-225.

Hobday, M. (1995). East Asian latecomer firms: Learning the technology of electronics. *World Development*, 23(7), 1171-1193.

Hobday, M. (2000). East versus Southeast Asian innovation systems: Comparing OEM- and TNC-led growth in electronics. In Kim, L., & Nelson, R. R. (Eds.), *Technology, Learning, and Innovation:Experiences of Newly Industrialized Economies* (pp. 129-169). Cambridge, UK: Cambridge University Press.

Hsu, C. W., Chen, H., & Jen, L. (2008). Resource linkages and capability development. *Industrial Marketing Management*, 37(6), 677-685.

Humphrey, J., & Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies*, 36(9), 1017-1027.

Huang, C-W., & Lo, C-P. (2003). Using postponed manufacturing to reconfigure the supply chain in the desktop personal company industry: The case of Taiwan. *International Journal of Management,* 20(2), 241-256.

Huang, Z., Zhang, X., & Zhu, Y. (2008). The role of clustering in rural industrialization: A case study of Wenzhou's footwear industry. *China Economic Review*, 19(3), 409-420.

Huston, L., & Sakkab, N. (2006). Connect and develop. *Harvard Business Review*, 84(3), 58-66.

Jin, J., & Von Zedtwitz, M. (2008). Technological capability development in China's mobile phone industry. *Technovation*, 28(6), 327-334.

Kadarusman, Y. (2010). *Global Value Chains and Technological Capabilities: Analysing the Dynamics of Indonesia's Garments and Electronics Manufacturers,* PhD dissertation, The University of Manchester, Manchester, UK.

Karim, S., & Kaul, A. (2015). Structural recombination and innovation: Unlocking intraorganizational knowledge synergy through structural change. *Organization Science*, 26(2), 439-455.

Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, 45(6), 1183-1194.

Kim, L. (1980). Stages of development of industrial technology in a developing country: A model. *Research Policy*, 9(3), 254-277.

Kim, L. (1999). Building technological capability for industrialization: Analytical frameworks and Korea's experience. *Industrial and Corporate Change*, 8(1), 111-136.

Laufs, K., & Schwens, C. (2014). Foreign market entry mode choice of small and medium-sized enterprises: A systematic review and future research agenda. *International Business Review*, 23(6), 1109-1126.

Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, 27(2), 131-150.

Lee, K., Jee, M., & Eun, J-H. (2011). Assessing China's economic catch-up at the firm level and beyond: Washington Consensus, East Asian Consensus and the Beijing Model. *Industry and Innovation*, 18(5), 487-507.

Lee, K., Song, J., & Kwak, J. (2015). An exploratory study on the transition from OEM to OBM: Case studies of SMEs in Korea. *Industry and Innovation*, 22(5), 423-442.

Leiponen, A., & Helfat, C.E. (2010). Innovation objectives, knowledge sources, and the benefits of breadth. *Strategic Management Journal*, 31(2), 224-236.

Li, W., Wu, W, Yu, B., & Foo, C-T. (2015). Is China transmuting to fast overtake the USA in innovation? R&D case-studies in advanced technology manufacturing. *Chinese Management Studies*, 9(1), 8-26.

Long, H. L., Zou, J., Pykett, J., & Li, Y. R. (2011). Analysis of rural transformation development in China since the turn of the new millennium. *Applied Geography,* 31(3), 1094-1105.

Lu, L. Y. Y., & Yang, C. (2004). The R&D and marketing cooperation across new product development stages: An empirical study of Taiwan's IT industry. *Industrial Marketing Management*, 33, 593-605.

Luo, C-M., & Chang, H-F. (2011). SME competitive strategy: Learning from Taiwan's ODM industry. *Business Strategy Serie*s, 12(3), 107-114.

Mahr, D., & Lievens, A. (2012). Virtual lead user communities: Drivers of knowledge creation for innovation. *Research Policy*, 41(1), 167-177.

Mathews, J. (2008). China, India and Brazil: Tiger technologies, dragon multinationals and the building of national systems of economic learning. *Asian Business & Management*, 8(1), 5-32.

McElwee, G., & Smith, R. (2014). Rural entrepreneurship. In Fayolle, A. (Eds.), *Handbook of Research on Entrepreneurship* (pp.423-470). Cheltenham: Edward Elgar.

Miao, Y., Song, J., Lee, K., & Jin, J. (2018). Technological catch-up by East Asian firms: Trends, issues, and future research agenda. *Asia Pacific Journal of Management*, 35(3), 639-669.

Nelson, R. R. (1991). Why do firms differ, and how does it matter? *Strategic Management Journal*, 12(S2), 61-74.

No, S., & Kwak, J. (2018). Building global brands for Chinese private-owned enterprises: Strategic paths to upgrade the value chain. *Issues & Studies: A Social Science Quarterly on China, Taiwan, and East Asian Affairs,* 54(2), 1850003/1-26.

Ozer, M. (2005). Factors which influence decision making in new product evaluation. *European Journal of Operational Research*, 163(3), 784-801.

Ozer, M. (2009). The roles of product lead-users and product experts in new product evaluation. *Research Policy*, 38(8), 1340-1349.

Pacauskas, D. (2016). *The Role of ICT in the Value Co-Creation Process*. PhD dissertation, Aalto University, Helsinki, Finland.

Pacauskas, D., Durgam, P., & Fomin, V. V. (2014). How companies can modify R&D for integrating social media activities into the new products development. In *Proceedings of the 27th Bled eConference: eEcosystems*, Bled, Slovenia, June 1-5, Paper 39.

Pack, H., & Westphal, L. E. (1986). Industrial strategy and technological change: Theory versus reality. *Journal of Development Economics*, 22(1), 87-128.

Pato, M. L., & Teixeira, A.A.C. (2014). Twenty years of rural entrepreneurship: A bibliometric survey. *Sociologia Ruralis,* 56(1), 4-28.

Petersen, B., Pedersen, T., & Lyles, M. A. (2008). Closing knowledge gaps in foreign markets. *Journal of International Business Studies*, 39(7), 1097-1113.

Piller, F. T., & Walcher, D. (2006). Toolkits for idea competitions: A novel method to integrate users in new product development. *R&D Management*, 36(3), 307-318.

Pittaway, L., Robertson, M., Munir, K., Denyer, D., & Neely, A. (2004). Networking and innovation: A systematic review of the evidence. *International Journal of Management Review*, 5/6(3&4), 137-168.

Poon, J. P. H., & MacPherson, A. (2005). Technology acquisition among Korean and Taiwanese firms in the United States. *International Business Review,* 14(5), 559-575.

Porter, M.E. (2001). Strategy and the Internet. *Harvard Business Review*, March, 62-78

Rayna,T., Striukova, L., & Darlington, J. (2015). Co-creation and user innovation: The role of online 3D printing platforms. *Journal of Engineering and Technology Managemen*, 37, 90-102.

Sayer, A. (1992). *Method in Social Science: A Realist Approach.* London: Routledge.

Simula, H., & Ahola, T. *(*2014). A network perspective on idea and innovation crowdsourcing in industrial firms*. Industrial Marketing Management*, 43(3), 400-408.

Siu, W. S. (2005). An institutional analysis of marketing practices of small and medium-sized enterprises (SMEs) in China, Hong Kong and Taiwan. *Entrepreneurship & Regional Development*, 17(1), 65-88.

Soukhoroukova, A., Spann, M., & Skiera, B. (2012). Sourcing, filtering, and evaluating new product ideas: An empirical exploration of the performance of idea markets. *Journal of Product Innovation Management*, 29(1), 100-112.

Spithoven, A., Clarysse, B., & Knockaert, M. (2010). Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation*, 30(2), 130-141.

Strauss, A. L., & Corbin, J. (1994). Grounded theory methodology: An overview. In Denzin, N. K., & Lincoln, Y.S. (Eds.), *Handbook of Qualitative Research.* Thousand Oaks, CA: Sage Publications.

Sun, Y., & Grimes, S. (2016). China's increasing participation in ICT's global value chain: A firm level analysis. *Telecommunications Policy*, 40(2/3), 210-224.

Tsang, E.W.K. (2014). Case studies and generalization in information systems research: A critical realist perspective. *Journal of Strategic Information System*, 23(2), 174-186.

Usman, M., & Vanhaverbeke, W. (2017). How start-ups successfully organize and manage open innovation with large companies. *European Journal of Innovation Management*, 20(1), 171-186.

Usman, M., & Vanhaverbeke, W. (2018). Business model innovation: Role of entrepreneur for open innovation in SMEs. *Presentation at the DRUID Academy Conference 2018*, University of Southern Denmark, Odense, Denmark, Jan. 17-19.

Veugelers, M., Bury, J., & Viaene, S. (2010). Linking technology intelligence to open innovation. *Technological Forecasting & Social Change*, 77(2), 335-343.

Vogel, E.F.. (1991). *The Four Little Dragons: The Spread of Industrialization in East Asia*. Cambridge, MA: Harvard University Press.

von Tunzelmann, N., & Acha, V. (2005). Innovation in "low-tech" industries. In Fagerberg, J., Mowery, D., & Nelson, R. (Eds.), *The Oxford Handbook of Innovation* (pp. 407-432). Oxford, UK: Oxford University Press.

Wang, H.W., & Wu, M.C. (2012). Business type, industry value chain, and R&D performance: Evidence from high-tech firms in an emerging market. *Technological Forecasting & Social Change*, 79(2), 326-340.

West, J., & Bogers, M. (2014). Leveraging external sources of innovation: A review of research on open innovation. *Journal of Product Innovation Management*, 31(4), 814-831.

Xie, W., & Wu, G. (2003). Differences between learning processes in small tigers and large dragons: Learning processes of two color TV firms within China. *Research Policy*, 32(8), 1463-1479.

Yan, H-D. (2012). Entrepreneurship, competitive strategies, and transforming firms from OEM to OBM in Taiwan. *Journal of Asia-Pacific Business*, 13(1), 16-36.

Yan, H-D., Chiang, C., & Chien, C.S. (2014). From original equipment manufacturing to branding: Entrepreneurship, strategic leadership, and Taiwan's firm transformation. *International Entrepreneurship and Management Journal,* 10(1), 81-102.

Yang, Y-R., & Hsia, C-J. (2007). Spatial clustering and organizational dynamics of transborder production networks: A case study of Taiwanese information-technology companies in the Greater Suzhou Area, China. *Environment and Planning A*, 39(6), 1346-1363.

Yin, R. K. (2009). *Case Study Research, Design & Methods,* 4th ed., Thousand Oaks, CA: Sage Publications.

Zhou, K. Z., & Wu, F. (2010). Technological capability, strategic flexibility, and product innovation. *Strategic Management Journal*, 31(5), 547-561.

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