Interim report for *Industrial organisation in China: Theory building and analysis of new dimensions*, IDE-JETRO, Fiscal year 2016

Overseas expansion and technological capabilities: The case of Chinese electronics firms

Koichiro Kimura*

Abstract

Many indigenous Chinese firms have become outward looking for further growth. It is known that the productivities of internationalizing firms are higher on average than those of their non-internationalizing counterparts. As predicted, Chinese firms with increasing technological capabilities also have been accelerating overseas operations. The formation of technological capabilities is, however, different among firms. In this case study, we analyse the formation of technological capabilities in China's home appliance and electronics industry, focusing on the technological gaps between foreign and Chinese firms. We show that when technological gaps are smaller, firms have possibilities to increase technological capabilities by acquiring businesses of firms in developed countries. However, in the telecommunication equipment industry, wherein bigger gaps exist, it is still difficult to buy major competitors because they retain competitiveness. Moreover, since business opportunities in new markets are increasing and the hurdles for starting businesses are decreasing, even startups from developing countries have opportunities to seize first-mover advantages.

Keywords: innovation, R&D, M&A, startups, China, electronics industry

* Associate Senior Research Fellow, Inter-disciplinary Studies Center, Institute of Developing Economies (IDE), Japan. The author thanks the members of the research project "Industrial Organisation in China: Theory Building and Analysis of New Dimensions," Dr. Mai Fujita (the project leader, IDE), Dr. John Humphrey (University of Sussex), Professor Shiro Hioki (Tohoku University), and Dr. Ke Ding (IDE) for their comments. Certainly all remaining errors are my own.

1 Introduction

As the domestic market has been saturated, many indigenous Chinese firms have become outward looking for further growth. Numerous Chinese firms now have global operations, such as Huawei Technologies (hereafter, Huawei) and ZTE in the telecommunication equipment industry, Haier Group (Haier) and Midea Group (Midea) in the home appliance industry, and Lenovo in the PC industry, among others. In addition to these major incumbents, there are an increasing number of hardware startups that are aggressively developing overseas markets immediately after they start businesses. Examples of such startups include Da-Jiang Innovations Science and Technology (DJI), which was founded in 2006 and sells drones, and Makeblock, which was founded in 2011 and sells a robot production platform, among others.

This paper discusses the overseas expansion of Chinese firms and their technological capabilities vis-à-vis their competitiveness in the global market. In this study, we limit the discussion to firms that have own-brand products. Although there are numerous contract manufacturers that are exporting huge product volumes to customer firms, the business strategies of firms with own brands are different from those of contract manufacturers in terms of product development, marketing, etc. Hence, we concentrate on the rise of global brands from China in this study. Besides, among a variety of aspects of business internationalization, we are concerned with overseas market expansion through exports and/or outward foreign direct investment (ODI). Therefore, herein, we limit the aims of ODI to the market-seeking objective, though there are other purposes for investment such as resource-seeking, strategic asset-seeking ODI, etc. (Buckley et al., 2007).

It is known that the productivities of internationalizing firms through exports and/or ODI are higher on average than those of their non-internationalizing counterparts (Antràs, 2016; Antràs and Helpman, 2004; Helpman et al., 2004; Melitz, 2003). Because overseas expansion requires additional fixed costs to understand and adapt to foreign trade institutions, markets, rules, etc., only high-productivity firms can bear the costs of such expansion. Also, research on ODI determinants has established that having competitive technology/expertise (the ownership advantage) is one of the determinants of ODI as well as a reason to invest there and independently (the location and internalization advantages, respectively) in the OLI paradigm for ODI mechanisms

(Dunning and Lundan, 2008).[1] ODI offers a business opportunity to investors but also requires additional fixed costs associated with international ventures for the same reasons mentioned above. Therefore, investors must exhibit a certain degree of competitiveness in comparison with rivals.

As the previous studies in international economics predict, Chinese firms are the case. Chinese firms with increasing technological capabilities have been accelerating overseas operations. In addition to technology introduction from developed countries, major Chinese firms have gradually increased research and development (R&D) efforts for decreasing production costs and launching high value-added products under fierce competition and rapid wage growth in China. As a result, Chinese firms actively looking abroad are increasing to adapt to the tougher of the business conditions in China.

The technological capabilities and configurations of Chinese firms are, however, different among firms. Many Chinese firms have increased technological capabilities by introducing technologies from developed countries and by virtue of learning-by-doing through huge production. Moreover, every firm that is internationalizing business will be accumulating through investments in R&D activities to internalize the product development stage, although to varying degrees. In contrast, some of the major incumbents have exhibited a tendency toward buying time for further growth through large-scale cross-border M&A. In addition to incumbents, startups striving to produce new products are increasing in the background of changes in the business environment and are associated with the birth of new markets and the development of startup ecosystems. Consequently, internationalizing firms share a similarity that they are uniformly increasing their technological capabilities but also exhibit differences in terms of process specificities related to their technological capabilities.

In this case study, we analyse the formation of technological capabilities in Chinese firms in the home appliance and electronics industry. Accordingly, we focus particularly on the technological gaps between foreign and Chinese firms, in addition to a variety of industry-specific and firm-specific factors. Importantly, the distance to the technological frontier established by firms in developed countries influences the formation of technological capabilities of firms in developing countries. Thus, the corollary can be presented: If the technological gap between firms in developed and

[1] This competitive advantage is termed the Ownership advantage in the OLI paradigm of ODI determinants. The L and I in OLI denote Location and Internalization advantages, respectively.

developing countries is wider or narrower, there would be concomitant impacts on these formation processes.

The remainder of this article is organized as follows. In the next section, we introduce the growth pattern and overseas expansion of Chinese firms that are the focus of this study. In Section 3, we analyse the formation of technological capabilities in Chinese firms, focusing on the technological gaps. Section 4 concludes.

2 Growth of Chinese Firms

In this section, we introduce the growth of Chinese home appliance and electronics firms as a precursor to the analysis in the next section. First, the growth pattern of Chinese firms in the period up to the mid-2000s is shown in Section 2.1. Subsequently, contemporary overseas expansion of Chinese firms is introduced in Section 2.2.

2.1 Previous Growth Trends

Chinese home appliance and electronics firms have rapidly grown by being likely to place greater emphasis on market-oriented stages in product value chains—product development, manufacturing, and sales—in the period up to the mid-2000s (Kimura 2014; Marukawa 2007; Ohara 2000; Watanabe 2015); they have been also trying to become increasingly technology-oriented recent years. Market-oriented stages specifically include downstream operations in value chains, such as building nationwide sales and after-sales networks and providing products catered to the tastes and lifestyles of Chinese consumers in a variety of areas, income levels, etc. In contrast, technology-oriented stages include upstream operations, such as designing and developing new products and developing and manufacturing core components of products. Product assembly and manufacturing locates between the market- and technology-oriented stages just described.

Chinese firms have been rapidly growing since the economic liberalization in the late 1970s. Since there were significant technological gaps between foreign and Chinese firms when this period of liberalization commenced, Chinese firms began to introduce production lines and related technologies from developed countries. Moreover, they have accumulated technological capabilities and expertise on assembling and manufacturing products through the rapid expansion of production volumes.

Consequently, technological gaps in the product assembly and manufacturing stage have narrowed.

However, it was not rational for Chinese firms facing significant technological gaps to accumulate technological capabilities for product development and core components independently at that time. Therefore, they have heavily depended on product design services and core components provided by outside specialized firms. Chinese firms did not possess advanced technologies, and it was rational to use outside firms because product structures had become modularized through digitalization and because industrial structures also had become vertically specialized along with modularization.

On the other hand, Chinese firms have been more likely to internalize the market-oriented stage than the technology-oriented stage. They have actively established nationwide sales and after-sales service networks, including the markets in local cities and rural areas where foreign firms have not been affiliated with. Moreover, they have differentiated products to adapt to consumers' diversified tastes by actively utilizing local knowledge as indigenous firms in the Chinese market.[2] In other words, they have been able to enjoy the home advantage in the domestic market. Consequently, Chinese firms have realized rapid growth by finding an optimal balance of the following three factors: technological accumulation, utilization of outside firms to fill technological gaps, and the home advantage as indigenous firms.

Although the market-oriented strategy has worked well for Chinese firms in the domestic market, it is not effective for the global market (Kimura, 2014). First, because Chinese firms still face technological gaps in product development, their technological capabilities are insufficient to differentiate products in the context of fierce competition in the global market. Second, because the accessibility of vertical specialization can be an advantage for not only Chinese firms but also firms in other emerging countries, the advantage can decrease in foreign markets. Third, as they have enjoyed the home advantage in the Chinese market in comparison with foreign firms, in turn, they face the away disadvantage as foreign firms in other markets. So, they have been attempting to increase technological capabilities as the business environment in China has become tougher for Chinese firms.

[2] Moreover, protectionist policies significantly helped the domestic market expansion of Chinese firms, especially until China's World Trade Organization (WTO) accession in 2001. However, we cannot underestimate the effect that fierce competition among indigenous Chinese firms had on enhancing the competitiveness of those firms (Kimura, 2011).

2.2 Overseas Expansion for Further Growth

Given the increasing technological capabilities of Chinese firms, they are expanding overseas operations for further growth. In the telecommunications equipment industry, Huawei and ZTE are rapidly growing in the global market. Huawei already takes its place among the top telecommunications equipment venders with Ericsson (Sweden) and Nokia (Finland). Huawei's revenue was 395,009 million RMB in 2015, and the revenue by market was as follows: 42% from China; 32% from Europe, the Middle East, and Africa; 13% from Asia-Pacific; and 10% from the Americas (Huawei Investment & Holding Co., Ltd., 2016).[3] Further, although ZTE is not included in the top group in the global telecommunication equipment market, it has become one of the leading firms in the industry. ZTE's revenue was 81,471.3 million RMB in 2014 (ZTE official website).[4] Half of this revenue emanates from the Chinese market and the other half from overseas markets.

Many home appliance and electronics firms are also expanding overseas operations. Table 1 shows domestic and foreign market shares of major Chinese firms in 2015.[5] The firms in the table are those ranked within the top five in each product market in China. Also, they are listed in descending order of foreign market share in each product market. We have to note that the foreign market shares might be smaller than the market shares of Chinese firms in each individual product market because the market categories in the table include some products, though we can find comparative situations which firm is expanding overseas operation and which one is not.[6]

[3] Sales by business category were as follows: 59% from the carrier business, 33% from the consumer business, 7% from the enterprise business, and the remainder from other businesses.

[4] Sales by business category were as follows: 57% for carriers' networks; 28% for handset terminals; and 14% for telecommunications software systems, services, and other products.

[5] Shares in the foreign market are standardized by the size of every market. "Foreign Market" includes the following 45 countries and regions: Australia, China, Hong Kong, India, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand, and Vietnam in the Asia-Pacific region; Argentina, Brazil, Canada, Chile, Colombia, Mexico, US, and Venezuela in the Americas; Austria, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Romania, Russia, Spain, Sweden, UK, and Ukraine in Europe and the Commonwealth of Independent States; and Egypt, Israel, Morocco, Saudi Arabia, South Africa, UAE, and Turkey in the Middle East and Africa.

[6] For example, the category of computers and peripherals includes desktop and portable computers, monitors, and printers. The category of refrigeration appliances includes refrigerators, freezers, electric wine coolers, etc.

Table 1: Domestic and Foreign Market Shares by Firm and Market, 2015

Firm	Brand(s)	Market	Domestic Market (%)	Foreign Market (%)
Lenovo	Lenovo	Computers and peripherals	24.8	5.5
Haier	Haier	Refrigeration appliances	39.1	4.2
Haier	Haier	Home laundry appliances	44.8	2.3
Hisense	Hisense, Ronshen	Refrigeration appliances	11.4	1.0
Haier	Haier	Microwaves	13.1	0.6
Midea	Midea	Microwaves	36.8	0.6
Hisense	HiSense	Televisions	17.5	0.3
Midea	Midea	Refrigeration appliances	10.5	0.2
TCL	TCL	Televisions	16.4	0.2
Midea	Midea, Little Swan	Home laundry appliances	23.9	0.2
Changhong	Changhong	Televisions	8.0	0.1
Skyworth	Skyworth	Televisions	17.0	0.0
Konka	Konka	Televisions	9.6	0.0
Meiling	Meiling	Refrigeration appliances	8.0	0.0
TCL	TCL	Home laundry appliances	3.3	0.0
Galanz	Galanz	Microwaves	44.1	0.0

Source: Constructed by the author through Euromonitor's Passport.

Table 1 shows that some of the major firms in the domestic market are expanding foreign market shares. The revenue of Lenovo, the biggest PC vender, mainly comes from overseas markets, with just 32% coming from China in 2014. The geographical breakdown of its foreign revenue is as follows: 26% from the Americas, 14% from Asia-Pacific, and 28% from Middle East and Africa. Haier is one of the biggest home appliance manufacturers in the global refrigerator and washing machine market. They are ranked first in China, with the market shares, 39.1% and 44.8% in Chinese refrigeration and home laundry appliances markets, respectively. Moreover, they are trying to expand shares in markets both in developed and developing countries. Other home appliance manufacturers are also endeavouring to expand overseas business, although the majority is still captured by Samsung and LG in South Korea and certain Japanese firms in the home appliance market.

In addition to these major incumbents, an increasing number of hardware startups are also vying to sell newly developed products in the global market (Kimura, 2017). The rapid expansion of the global commercial drone market was initially led by

Parrot in France, 3D Robotics in the U.S., and DJI since approximately 2010; according to DJI, they capture circa 70% of the market in 2016. Makeblock, a Shenzhen-based platform provider for making robots, is also expanding overseas sales in more than 140 countries especially in the Western market. In addition to electronics hobbyists, the robot platform has become popular for consumers who are interested in STEM education and also appeals to children.

As discussed above, an increasing number of Chinese firms are currently trying to increase their technological capabilities and expand foreign operations. However, the formations of technological capabilities are different among firms; this is discussed in detail in the next section.

3 Technological Capability Formations and Their Backgrounds

Since we are interested in the formation of technological capabilities in firms in developing countries, we first stipulate average technological gaps between foreign and indigenous firms vis-à-vis China's home appliance and electronics industry (Table 2 from Kimura, 2016). The data cover the 2005–2007 period, when the Chinese government began to put emphasis on R&D activities. The home appliance electronics industry is here divided into 15 industries, as shown in the table, on the basis of China's standard industrial classification (the standard codes are shown in parentheses).[7] The technological gaps in the second column show the differences between average productivity levels of foreign and Chinese firms, specifically calculated for each industry as follows: average total factor productivity (TFP) level of foreign firms − average TFP level of Chinese firms. The 15 industries are ranked in descending order of the technological gaps. In the last column—R&D—the signs + + + (− − −), + + (− −), and + (−), pertain to industry dummies for an R&D determinants equation.[8] They show

[7] The industries included at the two-digit level of classification are as follows: the manufacturing of electrical machinery and equipment (39) and the manufacturing of computer, communications, and other electronic equipment (40). Radar and auxiliary equipment manufacturing (402) was omitted because of the small number of firms in the industry.

[8] The probit regression equation is as follows:

$$rd_{it} = \alpha + x'_{it}\,\beta + \gamma\, sector + \varepsilon_{it},$$

where *rd* is the binary variable (1: a firm conducts R&D, 0: a firm does not conduct R&D), *x* is the vector of control variables (output, export value, profit rate, firm age), *sector* is the industry dummies, and ε is the error term (Kimura, 2016). *i* is the firm and *t* is the year.

that firms in every industry are (not) likely to conduct R&D at significance levels of 1, 5, and 10%, respectively; empty spaces denote that there is no significance.

Table 2: Technological Gaps and R&D

Industry (Code)	Technological Gap	R&D
Telecommunication equipment manufacturing (401)	0.3188	+ + +
Household AV product manufacturing (407)	0.2665	+
Electronic computer manufacturing (404)	0.1949	+ + +
Battery manufacturing (394)	0.1691	
Other electrical machinery and equipment manufacturing (399)	0.1507	+ +
Electronics device manufacturing (405)	0.1212	+ + +
Electrical equipment manufacturing (391)	-0.0024	Base
Electric power transmission and distribution and control equipment manufacturing (392)	-0.0135	+ + +
Electronics component manufacturing (406)	-0.0216	
Home appliance manufacturing (395)	-0.0240	
Lighting equipment manufacturing (397)	-0.2015	- - -
Cable and other electric equipment manufacturing (393)	-0.2590	- - -
Broadcasting equipment manufacturing (403)	-0.3446	+ + +
Other electronics machinery and equipment manufacturing (409)	-0.3518	+ + +
Household non-electric equipment manufacturing (396)	-0.4883	

Source: Kimura (2016).

The results in Table 2 can be described as follows. First, technological gaps are industry-contingent. The average TFP levels of Chinese firms in the lower nine industries are higher than those of foreign firms; however, those of Chinese firms in the

upper five industries are not. According to the description of the 15 industries, it would appear that technologies used in upper industries are not only advanced but also have room for technological advancement. Therefore, even if Chinese firms in upper industries increasing their productivities, technological frontiers in the industries might proceed upward. Second, firms are heterogeneous in terms of likelihood to conduct R&D. In particular, firms in lighting equipment manufacturing and cable and other electric equipment manufacturing are unlikely to conduct R&D, as the negative signs show. Third, firms in the industries associated with bigger gaps are likely to conduct R&D. Although firms in broadcasting equipment manufacturing and other electronics machinery and equipment manufacturing are likely to conduct R&D, the technological gaps therein are smaller than in other industries. The numbers of firms in these industries, 552 and 570 firms, respectively, are small relative to the average number of firms (i.e., 2,513 firms), and products in the latter industry are miscellaneous.[9] Therefore, we can say posit that although firms in industries associated with bigger gaps can learn more from foreign firms, they are also likely to conduct R&D themselves. If firms in high-tech industries do not conduct R&D, it could be difficult for them to realize further growth.

As firms in telecommunication equipment manufacturing in Table 2 are likely to conduct R&D, Huawei and ZTE have also accumulated technological capabilities through R&D before the Chinese government began to put emphasis on innovation in the mid-2000s. In the case of Huawei, the ratio of R&D to revenue has been over 10% (Huawei Investment & Holding Co., Ltd., 2016). Since technological innovation in telecommunications equipment has been rapid, firms in developing countries in this industry have also been required to conduct R&D. As a result, Huawei has continuously filed a large number of patent applications every year, ranked first in the world with 3,898 Patent Cooperation Treaty (PCT) applications in 2015.

[9] The number of firms in the other electrical machinery and equipment manufacturing are also less than 600 firms, precisely 573 firms, following the two industries.

Table 3: Cross-Border M&A Deals over 100 Million USD

Acquiror	Target	Target Country	Deal Type	Deal Status	Deal Value (Mil USD)	Announced Date
Huawei	Sunday Communications Ltd	Cayman Islands	Minority stake increased from 7.11% to 8.02%	Completed	155.04 *	05/26/2004
Haier	Haier Electronics Group Co., Ltd	Bermuda	Acquisition increased from 19.38% to 51.31%	Completed Assumed	249.77	12/11/2009
Haier	Haier-CCT Holdings Ltd	Bermuda	Acquisition increased from 29.94% to 84.85%	Completed	126.34	03/16/2004
Haier	Haier (Hong Kong) Ltd	Hong Kong	Acquisition increased from 100% to 100%	Announced	806.04	05/26/2015
Haier	Haier Sanyo Eelectric Co., Ltd	Japan	Acquisition	Completed	121.26 *	10/18/2011
Haier	Fisher & Paykel Appliances Holdings Ltd	New Zealand	Capital Increase 50%	Completed Assumed	117.04 *	05/27/2009
Haier	Haier Singapore Investment Holding Pte Ltd	Singapore	Acquisition 100%	Announced	785.68	05/26/2015
Haier	GE Appliances	US	Acquisition 100%	Completed	5,400.00	01/15/2016
Midea	KUKA AG	Germany	Minority stake increased from 5.4% to 10.2%	Completed	136.95 *	02/04/2016
Midea	Toshiba Lifestyle Products & Services Corporation	Japan	Acquisition 80.1%	Completed	499.51 *	03/30/2016
Midea	Carrier Latin America Holding Company	n.a.	Acquisition 51%	Completed Assumed	223.00 *	08/08/2011
Lenovo	Comércio de Componentes Eletr ônicos (CCE) Ltda	Bermuda	Acquisition 100%	Completed	146.38 *	09/05/2012
Lenovo	Medion AG	Germany	Minority stake 36.656%	Completed	330.62	06/01/2011
Lenovo	Medion AG	Germany	Acquisition increased from 36.656% to 73.955%	Completed Assumed	311.75	06/01/2011
Lenovo	Medion AG	Germany	Acquisition increased from 61.49% to 79.81%	Completed Assumed	146.33	10/09/2012
Lenovo	Lenovo Group Ltd	Hong Kong	Share buyback 4.7%	Announced	152.37	05/04/2005
Lenovo	NEC Personal Computer KK	Japan	Acquisition 100%	Completed	224.3 *	01/27/2011
Lenovo	Motorola Mobility Holdings Inc.	US	Acquisition 100%	Completed	2,910.00 *	01/29/2014
Lenovo	IBM Corporation's X86 Server Hardware Business	US	Acquisition 100%	Announced	2,300.00 *	01/23/2014
Lenovo	IBM Corporation's PC Business	n.a.	Acquisition 100%	Completed	1,750.00	12/07/2004

Notes: (1) The author accessed the M&A database on February 3, 2017.

(2) The following names were used to search M&A deals for each firm: Huawei Technologies Co., Ltd (registered in China) for Huwaei; ZTE Corporation (in China) for ZTE; Haier Group Corporation (in China) and Qingdao Haier Co., Ltd (in China) for Haier; Midea Group Co., Ltd (in China), Midea International Corporation Co., Ltd (in Hong Kong), and GD Midea Holding Co., Ltd (in China) for Midea; Lenovo Group Ltd (in Hong Kong), Lenovo Germany Holding GmbH (in Germany), and Lenovo NEC Holdings BV (in the Netherlands) for Lenovo.

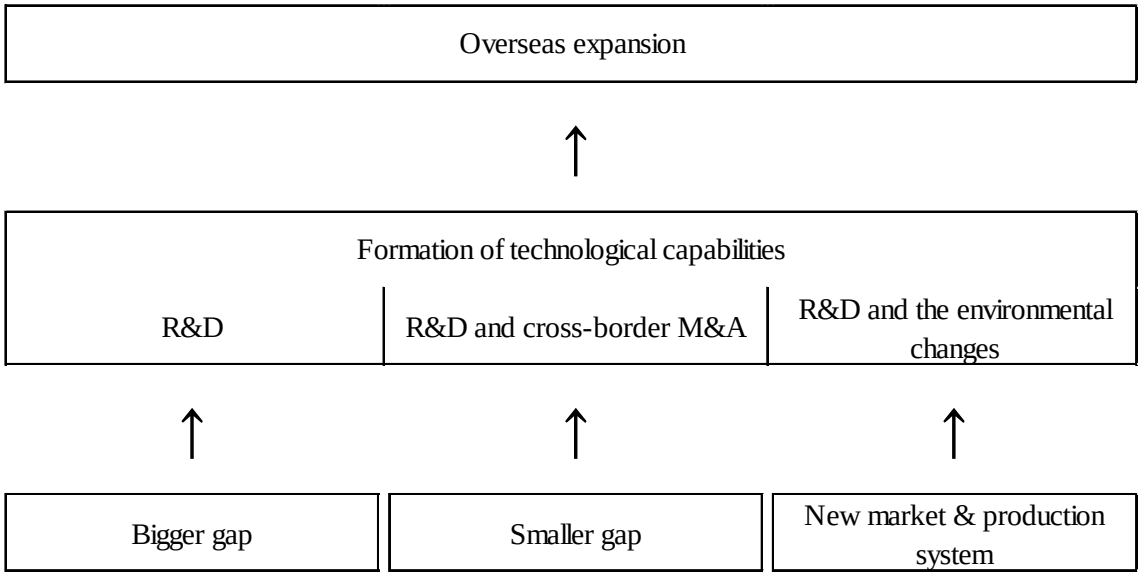
(3) "Deal Status" includes "Completed Assumed," "Completed," "Announced," and "Pending" and excludes "Withdraw" and "Rumor."

(4) Asterisks (*) denote deal values estimated from various sources.

Source: Constructed by the author through Bureau van Dijk's Zephyr.

Although Huawei has also concluded various M&A deals to expand business, cross-border M&A deals over 100 million USD are less common, according to the database provided by Bureau van Dijk (Table 3). It is difficult to buy major competitors in the same industry, and those competitors maintain active roles by sustaining technological advantages. Moreover, some political concerns from governments in developed countries also inhibit Huawei's and ZTE's ODI. Consequently, Huawei has tended to accumulate technological capabilities by investing in R&D activities, as shown in the left case of "Bigger gap" in Figure 1.

Figure 1: Formation of Technological Capabilities and Technological Gaps



Source: Constructed by the author.

Next, ZTE has also accumulated technological capabilities by continuously conducting R&D. According to ZTE's official website, it allocates 10% of its revenues to R&D. Consequently, ZTE has continuously filed numerous patent applications. It was the third largest applicant in the world with 2,155 PCT applications in 2015, after Huawei and Qualcomm Inc. (the U.S.). However, according to Table 3, they have not concluded cross-border M&A deals over 100 million USD. ZTE also shares the same case as Huawei in Figure 1.

The formation of technological capabilities in the home appliance industry is different from firms in the telecommunication equipment industry. As shown in Table 2, there are many Chinese firms in the former industry that do not conduct R&D. Of course, to decrease production costs and develop high value-added products, major

home appliance manufacturers such as Haier and Midea have been investing in R&D activities. Indeed, Haier has five major R&D centers around the world.

In addition to R&D, they have had opportunities to acquire white goods businesses from firms in developed countries in the same industry.[10] According to Table 3, Haier bought Fisher & Paykel (New Zealand) in 2009, the washing machine and refrigeration business of Sanyo (Japan) in 2011, and the home appliance business of GE (the U.S.) in 2016. Consequently, Haier has been able to increase its market share by buying home appliance businesses in developed country contexts. Next, Midea is also trying to expand its reach by acquiring the Latin American business of Carrier (the U.S.) in 2011 and the white goods business of Toshiba (Japan) in 2016 (Table 3).[11]

In industries in which related technologies have gradually matured, technological gaps often become smaller and this "catching up" manifests itself in productivity increases across firms in developing countries. Consequently, major firms in developed countries can lose their competitive edge over firms in developing countries. This dynamic evolution can then proceed such that firms in developing countries end up buying the businesses of the defeated firms and increasing their technological capabilities, brand power, and a variety of assets such as patents and sales networks in overseas markets. Therefore, growing firms in developing countries need to consider the balance between the possibilities to acquire businesses of competitors in the same industry and R&D investments themselves for enhancing competitiveness, although excessive large-scale M&A is also risky as well as excessive R&D investments. In this way, Haier and Midea have accumulated technological capabilities by investing in R&D activities and cross-border M&A, as shown in the middle case of "Smaller gap" in Figure 1.

The mixed case of the telecommunication equipment and home appliance industries is evident in Lenovo. To expand the business, Lenovo has also been conducting R&D in the electronic computer manufacturing industry (with its relatively bigger gap), but the ratio of R&D to revenue is not so high, 2.6% in 2014, compared

[10] In addition to the formation of technological capabilities, it is also required to consider whether or not large-scale cross-border M&A influences the position of Chinese firms in global value chains. Acquires might partially introduce the positions of target firms in global value chains in the process for strengthening businesses. The governance patterns of global value chains are different in firm and industry (Gereffi et al., 2005).

[11] Moreover, Midea bought a robot manufacturer in Germany, KUKA, and is trying to absorb robotics technologies and expand business.

with that of Huawei and ZTE. However, Lenovo has expanded the businesses by buying the businesses of firms in developed countries such as the PC business of IBM (the U.S.) in 2004, Medion (Germany) in 2011, and the PC business of NEC (Japan) in 2011.[12] Therefore, Lenovo is the case straddling the left and middle cases in Figure 1.

These major firms have achieved rapid growth by catching up with firms in developed countries in the same industries. With emerging new markets such as drones, IoT devices, wearable devices, and robots, hardware startups focusing on developing new products are on the rise. In these new markets, gaps are much less substantive; in other words, firms in developed and developing countries are standing at similar starting points, although the former will still benefit from certain advantages over the latter. In addition, reducing barriers to starting businesses also contributes to closing gaps. Specifically, we can observe the rise of new business systems, such as open source software/hardware, 3D printers, cloud computing services (e.g., Amazon Web Services [AWS]), and crowdfunding (e.g., Kickstarter). Startup ecosystems are also rapidly developing. The number of shared office and work spaces for entrepreneurs are increasing. Therefore, entrepreneurs can start businesses with low budget. In addition, according to a service provider in China's venture capital (VC) and private equity (PE) industry, Zero2IPO, the amount of venture investment in 2016 was 130 billion RMB, increased 3.7 times in comparison with that in 2010. Therefore, the case of startups can be positioned in the right of Figure 1.

Enjoying advantages provided by such techno-economic changes, hardware startups such as DJI and Makeblock are striving to develop new products. DJI has been expanding markets by focusing on the development of flight controllers and cameras and gimbals for enhancing video shooting functionalities. Makeblock has realized rapid growth by developing high-quality parts and easy-to-use programing software for controlling robots in order to increase the value of products. Such startups have been growing by developing new markets as first-movers, not followers like the Chinese firms of recent history.

[12] In addition to the PC business, Lenovo bought Motorola Mobility to enhance the competitiveness of their mobile handset business.

4 Conclusions

As discussed herein, an increasing number of Chinese firms that have been accumulating technological capabilities are trying to expand overseas operations for further growth. However, the formation of technological capabilities differs among firms. Thus, we have analysed the differences in terms of technological gaps.

We have shown that when technological gaps are smaller, firms have possibilities to increase technological capabilities and accelerate growth by acquiring businesses of firms in developed countries. If technologies do not change rapidly, then there is the potential that firms in developing countries can rapidly catch up with and overtake the technological levels of firms in developed countries, thereby securing important competitive advantages.

However, in the telecommunication equipment industry, wherein bigger gaps exist, it is still difficult to buy major competitors because they retain competitiveness. Yet, many contextual issues and nuances in the domain of technological capabilities and, specifically, the dynamics of these capabilities over time and space remain to be researched. As mentioned above, it is difficult to provide conclusive remarks regarding the case of the telecommunication equipment industry because political factors act to inhibit Huawei's and ZTE's ODI in developed countries. Exploring and delineating the nature and importance of such factors in that context is worthy of future study.

Since business opportunities in new markets are increasing and the hurdles for starting businesses are decreasing, even startups from developing countries have opportunities to seize first-mover advantages. The increase in such new business opportunities is also significant characteristic of the era of globalization and digitalization.

The technological capabilities of firms in developing countries have been prioritized for innovation and further growth in middle-income countries. Examining the case of Chinese firms, this study found that there are many factors that influence the formation of technological capabilities in the era of globalization and rapid changes in technology and business environment. Therefore, it is imperative to verify the patterns of technological capability formations.

References

Antràs, Pol (2016) *Global Production: Firms, Contracts, and Trade Structure*, Princeton: Princeton University Press.

Antràs, Pol, and Elhanan Helpman (2004) "Global Sourcing," *Journal of Political Economy* 112(3): pp. 552–580.

Buckley, Peter J., L. Jeremy Clegg, Adam R. Cross, Xin Liu, Hinrich Voss, and Ping Zhang (2007) "The Determinants of Chinese Outward Foreign Direct Investment," *Journal of International Business Studies* 38: pp. 499–518.

Dunning, John, and Sarianna M. Lundan (2008) *Multinational Enterprises and the Global Economy*, 2nd ed., Cheltenham: Edward Elgar.

Gereffi, Gary, John Humphrey, and Timothy Sturgeon (2005) "The Governance of Global Value Chains," *Review of International Political Economy* 12(1): pp. 78–104.

Helpman, Elhanan, Marc J. Melitz, and Stephen R. Yeaple (2004) "Export Versus FDI with Heterogeneous Firms," *American Economic Review* 94(1): pp. 300–316.

Huawei Investment & Holding Co., Ltd. (2016) *2015 Annual Report*, Shenzhen: Huawei Investment & Holding Co., Ltd.

Kimura, Koichiro (2011) "China and India's Electrical and Electronics Industries: A Comparison between Market Structures," in Moriki Ohara, M. Vijayabaskar, and Hong Lin, eds., *Industrial Dynamics in China and India: Firms, Clusters, and Different Growth Paths*, New York: Palgrave Macmillan.

Kimura, Koichiro (2014) *The Growth of Chinese Electronics Firms: Globalization and Organizations*, New York: Palgrave Macmillan.

Kimura, Koichiro (2016) "Technological Development Conditions and R&D: The Case of Electrical and Electronics Industry", Hiroyuki Kato and Kai Kajitani, eds. *The Evolving Chinese-model Capitalism beyond Double Trap*, Kyoto: Minerva Shobo (in Japanese).

Kimura, Koichiro (2017) "A Change of Chinese Firms: Innovation through Starting Businesses," *Ajiken World Trend* No. 258: pp. 38–42 (in Japanese).

Marukawa, Tomoo (2007) *Gendai Chugoku no Sangyo: Bokko Suru Chugoku Kigyo no Tsuyosa to Yowasa* [*Modern China's Industries: Strengths and Fragilities of Growing Chinese Firms*], Tokyo: Chuokoron-Shinsha (in Japanese).

Melitz, Marc J. (2003) "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica* 71(6): pp. 1695–1725.

Ohara, Moriki (2000) “Chugoku Kaden Meka no Kyoso Yui [Competitive Advantages of Chinese Home Appliance Manufacturers],” *Nicchu Keikyo Journal* No. 2: 6–16 (in Japanese).

Watanabe, Mariko, ed. (2015) *The Disintegration of Production: Firm Strategy and Industrial Development in China*, Cheltenham: Edward Elgar.