

# 1. Introduction to *Innovative Capabilities and the Globalization of Chinese Firms*

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## 1. INTRODUCTION

How do Chinese companies learn to innovate and compete on global markets? This book explores how Chinese firms are developing capabilities for innovation and globalization, in relation to their economic environment. Firms studied here are active in a variety of different industries, ranging from pharmaceuticals and artificial intelligence to transportation, telecommunication, and mechanical manufacturing.

Taken together, the chapters in this book provide a conceptualization of one restricted part of the vast transformation ongoing in China. This book does not aim to cover all types of Chinese firms, nor all the transformations ongoing within China per se. Instead, our focus is upon the three intertwined processes involving innovation, technological capabilities, and globalization. Western countries have long taken the lead in developing knowledge and transforming it into business and social innovation, but in recent decades the Chinese economy has been rapidly advancing. Chinese firms are developing innovative capabilities and engaging in globalization, which affects not only China but also the world.

Hence, this book only focuses upon a selected few Chinese firms and industries which already have shown to be – or are actively striving to become – world-leading in their technologies and markets. We are interested in why and how they use and develop advanced technology as well as how they can obtain economic returns on the market, often global markets. More generally, we have chosen to study firms and industries which are attempting to move the basis of their competitiveness from imitation to innovation; from being a player on a home market to a global market; and from being a follower to being an innovative leader. Our analysis places these firms in relation to the

macro processes in the ecosystem, such as economic growth, public policy for science and technology, and collaborative network relationships.

China is already aiming for – and in some cases taking – a leading position in developing important new technologies such as AI, e-mobility and nano-technologies. In these emerging tech industries, China has become one of the three strongest countries in the field of artificial intelligence (AI), with more than 4000 high-tech firms in the AI field (Deloitte 2019). In addition, China has become a leading market and main competitors in the new energy vehicle industries (Jin and McKelvey 2019) and improved its competitiveness in the nano-tech industry (Zhang et al. 2017). Some of these shifts are leading to topics outside this book. For example, China is rapidly introducing disruptive technology into the global economy, which may help explain the changing global institutions and regimes for international trade and collaboration. Our aim is not to analyze these broad institutional changes, but instead to focus upon the underlying causes of how Chinese firms are becoming leaders within what we call a global knowledge-intensive innovative ecosystem. We do, however, include empirical indications of a paradigm shift in technology activities in China, as indicated by figures such as the long-term increase of foreign R&D investment in China, which is also accompanied by domestic investments in R&D. Our interpretation of the trends underlying such figures, as argued in Chapter 2, is that China has both increased internal technology and innovative capabilities, and also actors have increased their embeddedness in collaborative networks.

Successful Chinese emerging market multinational enterprises can be found in several industries (see Chapters 5, 7, 8, 12, and 13). Two relevant examples are Alibaba and Huawei. Alibaba is a leading internet (e-commerce) firm, and Huawei has become the largest telecommunications equipment manufacturer in the world. Arguably, the technological proficiency of Huawei and ZTE underlie some of the recent trade disputes, which is interesting for other research. Moreover, knowledge-intensive innovative entrepreneurial (KIE) firms (Malerba and McKelvey 2018) are, we argue, also present in China, and rapidly developing their innovative capabilities based on advanced technology (see Chapters 4, 10 and 11). Knowledge-intensive industries where Chinese firms have been successful include a range from pharmaceuticals, windmills to AI and data analytics. So how did these various firms develop their technologies, along with their capabilities to innovate and globalize, in relation to the wider ecosystem?

Subsequent chapters help explain how interlinked micro and macro processes unfold over time, and do so by relating the strategic decisions of companies and entrepreneurs to trends in the Chinese knowledge-intensive innovative ecosystem. Thereby, each chapter will provide slightly different answers about how and why the three processes of innovation, technological

capabilities, and globalization are driving this transformation in China. In doing so, subsequent chapters draw upon theoretical perspectives spanning innovation management, entrepreneurship, international business, economics of technology, and business strategy.

## 2. THE BROADER ANALYTICAL FRAMEWORK AND THREE THEMES

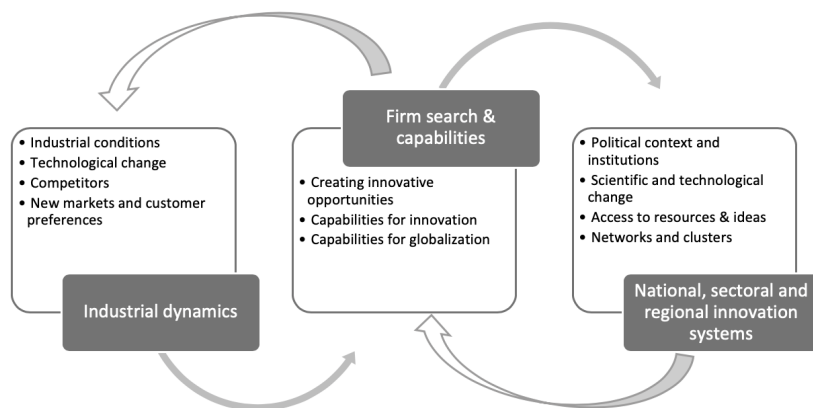
Lee and Malerba (2017) argue that nations can catch-up to leaders if late-comer firms and countries react appropriately, in relation to three windows of opportunity. The first dimension is changes in knowledge and technology; the second changes in demand; and the third is changes in institutions and public policy. Their perspective on catch-up includes the micro level of firms, as well as the macro level of sectoral innovation systems. This book is aligned with arguments in these related, broader streams of theoretical literature on catch-up from a Schumpeterian perspective (Malerba and Nelson 2012; Lee 2013; Lee and Malerba 2017; Zhang et al. 2017).

Figure 1.1 represents our broader analytical framework for conceptualizing a knowledge-intensive innovative ecosystem. We propose to conceptualize a knowledge-intensive innovative ecosystem as three-way interactions between firms, industrial dynamics and innovation systems. This broader theoretical framework builds explicitly upon McKelvey and Bagchi-Sen (2015) and McKelvey (2016). The purpose of this framework for this book is to help us identify a range of relevant factors which explain how Chinese companies can learn to innovate and compete on the global market. Taken together, these processes constitute the key interactions between the firm and knowledge-intensive innovative ecosystems.

Figure 1.1 visualizes that the micro level of the firms – set at the center – is highly affected by the macro level in terms of industrial dynamics and innovation systems.

Three core concepts in our analytical framework are: firm search and capabilities for technology and innovation, industrial dynamics, and innovation systems. Each concept is introduced below in relation to this overall process, and later chapters address an aspect of each, in relation to explaining how Chinese companies can learn to innovate and compete on the global market.

The box found at the center in Figure 1.1 represents the processes of firm search and capabilities for technology and innovation. According to literature in innovation management, we should focus upon firm-level processes whereby “an innovative outcome involves the successful application of new ideas, which results from organizational processes that combine various resources to that end” (Dodgson et al. 2014:5). The key notion is that the firm does not just passively acquire new knowledge, but must instead actively search, thereby



Source: Revised analytical framework, based upon prior work (McKelvey 2016; McKelvey and Bagchi-Sen 2015).

Figure 1.1 Firms within knowledge-intensive innovative ecosystems

devoting resources to both creating new knowledge and using it in innovation sold on the market. A key insight is that a combination of public and private knowledge is needed to create innovations (McKelvey 2014), and the firm searches and combines technology with other capabilities in order to innovate. Thus, firm search and strategy are interesting to analyze, because firms are heterogeneous in a way that impacts the outcomes – for example, there is no representative firm. This stream of literature is closely related to the theory of the firm by Edith Penrose, and later developments, especially dynamic capabilities (Teece et al. 1997; Teece 2007). A business model affects the firm's dynamic capabilities, which in turn impacts the viability of strategies within the firm (Teece 2018). Research on innovation management explicates how the internal capabilities of the firm also rely upon external sources of knowledge, and specifically that the firm must also rely on relationships and networks in order to search, identify and seize relevant business opportunities (Dodgson et al. 2014). Firms search for new knowledge, which solves internal problems, and must also balance routines for continuation and exploration of new ideas (Nelson and Winter 1982; Laursen 2012).

Another key concept is processes related to industrial dynamics, represented in Figure 1.1 in the left-hand box. We conceptualize industrial dynamics as factors, which sets the conditions and helps define the opportunity set within which any given firm can act upon within their sector (Carlsson 2016). We include industrial conditions, technological change, competitors, and new markets and customer preferences under industrial dynamics. Our interpre-

tation of industrial dynamics is that they help to generate new technological opportunities, as well as market opportunities.

Industrial dynamics change the conditions for the economy, through new technologies and through business innovation in large companies and through entrepreneurship through new companies (Schumpeter 1934, 1942). In evolutionary and Schumpeterian economics, capitalism is conceptualized as restless, described as emergent properties of change which are endogenously created in the economy (Nelson 1996; Metcalfe 2002, 2008; Horst and Pyka 2004). In this literature, industrial dynamics are explicitly linked to the key role of knowledge and innovation in the economy in stimulating transformation. Metcalfe (2002, 2008) argues that the restless nature of capitalism has to do with knowledge, as the pre-eminent source which creates variation in the economy, and where markets are the primary arena for selection of firms. Thus, it is interesting to study the acquisition of new capabilities because the firm's internal combination of routines, resources, capabilities, and learning will change over time, in response to internal and external conditions (Nelson 1996).

Finally, in Figure 1.1, the right-hand box represents national, sectoral, and regional innovation systems. By using this concept of innovation systems, we focus upon the linkages between firms and other actors, and specifically those which promote knowledge generation and innovation. Institutional and evolutionary economics and related innovation systems perspective has long highlighted the key importance of knowledge, networks, learning and institutions in economic growth (Nelson 1993; Cooke et al. 1997; Edquist and McKelvey 2000; Lundvall et al. 2002; Malerba 2002, 2009; Edquist 2006). Innovation systems are useful in this conceptual framework, because they help to define a set of interactions, agents and processes within regions, sectors and nations. Moreover, the innovation system approach associated with learning and development of firm capabilities has also been applied to understanding emerging markets in terms of catch-up processes (Malerba and Nelson 2012).

There has been much discussion of the relationship between innovation systems and ecosystems, in different streams of literature. Initial strategy literature on ecosystems stressed the importance of firm strategy in relation to their supply chains (Jacobides et al. 2018), whereas other streams stress a variety of entrepreneurial and innovation ecosystems impacting regions (Stam 2015; Spigel 2017; Stam and Spigel 2017; Autio et al. 2018). Relating closely to an innovation system definition, an innovation ecosystem can be defined as the evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors (Granstrand and Holgersson 2019). Therefore, by placing innovation systems in relation to firms' search and capabilities as well as industrial dynamics, we highlight the

transformation of the Chinese knowledge-intensive innovative ecosystem, as well as how Chinese firms may interact with other ecosystems.

Taken together as interlinked processes, Figure 1.1 leads to three main implications for this book: 1) new technological and market opportunities are generated by institutions and forces within the national and global economies; 2) firms must act upon opportunities, and create new technological and market capabilities in order to become leaders on the global market; and 3) by reacting to such opportunities, some firms will be successful, and others fail, but by increasing productivity, these economic processes will in turn positively impact economic growth and societal well-being.

Our theoretical view from Schumpeterian and evolutionary economics is that in the modern economy, the competitiveness of firms depends upon their use of advanced knowledge for innovation as well as their ability to act globally. The firms not only make their own decisions, but they are also affected by, and are working within, a context involving also public policy and innovation ecosystems. In our conceptualization, these firms are searching for market, technological and productive opportunities and accessing multiple resources through networks within a global knowledge-intensive innovation ecosystem. Therefore, many factors affecting the firms will include macro-level factors that affect knowledge creation and diffusions, such as collaborative networks and reverse engineering.

Chapters in this book are organized around these themes:

- Theme: Specifying where innovation systems can affect the ability of Chinese firms to identify and act upon innovative opportunities.
- Theme: Analyzing why Chinese firms' acquisitions and collaboration can affect their capabilities for technology, innovation and globalization.
- Theme: Exploring how Chinese firms develop new capabilities.

The concluding chapter provides an overview of the research results for each theme, as well as our propositions and topics for future research.

### 3. SUMMARY OF EACH CHAPTER

Chapter 2 explains how seven empirical phenomena about the development of China and Chinese firms is impacting technology, innovation and globalization. In doing so, the chapter conceptualizes innovative opportunities as consisting of technological, entrepreneurial, and productive opportunities, and categorizes the trends accordingly. These seven empirical phenomena are described through the data: 1) national innovation system, public policy and university–industry collaboration; 2) sheer size and growth of economies; 3) increasing competitiveness of Chinese business; 4) strengthening global ties –

flows inward and outward foreign direct investment (FDI); 5) increasing R&D investment; 6) increasing human capital on science and technology (S&T), including education on STEM; and 7) increasing S&T outputs. Based on the data, we argue that the rising market, technological, and productive opportunities contribute to Chinese firms capturing and upgrading their technological capabilities. These empirical trends matter for the future. This chapter thus analyzes the Chinese innovation system as part of a global innovation space, in order to help explain how China is affecting both Chinese and foreign firms.

Chapter 3 evaluates the National High- and New-Tech Industrial Development Zones in China, by applying the concepts of ecological theories and innovation ecosystem. Such zones are similar to science and technology parks and are one of the important policy instruments of the Chinese national innovation system for this purpose. The National High-Tech Industrial Development Zones have developed rapidly in China, from 53 in mainland China in the early 1990s to 188 in 2016. The chapter primarily evaluates the structure, function, and information flows of the innovation activities inside the zones – instead of only evaluating the usual measures of innovative capacity and output performances. The empirical examination is applied to 53 National High-Tech Industrial Development Zones in China between 1990 and 2014, and the cases of Zhongguancun (Beijing) and Zhangjiang (Shanghai). The results indicate that these zones play vital roles in stimulating a faster development of high-tech industries in China, but they do so in diversified ways because of the diversified regional innovation ecosystems.

Chapter 4 analyzes how patent cooperation networks influence the innovation performance of enterprises, applied to the case of technology-based SMEs in the pharmaceutical industry in China. The patent cooperation networks provide an opportunity for this type of knowledge-intensive enterprise to access innovation resources and to improve their innovative capabilities. Based on the specification of the breadth and depth of patent cooperation, this chapter analyzes and classifies the structure of patent collaborative networks. By analyzing this type of firms in the Chinese pharmaceutical industry, this chapter suggests that patent collaboration networks can be divided into two main types, namely exploration and exploitation. The patent cooperation network for exploration has a more significant positive impact on the innovation performance of these firms than the patent cooperation network for exploitation. The chapter proposes that the exploration patent cooperation network provides more breakthrough paths and also opportunities for this type of firms to acquire innovation resources and elevate their innovative capabilities.

Chapter 5 addresses what enables technological self-reliance for indigenous innovation, as well as empirical studies within three complex product industries in China. This empirical analysis of telecom equipment, concrete machin-



ery and diesel engines helps explore technological self-reliance at the sectoral level. The chapter argues that the evolution of embedded demand and the accumulation of national technological capability in a sector help determine the relative reliance upon imported technology and indigenous innovation. Thus, this chapter proposes that technological self-reliance, as an independent concept which depicts the middle stage between technological dependence and innovating, is a useful tool to understand the logic and paths of capability building in catching-up countries such as China.

Chapter 6 explores Chinese KIE firms, specifically small and medium enterprises (SMEs) in high-tech industries, which undertake cross-border acquisitions in the EU, USA, and Japan, and focuses upon the technological characteristics. The chapter highlights the roles of these firms as connecting nodes between the home and host regions, where regions are characterized by different degrees of technological distance. The chapter uses a Technology Proximity Index in order to analyze how homogeneous the patents are in terms of technological classes in the home and host regions. The descriptive analysis is based on a sample of 95 acquisitions occurring between 2003 and 2011, and on the investors' patent portfolio characteristics, such as technology specialization, experience, size and number of collaborative patents. The chapter reveals that investors with stronger knowledge bases and with more diversified and larger patent portfolios are more likely to invest in more technologically distant regions. In addition, although they are more involved in collaborative patents at home and abroad, these investors are not more likely than other Chinese multinational firms to establish international collaborations for patents.

Chapter 7 investigates how firms build technological capability during internationalization, by examining one in-depth case study in the energy sector, namely wind energy. The case study outlines a 20-year-long process of internationalization in relation to technological capability building. The chapter examines the firm's strategic intention as well as strategic process in order to understand how the firm has built up its technological capability and transited from production to innovation. The chapter finds that the transition of the firm from production to innovation is facilitated by cross-border technological learning through human mobility between the headquarters and its foreign counterpart. In addition, the cross-border technological learning is enabled by cross-border relationships and trust developed through a long-term personal relationship building among the key managers.

Chapter 8 addresses the process of knowledge and technology transfer within an acquired firm, after acquisition by a Chinese multinational firm. The empirical case study is taken from the acquisition in 2010 of Volvo Car Corporation by Zhejiang Geely Holding Group. The process of knowledge transfer between Volvo Car and Geely Group includes many different aspects.



The chapter provides details of this knowledge transfer, through integrated greenfield plants, collaboration in a new engine plant, coordination and cooperation at supply systems, integration of management and engineering resources, joint R&D ventures, as well as development based on a joint platform Compact Module Architecture (CMA). It argues these are the aspects that are used by the Geely Group, in order to gradually upgrade their process, product, functional, and production capacity, and thereby achieve an upgrading in the global value chain.

Chapter 9 identifies and analyzes a new phenomenon of globalization, namely the reverse innovation, the processes whereby technology, innovation, and new products are developed or marketed in developing countries and are then transferred from developing countries to advanced countries. The chapter identifies three ideal types of reverse innovation, which are also empirically illustrated, based on a matrix framework based on type of innovation strategy and the location of commercialization. They are Ideal Type I: reverse innovation based on transferred technology; Ideal Type II: original reverse innovation; and Ideal Type III: original reverse innovation (front-end technology). The firm's innovation capabilities play a critical role in reverse innovation. The chapter indicates that Ideal Type I is a good strategy for firms in developing countries to achieve reverse innovation in mature technology, whereas the Ideal Types II and III are suitable for firms in developing countries to achieve reverse innovation in emerging technologies and markets.

Chapter 10 discusses Chinese indigenous innovation and the influence of global markets, within Chinese KIE ventures. This chapter questions whether Asian innovation efforts are primarily associated with imitation and efficient market exploitation, which has been found in previous theoretical and empirical research. In contrast to previous research, the findings demonstrate that these ten Chinese KIE ventures accord a low degree of importance to global knowledge, whereas their own internal skills and knowledge are the source of their innovations. Thus, these results capture novel empirical developments, and raise interesting questions about how this type of Chinese firm engages in domestic and international technological development, now and in the future.

Chapter 11 explores the development of advanced technical capabilities, in one Chinese knowledge-intensive venture in the emerging industry of artificial intelligence, applied to visual recognition and surveillance systems. Using theories from knowledge management, the analysis reveals the essential engagement of customers in new product development, and why their knowledge is needed due to the unclear description of market needs. Hence, this chapter suggests that a pre-linguistic embodiment of tacit knowledge can be found in field tests and prototypes, during knowledge creation. Moreover, that they can be useful tools for externalization of knowledge for the further development of advanced technical knowledge.

Chapter 12 explores the specific strategic roles that a Chinese overseas research and development (R&D) center can play in a Chinese multinational firm, and they do so by analyzing CEVT as an organization positioned between Geely and Volvo. The development of China Euro Vehicle Technology AB (CEVT), a wholly subsidiary of Geely Auto, shows a specific strategic role and management system of a Chinese overseas R&D center. Taking the fast growth of CEVT as a case, we explore the distinguished role of CEVT in Geely after its M&A of Volvo Cars and the co-development of Geely Auto, Volvo Cars, and CEVT. The analysis suggests that the independent technology firm can work as a broker between bilateral parties in an M&A event from the aspect of new product and technology development as well as the global market strategy. This chapter highlights the important role of an independent technology firm to promote the co-development of bilateral parties of an M&A with a hidden internal technology trade. The analysis has important implications for the global R&D strategy and technological M&A, especially for firms in mature industries from emerging countries.

Chapter 13 applies a conceptual perspective from the management of an innovation ecosystem perspective, in order to understand the strategies and development of Chinese multinational firms, which are latecomers. Two case studies explore two of the most innovative firms in the Chinese smartphone industry, Huawei and Xiaomi. The chapter identifies two complementary approaches to implementing latecomer strategies. Complementary to previous studies on technological catch-up in developing countries, the analysis of these two case studies reveals that a latecomer firm should interact and co-create value with many other players in its innovation ecosystem in order to catch-up to leading country firms through innovation.

Chapter 14 is organized according to our three themes of: 1) specifying where innovation systems can affect the ability of Chinese firms to identify and act upon innovative opportunities; 2) analyzing why Chinese firms' acquisitions and collaboration can affect their capabilities for technology, innovation, and globalization; and 3) exploring how Chinese firms develop new capabilities. The chapter then provides three propositions and outlines a future research agenda, and ends with some words about innovation and development facing the challenges of digitalization and globalization in the decades ahead.

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