

© 2012

Shengsheng Huang

ALL RIGHTS RESERVED

THE DYNAMIC EFFECT OF FDI ON THE GROWTH OF INDIGENOUS FIRMS:
THE ROLE OF COMPETITION, TECHNOLOGY DIFFUSION, AND CAPABILITY
ACCUMULATION

by

SHENGSHENG HUANG

A Dissertation submitted to the
Graduate School-Newark
Rutgers, the State University of New Jersey
in partial fulfillment of the requirements

for the degree of

Doctor of Management

Graduate Program in

written under the direction of

John Cantwell

and approved by

Newark, New Jersey

January, 2012

ABSTRACT OF THE DISSERTATION

The Dynamic Effect of FDI on the Growth of Indigenous Firms: The Role of
Competition, Technology Diffusion, and Capability Accumulation

By SHENGSHENG HUANG

Dissertation Director:
John Cantwell

This dissertation disentangles the dynamic impact of inward foreign direct investment (FDI) on host country indigenous firms in two respects, namely, the competition effect and technological diffusion effect of FDI, and it addresses the role of heterogeneous technological accumulation among indigenous firms in creating variations in the form of foreign-indigenous interaction. From the perspective of competition and technology diffusion, the dissertation unpacks the varying dynamic nature of FDI in different segments of domestic industry. This dynamic approach provides an explanation for some previously controversial findings in the literature. In making a contribution to the evolutionary theory of the firm, the dissertation also enriches our understanding of continuous corporate technological accumulation in a transitional external environment. The different learning outcomes observed among indigenous firms may reflect their partially inherited dynamic capabilities in managing a transition to a new technological trajectory, and not merely their absorptive capacity as measured by the extent of their

prior knowledge overlap with foreign firms.

These arguments are tested in the context of technological capability formation of firms in the Chinese automobile industry - in particular, firms that assemble passenger cars or that produce components for them. Using firm-level longitudinal datasets gathered from various secondary sources that cover the Chinese automaker and major parts and component categories, the dissertation also contributes to the debate about the effect of joint venture policy on indigenous growth by exploring its indirect positive impact.

To my parents, Biao Huang and Jingyun Qiu

TABLE OF CONTENT

1.	Introduction	1
1.1	<i>The Dynamic Nature of FDI Spillover</i>	1
1.2	<i>Scope of Research</i>	4
1.3	<i>Contributions</i>	6
1.4	<i>Organization and Overview of the Dissertation</i>	7
2.	Literature Review	9
2.1	<i>Conceptual Issues of Spillover Research</i>	9
2.2	<i>Prior Research on FDI Spillovers</i>	12
2.2.1	Theoretical underpinnings	13
2.2.2	Findings from literature.....	15
2.2.3	A critique and new directions	21
3.	Theory Development: A Dynamic View of Competition, Technology Diffusion, and Capability Accumulation	28
3.1	<i>Defining Some Key Terms</i>	29
3.2	<i>Reconceptualization: Two Fundamental Dimensions</i>	30
3.3	<i>Possible Effects from Two Dimensions of Interaction</i>	33
3.4	<i>A Net Impact of Competition and Technology Diffusion: A Dynamic Process</i>	38
3.4.1	The initial shock and the trend of competition intensity	38
3.4.2	The challenges of learning and non-linear diffusion	41
3.4.3	The possible interaction between competition and diffusion	46
3.4.4	The role of firm-level technology accumulation	47
3.4.5	The net impact.....	49
3.5	<i>Discussions on the Framework and Net Impact</i>	52
4.	Hypothesis Development with Respect to China Passenger Car Industry	57
4.1	<i>Research Settings for Empirical Test</i>	57
4.1.1	Ideal settings for empirical test	57
4.1.2	China automobile industry as a research subject.....	58
4.2	<i>A Brief History of China Passenger Car Industry</i>	63
4.3	<i>The Debate of China Passenger Car Industry</i>	72
4.4	<i>Hypotheses Development</i>	75
4.4.1	Effects of competition	76
4.4.2	Effects of diffusion: Vertical diffusion	83
4.4.3	Effects of diffusion: Horizontal learning and IJV	87
4.4.4	Effects of diffusion: Indirect channels.....	91
4.4.5	The role of technological accumulation	99
4.4.6	A net overall effect	101
5.	Data Sources and Compilation.....	105
5.1	<i>Sources and Description of Raw Data</i>	105
5.1.1	China Automotive Industry Yearbook (1983-2008) (CAIY).....	105
5.1.2	China patent database.....	107

5.1.3 New model release database.....	108
5.1.4 The History of China Light Vehicle Industry	108
5.1.5 China Statistic Yearbook.	108
5.2 <i>Data Processing for Hypotheses Testing</i>	109
5.2.1 Unit of analysis.....	109
5.2.2 Identification of indigenous vs. foreign cars	114
5.2.3 Vehicle classification and compilation	116
5.2.4 Treatment for longitudinal changes of firms	118
5.2.5 Date preparation for testing hypotheses	119
6. Variables, Measurement, and Model Specification.....	124
6.1 <i>Variables and Measures</i>	124
6.1.1 Major variables.....	124
6.1.2 Control variables	134
6.2 <i>Model Specification</i>	136
7. Findings and Discussion	140
7.1 <i>Descriptive Analysis</i>	140
7.2 <i>Statistical Findings and Discussion</i>	143
7.3 <i>Robustness Check</i>	151
7.4 <i>Conclusions, Implications, and Limitations</i>	152
8. Concluding Remarks.....	157
9. References.....	163

1. Introduction

1.1 The Dynamic Nature of FDI Spillover

At the ceremony for Eminent Scholar Award in Academy of International Business 2011 Conference, Dr. Richard Nelson, the award winner, called for a transition from static methodology directly connecting outcome (dependent variables) to input (independent variables) to an investigation into the underlying dynamic mechanism. His appeal is extremely valid in the research on the impact of inward foreign direct investment (FDI) on host country economic growth. The topic of inward FDI and economic growth could be traced back to John Dunning's research on US investments in UK in 1950s, Stephen Hymer's in 1960, and later Richard Caves' in 1970s. While it has more practical implications than ever in the current globalization age with increasing international trade and FDI flows and the "Washington Consensus" that many developing countries are following, the existing "static" approach widely used in exploring the impact of FDI is sending this line of research to a somewhat "dead-end road".

Many early studies linking the presence of FDI with host country growth simply regressed the host country growth on the presence of FDI operationalized as flow or stock of investment or market share of the foreign invested firms financed by FDI, assuming the very existence of technology spillover or transfer from FDI to the host country. Later studies used industrial-level data to acknowledge that the spillover effect is actually industry specific. More recent studies employed firm-level panel data, which are assumed to be ideal for this type of research (Gorg & Greenaway, 2004), to include the characteristics of foreign invested enterprises (FIEs) and host country indigenous firms

(i.e., those firms being operated in host country and invested by host country nationals or entities¹) and add more context factors. A few studies focused on the foundations of the theory of spillover effect by unpacking the long-time understudied detailed mechanism of how knowledge is diffused through movement of people or other vehicles (e.g., Almeida & Kogut, 1999). Despite the fact that the abovementioned methodological and theoretic advancement has enriched the research and made the findings more reliable and plausible, the empirical evidence about whether FDI has a positive or negative impact on indigenous firms largely remains inconclusive (Blomstrom & Kokko, 2001; Gorg & Greenaway, 2004; Saggi, 2002; Smeets, 2008).

Several studies suggested that the inconclusiveness is attributed to issues of operationalization and measurement and the problem of the level of analysis (e.g., Gorg & Strobl 2001). However, more fundamental deficiency in current routine of spillover research is probably the ignorance of the context-specific and dynamic nature of technological spillover. Economic development, which is being driven by dynamic and continuous technological innovation, is a process against equilibrium (Schumpeter, 1934). Contrary to conventional treatment as easy imitation and free-riding from the recipient side, the process of spillover involves significant effort from individual recipient firm and often with a significant cost (Nelson & Pack, 1999) and even with complementary innovative efforts (Luo, Sun, & Wang, 2011). Technological spillover is not about the cost and return analysis under the assumption of profit or utility maximization, but rather an active and dynamic learning for technology absorption and resulting innovations.

¹ A formal definition will be given in Chapter 3.

One of the very few exceptions that addressed the dynamic part of the foreign-indigenous interaction is Cantwell (1989). His dynamic model of interaction between foreign and domestic firms delineates how domestic firms with historical technological strength were evoked by entry of foreign firms and how the interaction between them changed the pattern of international trade. More recent studies also provided some odd evidence about the dynamic nature of the impact of FDI. For example, using a firm level eight-year panel data from 1994-2001 in Czech Republic, Kosova (2010) detected a negative effect on the indigenous firms in the same industry in the first two years after the entry of foreign firms. This negative effect can be called “initial shock”. After the shock period, the market growth rate of FIEs was found to have a positive effect on that of indigenous firms. Kneller (2005) also revealed that physical distance plays a more negative role in the starting period of international technological diffusion than the later time, implying the accumulation of learning over time actually could overcome the spatial obstacle. In the case of Japan, Murakami (2007) found that in short run the market share of foreign firms lowered the total factor productivity growth of Japanese firms but, in the long run, Japanese firms benefited from technological spillover from foreign firms. Aitken and Harrison (1999), who found FDI’s negative effect on productivity of domestic firms in Venezuela, also suggest the possibility that the negative “market-stealing” impact might be outweighed by the positive spillover effect in the long run considering that most FDI in Venezuela was in its early stage in their data.

Blomstrom et al. (2000) argued that competition between multinational corporations (MNCs) and domestic firms should be analyzed from the perspective of industry

dynamics, not factor productivity. Without knowing its dynamic process, it is difficult, if not impossible, to understand, explain, and predict the outcomes from the interaction between FDI and host country indigenous firms. The input-outcome modeling methodology with a rationale of neo-classical equilibrium could barely get the same findings as that with a dynamic and evolutionary lens (Nelson & Winter, 2002). As I will argue in the following chapters, the mixed findings in previous studies may be actually consistent if incorporated into a same dynamic process of diffusion and considered temporal outcomes of the dynamics.

1.2 Scope of Research

In this dissertation, I adopt a dynamic lens to investigate how and why FIEs, especially those multinational corporations (MNCs) with strong technological strength, to developing countries could have impact on the survival and growth of host country indigenous firms within the same industry² and, more specifically, the latter's technological capability formation, captured by three interrelated constructs, productivity, innovation, and market performance, at individual firm level by looking at the industrial change triggered by the entry of *market-seeking* FDI. The dynamic theory explores the interaction between foreign and indigenous firms through an interrelated eco-system of competition and technology diffusion between the two and capability formation of the latter.

To find support for the dynamic approach of the interaction, it is more proper to take a

² i.e., they are competing with each other in the market. The "industry" here is narrowly defined. In spillover literature, the parallel terminology is "intra-industry" or "horizontal" spillover.

specific industry and search for the detailed mechanism. I choose China automobile industry as research subject for an empirical investigation not only because the growth of China automobile industry in recent years is phenomenal but also its history and evolution sets a perfect scenario for the test. The soaring mass production capacity,³ the emergence of competitive indigenous brands (“*Zi Zhu Pin Pai*” in Chinese), the significant outward internationalization in recent years,⁴ and the growth of domestic parts and component sectors⁵ suggest that a process of dramatic technological capability formation has been occurring among indigenous Chinese carmakers. All these achievements have been fulfilled after the long time isolation from the rest of the world until China opened its door to FDI in early 1980s. Thanks to the comprehensive data and numerous documents and records from different sources with more than 25 years, we are able to trace the whole process of competition and learning.

With respect to China automobile industry, and particularly the China passenger car industry, I explore some fundamental issues associated with the following two sets of questions. First, have those indigenous carmakers (i.e., assemblers) benefited from the presence of foreign multinational carmakers? If so, what is the detailed mechanism? Second, which type of indigenous firms can learn and survive after the entry of foreign carmakers? In other word, what are the determinants of variations in capability formation across individual indigenous carmaker? The answers to above questions are also

³ The increased production capacity is also accompanied by significant technological advancement and increased complexity indicated by model upgrading and new model launch. Chinese firms made 132 units of passenger cars in 1958, 20,427 units in 1982, and over 5.6 million in 2008.

⁴ Such as acquisitions of assets from Volvo, Rover, and SAAB by China indigenous firms.

⁵ For example, their increasing international competitiveness and strong exports (such as tires).

contributing to the existing debate of whether or not the joint venture policy in automobile industry has benefited the growth of China indigenous carmakers.

1.3 Contributions

This dissertation has two major contributions. The first is related to spillover literature. It disentangles the FDI's spillover effect from a dynamic perspective and, moreover, articulates the mechanism of how competition and technological diffusion could shape the net impact from foreign invested firms. As a reconceptualization of the conventional framework, this dynamic perspective provides a possible explanation for controversial findings from literature. By incorporating firm-level capability accumulation into spillover, this dissertation also enriches our understanding of continuous corporate technological accumulation in a transitional external environment. I found that that technological accumulation still played an important role despite the radical technological changes introduced by foreign players. The different learning outcomes observed among indigenous firms might reflect their partially inherited dynamic capabilities in managing a transition to a new technological trajectory, and not merely their absorptive capacity as measured by the extent of their prior knowledge overlap with foreign invested firms.

1.4 Organization and Overview of the Dissertation

This dissertation is organized as following. Chapter 2 presents a literature review on existing spillover research. The limitations of spillover research and the gap and conflicts in this line of research are also identified. In Chapter 3, I propose a dynamic model of foreign-indigenous interaction by first introducing two different dimensions, technology

diffusion and competition. Then I describe some possible effects from these two dimensions, respectively. I then argue that the net impact of foreign firms initially is negative in nature because of the difficulties in direct intra-industry learning, vertical competition effect, and in some situations the “market-stealing” effect. Then after this stage, a gradually increasing learning happened primarily indirectly through supplier network benefited the growth of the indigenous counterparts. As foreign firms localize their production network, selected indigenous firms in supplier sectors could benefited from the intentional technology transfer and mutual learning for the technologies at a relative simple and specialized level. The consequent forward linkage from those suppliers who benefited from foreign technologies could help the growth of indigenous firms. The second part of the dynamic process is which firms could benefit the most from foreign firms. I argue that the emergence and growth of indigenous firms, or the “catfish effects”, are largely determined by their existing pool of capabilities accumulated historically as well as their absorptive capacity.

In Chapter 4, I develop six sets of hypotheses based on the dynamic theory proposed in Chapter 3 and give an empirical test in the context of China passenger car industry. In Chapter 4, I give an introduction and a history of technological development of China automobile industry to justify the advantages to take this industry as my research setting for empirical test. After that six sets of testable hypotheses are proposed. Chapter 5 and Chapter 6 describe the data sources and methodologies exploited. First I give a review of the data sources and how I compiled the dataset for each set of hypotheses. Then operationalization and measurement of variables and model specification are discussed.

Chapter 7 reports the findings and also discussion on the findings. Their implications for China automobile industry are also offered. Chapter 8 readdresses the overall contributions of the dynamic view, and the positioning of the theory in existing literature body, and some research directions are also proposed.

2. Literature Review

2.1 Conceptual Issues of Spillover Research

While most studies rooted their theories in MNCs' technology transfer to exploit their existing technological advantage in foreign subsidiaries, not many studies made a clear distinction between those spillover effects associated with the actual diffusion of knowledge and those without. If the term "spillover" is an analogy to "externality" in Economics, it could be defined as the unintended and unexpected impact of a certain economic activity from which the actor is not directly involved in this impact. Based on the types of externalities indicated in Henderson (1997), the spillover effects of FDI could be unrelated to actual diffusion of knowledge. Blomstrom and Kokko (1998) identified two types of spillover to host country firms: productivity spillover and market access spillover. Productivity spillovers could happen when indigenous firms learned the proprietary knowledge from foreign-owned firms or when indigenous firms created or updated their own knowledge in response to the increasing competition brought by the entry of foreign firms. The market access spillover refers to the indigenous firms as subcontractors of multinational firms obtained the access to the international market and other benefits such as achievement of economy of scale, and the knowledge for international market¹. Productivity spillovers from foreign firms to indigenous firms can be realized through the following channels (Blomstrom & Kokko, 1998): backward/forward linkages, movement of human capital, demonstration effects, and competition effects.

¹ The market access spillover is not the focus in this dissertation.

However, if we take technology diffusion and learning as more direct and dynamic gains from the foreign-indigenous interaction, some of the productivity spillovers, which are actually a proxy of technology advancement in empirical testing, do not involve the flow of knowledge from foreign to indigenous firms. While the linkages and movement of human capital may involve actual knowledge diffusion, demonstration and competition effects may not induce any learning from foreign firms. As Blomstrom and Kokko (2001) explained, demonstration effects refer to the situation that “the successful introduction of new production techniques and new products reduces the subjective risk surrounding the adoption of the innovation and should, therefore, promote its adoption more widely throughout the population of potential adopter in the host country”. Obviously, it is assumed that technologies are accessible by indigenous firms and what local firms learned are not the technologies in question but rather the reduced uncertainty associated with its adoption. Similarly, competition effect, which emerges when the indigenous firms are alerted and more actively to introduce new technologies and new products, also assumes the availability of newer technologies to indigenous firms.

The different theoretical roots for various types of spillover make it important to clearly distinguish those types involving actual knowledge diffusion from those actually not. As learning behavior underlying the technological spillover differs fundamentally from those competition effects in terms of procedures and determinants, a more conceptually consistent typology of those effects is necessary to illuminate the process and outcomes of foreign-indigenous interaction. Unfortunately, most of previous studies, with a few exceptions, did not treat those effects correctly.

Another issue is the concept of “technology spillover”. According to some literature (e.g., Javorcik, 2004), the concept of technology spillover refers to the technology flow from one to another from which the owner (or existing user) could not get return. It is theoretically rigorous but empirically awkward since it is very difficult to identify the intention of technology diffusion in practice. Many studies on spillover through vertical linkages are actually about intended knowledge transfer (Smeets, 2008). If indigenous firm A obtained a certain technology from foreign firm B unintentionally through their business partnership, we may call this gain as technology spillover. If B intentionally transferred the technology to A so that the latter can produce high quality components for B, this technology transfer might not qualify the definition of “spillover”. These two types differ dramatically in terms of the involvement of the technology sender and the degree of coordination between sender and receiver but unfortunately in practice it is hard to distinguish between intentional and unintentional technology flows. More complicated is that the residual value of an intentional transfer is indeed a spillover after B’s exploitation of that technology but the spillover could be barely calculated or even observed.

To overcome the conceptualization issue, I present a new conceptualization in Chapter 3. To maintain consistency, in the literature review part, I still use the conventional conceptual framework.

2.2 Prior Research on FDI Spillovers

This part offers a critical review of literature on FDI's general impact on indigenous technological growth. Since the empirical test will be conducted on China automobile industry, studies related to automobile industry will be reviewed in the coming Chapters to make a smooth content flow.

The impact of FDI on host country indigenous firms has been widely studied in the areas such as development economics, international business, technology management, international management, political economy, and regional studies. Majority of literature focuses on the spillover impact, in other word, the welfare that a firm's cross-border operations can create for the host country indigenous firms. In fact, the relationship between FDI and indigenous firms is a vital part of some of the theories of multinational corporations. For example, in Hymer's (1960) theory of foreign direct investment, the primary incentive for firm's cross-border expansion is to compete with host country firms using its monopoly power. Internalization theory argues that cross-border horizontal integration can solve the problem of easy leakage and difficulty of pricing originated from the free-riding nature of technology (Buckley & Casson, 1976). Some recent studies revealed that MNCs diversify and augment their technological competencies by tapping into host countries' knowledge pool (Cantwell, 1995; Cantwell & Janne, 1999; Kogut & Chang, 1991; Makino, Lau, & Yeh, 2002). In that sense, knowledge flows between MNC subsidiaries and indigenous firms are bi-directional. As the main concern of this dissertation is how the relatively lagged-behind indigenous firms could benefit from the presence of foreign invested firms, in the literature review I only focus on the studies

investigating knowledge flows from foreign invested to indigenous firms.

There are quite a few comprehensive review papers in spillover studies from various perspectives (e.g., Blomstrom & Kokko, 1998; 2001; Gorg & Greenaway, 2004; Gorg & Strobl, 2001; Keller, 2004; Meyer & Sinani, 2009; Pack & Saggi, 1997; Saggi, 2002; Smeets, 2008). In this dissertation I first review the theoretical underpinnings of those studies, and then summarize their empirical test and findings. Limitations of literature and proposed new directions are then identified at the end of this Chapter.

2.2.1 Theoretical underpinnings

Early studies have taken a simple approach of technology imitation assuming the public nature of technology. The level of analysis is usually country. By observing, reverse-engineering, and imitating the final products or production processes, indigenous firms are believed to be capable of acquiring those technologies exposed to host country market with a minimal cost. Stimulated by the controversial findings from the direct country- or industry- level tests, later studies investigated the detailed channels for technology diffusion and how country, industry, and firm-level characteristics at both sides of FDI and indigenous firms can alter the direction and significance of spillover. Underlying the tendency of embracing a micro and more sophisticated theoretical framework is the new understandings of technology development. Departing from the neo-classic assumption of the nature of technology, technology is considered partially tacit and difficult to codify (Cantwell, 1991; Kogut & Zander, 1993) instead of a public good. Technological development is accumulative, path dependent, partially irreversible,

and context specific (Cantwell, 1991; Nelson & Winter, 1982). Therefore, technological learning is not an easy process. First, as the context-specific technology is difficult to transfer from one party to another, some forms of interaction (linkage) between the transferor and recipient must be established. Second, the recipient must have some prior knowledge because learning need prior knowledge to recognize, assimilate, and apply the knowledge exposed. In other word, a certain amount of existing capabilities or “absorptive capacity” is needed to achieve effective learning (Cantwell, 1993; Cohen & Levinthal, 1990). This implies a dilemma of learning: if one has more to learn due to backwardness, he might be less able to learn due to poor learning capability. In other word, an effective and efficient imitator may be an active innovator. Imitation, as a learning process, would need significant effort from the recipient firm including cost and time. Sometimes, the cost for imitation is even higher than that of original innovation (Cohen et al., 2001; Levin et al., 1987). Third, it might be inappropriate to fully attribute the success of indigenous firms to the knowledge diffusion from foreign invested firms. Due to cumulative nature and path dependence, sustainable competitive advantage resides in the accumulation of technological competences that are firm-specific and tacit (Cantwell, 1991; Dierickx & Cool, 1989). More important in the story of spillover effect is indigenous firm’s own ability to incorporate foreign created technologies into their own set of technological capabilities. To some extent, the growth of the indigenous firms might be actually the revival from their unrevealed and endogenous capabilities.

Understanding the nature of technological development is critical to rationalize technology diffusion. A good example is the study on the role of technological

backwardness or technology gap between home country and host country. Early studies (e.g., Findlay, 1978) believe that more lagged-behind countries can gain more from the international technology flows because the large technology gap implies large potential to learn. But a few other studies (e.g., Glass & Saggi, 1998) found that large technology gap, which may also imply poor absorptive capacity (Girma, 2005; Girma & Gorg, 2007), might impede technology acquisition especially with the increasing technology complexity of goods produced and traded by multinational firms.

In general, research on FDI spillover to developing countries can be classified into three general directions if we borrow Blomstrom and Kokko's (2001) analytic framework where the recipient firms (i.e., indigenous firms) are at "demand" side and the foreign invested firms are at "supply" side. The first is the channels through which FDI impacts on indigenous firms. Most of the studies in this vein tried to identify the vertical linkage, competition and demonstration effect, and other interactions between foreign invested and indigenous firms to trace the actual knowledge flow from one to another. The second direction is to search for demand side characteristic that can explain nation, industry, and firm level heterogeneity in learning from foreign invested firms. The third direction, though less studied, focuses on how the supply side (i.e., foreign invested firms) activities and strategies influence the learning potential of indigenous firms.

2.2.2 Findings from literature

I keep this section short as there are quite a few comprehensive review papers that I mentioned at the beginning of this Chapter and those studies related to my theory

development will be reviewed in Chapter 3. Table 1 summarizes some representative empirical work on spillover research. Most studies can be classified into four categories: search for direct intra-industrial effects; for demand and supply side characteristics that moderate the effect size, and for diffusion channels. Here only some important studies are discussed in some details.

Findings in search for intra-industry main effect. This line of research normally checks the impact of foreign invested firms on indigenous producers competing with foreign invested firms in the host country market. In some studies, this spillover is also called horizontal spillover (e.g., Gorg & Greenaway, 2004), as a comparison to vertical spillover through backward or forward linkages. The conventional approach is to take the measures of diffusion effect (primarily total factor productivity or labor productivity) as dependent variable and regress them on measures of FDI presence. However, studies found mixed effects on the indigenous firms. Some of the studies found positive effects (e.g. Buckley, Clegg, & Wang, 2002; Buckley, Clegg, Zheng, Siler, & Giorgioni 2007) and some other studies (e.g., Aitken & Harrison, 1991; 1993) found negative impact of foreign invested firms. Considering the tendency that studies with insignificant testing results are unlikely to publish, it is expected that many more unpublished studies found no significant relationship.

Findings in search for demand and supply side contingencies. Some recent studies investigated the possible factors that moderate the effect size. One of the demand side factors is technological backwardness (or foreign-indigenous technology gap) and

absorptive capacity of indigenous firms (or of the recipient country). Some of studies found significant moderating effect of both backwardness (e.g., Findlay, 1978) and absorptive capacity (e.g., Girma & Gorg, 2007) on the size of spillover. However, the results of the role of technology gap and absorptive capability suffer from the poor conceptualization of these two definitely correlated variables. As Glass and Saggi (1998) suggest, large technological gap could imply low absorptive capacity, which could impede indigenous firms from learning. Moreover, inconsistent operationalization of technological gap and absorptive capacity makes findings of different studies difficult to compare (Smeets, 2008). The demand side factors in previous studies also include R&D activities of indigenous firms, the geographic proximity (or spatial distance) to the foreign invested firms (e.g., Bottazzi & Peri, 2003; Chang & Xu, 2008), ownership structure of indigenous firms (e.g., Buckley, Clegg, & Wang, 2002). Unfortunately, the findings in these factors are also inconclusive and even controversial. For example, Bottazzi & Peri (2003) found that spillover effect is bounded geographically from the data from 15 countries in European Union, but Chang and Xu (2008) suggest that spillover effect is more on national level and competition (rivalry) is on regional level using China firm level data. Definitely the contradicting results could attribute to the industrial technological characteristics or be confounded by the human capital mobility, which might be an important instrument to diffuse knowledge primarily locally (Almeida & Kogut, 1999).

The supply side factors investigated in empirical studies include entry mode of FDI (e.g., Blomstrom & Sjöholm, 1999; Dimelis & Louri, 2002; Javorcik, 2004; Javorcik &

Spatareanu, 2008), sources of FDI (e.g., Buckley, Clegg, & Wang, 2002; Buckley, Clegg, & Wang, 2007a,b; Javorcik, Saggi, & Spatareanu, 2004), and motives of investment (e.g., Driffield & Love, 2007; Girma, 2005; Protsenko, 2003). For example, based on Indonesian firm level data, Blomstrom and Sjolholm (1999) found that while there exists intra-industry spillover effect on productivity, the degree of participation of indigenous firms (i.e., joint venture or wholly owned firms) makes no significant differences in terms of size of spillover. In general, local partner requirement by the some governments would make indigenous partners to the proprietary technologies from foreign invested firms and reveal higher technological spillover. However, according to their findings, the multinational firms could actively protect their technology from being diffused to local partners if they think the only reason for joint venture is just for obeying the government policies. Buckley, Clegg, and Wang (2002; 2007a,b) found that investments from Hong Kong, Macau, and Taiwan (HMT) are more likely have positive spillover effect in labor-intensive industries and other non-Chinese investments have positive spillover effect in capital-intensive industries. But this finding could have bias if HMT investments are more focused on labor-intensive and other non-Chinese investments are capital-intensive. Regarding the investment motives, it is found that resource or efficiency seeking types of FDI generate positive technology spillover and market seeking type of FDI primarily increases the competition intensity (Protsenko, 2003). Driffield and Love (2007) and Girma (2005) found that assets-seeking type of investment produces less spillover effect than asset-exploitation type investment due to the technology-absorbing characteristics of former type investment. However, in a recent study by Cantwell and Smeets (2008), they found strong positive productivity spillover

for asset-seeking type of FDI suggesting that the active R&D activities and intense interaction with local entities in order to tap into local knowledge pool actually enlarge the learning potential for indigenous firms.

Findings in search for possible channels for spillover. Prior conceptual work of spillover suggests that spillover can be realized through forward and backward linkages, competition effect, demonstration effects, and movement of human capital (e.g., Blomstrom & Kokko, 1998). I will temporarily follow this framework in the literature review, although as I argued earlier, competition effect and demonstration effect are theoretically different from the channel of linkages. Relative rich literature focuses on vertical linkages. The linkages are considered the key for technological spillover (Rodriguez-Clare, 1996) in recent studies since the real linkage captures the concrete and efficient ways to diffuse technologies due to the tacit nature of technology. Most studies in this aspect confirmed that the backward linkage (i.e., from foreign invested firms to their indigenous suppliers) could generate positive technology spillover effect. The findings are very robust using different country data with different types, different model specification, and even alternative measures (e.g., Bwalya, 2006; Javorcik, 2004; Javorcik & Spatareanu, 2008; Kugler, 2006; Schoors & Vander Tol, 2001). But obviously, as I mentioned in earlier part, this technology diffusion should not be solely counted as unintentional “spillover”. Actually, this stream of literature is more associated to technology transfer and exploitation through partnership with indigenous supplier firms. For forward linkage, studies showed insignificant or even negative results (e.g., Bwalya, 2006; Kugler, 2006; Schoors & Vander Tol, 2001).

A few articles check the demonstration effects. Unfortunately the concept of demonstration effect in empirical studies is often equivalent to knowledge spillover and thus does not fit the cleanest definition offered in Blomstrom and Kokko (2001)² (See Smeets, 2008). For example, Cheung and Lin (2004) suggest that the number of applications for new product designs is an indicator of demonstration effects because this type of technologies embedded is most easily to create. However, as they made their argument based on China patent database from 1995 to 2000, when indigenous firms in those industries with high propensity of patenting are in their early stage of learning, the innovations at lower level might reflect their duplicative or innovative imitation that would lead to novel innovation at later time (Luo, Sun, & Wang, 2011).

Similarly, studies on competition effect also suffer from the vague conceptualization. Using data from Mexico, Kokko (1996) found a positive competition effect of FDI but Konings (2001) showed a negative impact. As discussed earlier, competition effect, defined in this vein of research (Chang & Xu, 2008; and Kosova, 2010 among few exceptions), is not only determined by the presence of foreign completion, but more importantly, by the existing capabilities of indigenous firms involved. Therefore, this effect should be considered the role of own capability accumulation (and, in other word, as a demand side factor) in learning from FDI (e.g., Cantwell, 1989). In our conceptualization in this dissertation, competition effect refers to the direct impact of market competition incurred by entry of FDI.

² Their definition of demonstration effect has been cited on page 16 of this dissertation.

-----INSERT TABLE 1 ABOUT HERE-----

2.2.3 A critique and new directions

The existing body of research on spillover has the following limitations and gaps. The first is the mixed findings (Gorg & Greenaway, 2004). While some review articles (e.g., Gorg & Strobl, 2001; Smeets, 2008) suggest some technical issues that might explain the inconsistent empirical results, a few other studies (e.g., Lipsey & Sjöholm, 2005) believe that some fundamental theoretical insights missing from the existing research paradigm. After echoing the previous critique about the methodological problems in existing studies, I raise two fundamental limitations that would overcome the current difficulties in going ahead: the problems of static nature of modeling and improper conceptual framework. Those limitations and deficiencies will be solved in a new dynamic approach of competition, diffusion, and capability accumulation delineated in Chapter 3.

Issues in methodology. First, firm-level study using firm data would be perfect (Gorg & Greenaway, 2004) but majority of empirical work has been based on industrial or more aggregated level (Gorg & Strobl, 2001). The uneven distribution of the benefits (or threats) from FDI among heterogeneous indigenous firms in various industries makes aggregated level of analysis less reliable and less explicit. For example, at industry or country level, if the presence of FDI crowds out those indigenous firms with lower productivity but with no real knowledge spillover revealed, there would be an increase of the average productivity at aggregated level. Accordingly, the positive relationship

between FDI and productivity of indigenous firms might be illusive³.

The second issue is the simplicity in capturing spillover effects. Productivity (e.g., total factor productivity or labor productivity) is the mostly popular variable adopted to capture spillover effect and even becomes the ultimate concept being investigated in spillover research. Productivity measure rooted in the logic of production functions in economics: when utilized technology is more advanced, the productivity could be higher. However, in an evolutionary view (Nelson, 1981; Nelson & Winter, 1982), firms might not be operated on a common production function because technological knowledge is not shared equally among firms, nor is it easily imitated by or transferred across firms. Even we assume that improvement of technological advancement would be reflected in the increased output efficiency, productivity is an ill-defined and inadequate measure of spillover especially the technology diffusion. On one hand, other antecedents contaminate productivity measure such that the productivity will not reflect the true technological gain. One example is the productivity measure at aggregated level, as discussed above. Moreover, As Abernathy (1978) argued, productivity emphasizing high reliability might conflict with innovation especially those major ones that encourage trial and error, variation, and unpredictable outcomes. In other word, the learning endeavor in imitation as well as innovation might be rightly captured by instant productivity gains. Another example is that if an indigenous supplier firm achieves economy of scale due to the large demand from foreign invested firms, the resulting increased productivity actually resembles the pecuniary externality in Krugman (1991), which is nothing related to technology diffusion.

³ Notably, Lipsey and Sjöholm (2005) believe that effect should be considered positive.

On the other hand, productivity, even used with caution and warning, is inadequate to reflect the size of technology diffusion. As diffusion is difficult to measure directly, productivity as a consequence-based indicator is based on the assumption that 1) if a firm's productivity is improved, some sort of technology diffusion must have happened, and 2) if there is technology diffusion, the firm's productivity must be improved. Existing studies already revealed that improved productivity could be the consequences of demonstration or competition effects, which are not associated with any technology diffusion. Therefore, the first assumption is disputed. If the recipient firms are engaged in major innovations or technological changes that alter the processes adopted and product offerings, the second assumption might lose its base as well.

The third issue is related to data type, measurement, and model specification. One of the explanations for the mixed findings is the possible bias in type of data, measurement, and model specification. Based on a meta-analysis on 21 intra-industry spillover studies, Gorg and Strobl (2001) found that cross-sectional studies report higher size or more negative spillover effects than panel data studies and that the definition and measurement of foreign presence affects the findings as well. Besides similar results found, a recent meta-analysis on 32 intra-industry spillover studies focusing on developing countries suggested that omitting important variables in model specification might have attributed to the overall weak productivity spillover (Wooster & Diebel, 2010). Smeets (2008) also raised some issues on model specification and measurement disparity. For example, different measurement for technological gap and absorptive capacity makes the results on

their moderating effect difficult to compare.

Lipsey and Sjöholm (2005) revisited the issues of types of data and model specification using data from Indonesian manufacturing sectors to check how these could change the findings. They show that both panel and cross-sectional datasets show positive intra-sector productivity spillovers. They further argued that the current mixed findings might not be caused by methodology problems but the failure to find universal relationships. In other word, search for more factors at different levels might be the key to explain the heterogeneous effect of foreign invested firms. They particularly raised the “impact of the ability of recipient firms (on countries) to benefit from the presence of foreign invested firms and their superior technologies”. As I will discuss in next Chapter, this dissertation argues that a change of view from static to dynamic and a remodeling of conceptual framework could also provide a good explanation for the controversial findings.

Problem of static approach. To my point, the biggest deficiency is that most studies on spillover lack dynamic content. Technologies are partially tacit and difficult to codify and technology development is accumulative, path dependent, partially irreversible, and context specific. This nature of technology suggests that technological diffusion is actually a process of intentional learning which takes significant time and cost. Although more and more scholars in spillover research accept this argument, the processes of learning and diffusion are still ignored in their theory development. Spillover is actually an outcome of strategic games between the involved parties including foreign invested

firms, indigenous firms, and host country governments. This process puts forward the evolution of the technologies as well as the market for them. In this process not only the factors that influence the gain or loss from foreign-indigenous interaction could change but also the effect size of these factors changes accordingly. As summarized by Smeets (2008), most studies (especially those early studies) simply put the measures for productivity of indigenous firms as dependent variable and put the presence of FDI on the right side of the model as independent variable after adding some control variables. This simple approach could not capture the complex nature of foreign-indigenous interaction process.

Another shortage of static treatment is that the intra-industry technological diffusion could be indirectly generated through vertical linkage to local firms. In a non-monopoly market, if the indigenous firms benefiting from technology diffusion from their foreign invested clients establish supply relationships with indigenous firms within the same industry as the foreign invested firms, intra-industry technology diffusion might be realized. But obviously this structural and sequential model, which implies the overall intra-industry effect changes over time, has not been explored in existing literature.

Some studies have been rooted in equilibrium rationale among which there are quite a few studies on the spillover effects using economic modeling (e.g., Lin & Saggi, 2005; Wang & Blomstrom, 1992). It is argued here that if the spillover processes in the real world are not following the strict assumptions⁴ of those models or still far from

⁴ The decision makers are human beings with bounded rationality and with limited and partially distorted information. In a behavior theory (Cyert & March, 1963) and an evolutionary theory of the firm (Nelson & Winter, 1982), managers

equilibrium, the equilibrium approach may not capture the status quo in real world. In other word, to find a complete theory of spillover, a process/dynamic approach is necessary not only because a time-related dimension is needed for time-consuming and cumulative learning but also because the foreign-indigenous interaction in the reality is far from equilibrium or even intentionally against it.

Confusion by conceptual framework. As I discussed in the beginning part of this Chapter, competition and technology diffusion have different mechanisms with different antecedents and consequences but very few studies treat them separately (Chang & Xu, 2008; and Lin & Saggi, 2005 as exceptions). For example, if the foreign invested firms contribute to indigenous supplier firms through technology diffusion by backward linkages, the overall effect of backward linkages in empirical testing could be uncertain because those suppliers who have not established any substantial linkages could be crowded out because their customers' declining market share directly caused by presence of foreign invested firms. But obviously we cannot deny there is a technology diffusion realized in the backward linkages. This illusion could be aggravated by the model specification without accounting for the existence of real supplier-customer linkages at firm level or by the analysis at industry or more general level. To deal with this issue, we need to reconceptualize the existing framework which treats channels such as vertical linkages, demonstration, and competition effects equally. First, we need to isolate the market competition from the process of technological spillover because only the latter is associated with real technology flows. Second, we need to consider separately the

search for solutions for existing decision problems based on some elements of randomness. This search process might not follow the simulated outcomes from the rationale-based economic modeling.

technology development with or without directly benefiting from the technology diffused from foreign invested firms. As one of a few possible consequences of market competition, revival primarily relying on existing capabilities and resources (i.e., “catfish” effect in my terminology) can be an impact of FDI but technology diffusion from FDI sometimes plays only a minor role in the process technology upgrading and innovation. As I defined early, this dissertation adopts a new conceptual framework to investigate the dynamic impact of FDI on indigenous growth.

Ignorance on indigenous firms’ own capabilities. As Lipsey and Sjöholm (2005) suggested, the different outcomes from the entry of FDI could be explained by the heterogeneous ability of the countries and the firms within countries to respond, to learn, and to innovate. Our new understanding of technologies suggests that essential determinants of possible gain from FDI reside in existing capabilities of indigenous firms. Cantwell (1989; 1991; 1993) clearly stated that crucial role of existing competencies accumulated historically. Wooster and Diebel (2010) found that omitting R&D variables tends to have more positive spillover effect. The reason could be that the R&D contributing to productivity also positively correlated with presence of FDI. If this correlation is not incurred by improper data and model specification, a possible explanation is that the indigenous firms intentionally increased their innovative input to catch up with foreign firms or/and strengthen their absorptive capacity (i.e., catfish effect of presence of FDI).

3. Theory Development: A Dynamic View of Competition, Technology Diffusion, and Capability Accumulation

Based on the last three critiques of literature in previous Chapter, a dynamic theory illuminating the processes of the interaction between foreign invested and indigenous firms is proposed in this Chapter. Intra-industry spillover effect is the main focus of this theory. Although in the empirical test I focus more in product and process related technological know-how, the term “technology” can be broadly defined as technological and managerial know-how. The theory is built upon following assumptions. First, the host country indigenous firms are lagged behind foreign invested firms in terms of technological competencies. This also implies that the possible knowledge flows are from foreign invested firms to indigenous firms rather than the other way round. Second, indigenous firms have experienced a relatively long period of technological development without much interaction with foreign firms. In other word, indigenous firms formerly have been operating in an isolated environment from foreign technologies. Third, the entry of MNCs financed by FDI is motivated by the host country market potential rather than low resource costs or productive efficiency. Lastly, the industries in question provide goods with high technology content, although they are not necessarily hi-tech industries such as information technology and pharmaceutical industries.

In the following part, I define some key terms first. Then I reconceptualize the ill-defined existing framework that I have discussed in first part of Chapter 2. Two dimensions determining the outcome of interaction between foreign invested and indigenous firms

are defined and their possible effects are described in details. The different dynamics of the two are elaborated before the possible integrative and net impact is proposed.

3.1 Defining Some Key Terms

In this dissertation, “indigenous firms” refer to those firms being operated in host country and owned by host country nationals or entities invested by the host country nationals. In empirical settings, a firm with a minimum equity share of 90% owned by abovementioned parties could be classified as an indigenous firm. The brands that indigenous firms created and owned are “indigenous brands”. Foreign invested firms (also called “foreign invested enterprises, FIEs”, or “MNC subsidiary” in this dissertation) are defined as those firms invested by foreign investors including individuals and/or non-individual entities. As a function definition, a firm with a minimum share of 10%¹ owned by above parties will be considered a foreign invested firm. Accordingly, those brands created and owned by the parent company and introduced to the host country are called “foreign brands”. A typical foreign invested firm is invested by multinational corporations (MNCs) and is a part of the multinational network. A large part of the technology transfer literature focus on how the knowledge is being transferred from parent company of the MNCs or its other subsidiaries to the focal subsidiary in a specific host country. However, I would not consider that process in our story of technology diffusion as they are different in terms of the cooperation between sender and receiver and the governance mechanism of transfer (Kogut & Zander, 1993). In other word, I only investigate the interaction between indigenous firms and foreign invested firms, which

¹ The threshold of foreign equity chose to define a firm as “foreign-invested” could have impact on the findings for empirical test. Previous studies in spillover used different classification approaches. See Wooster & Diebel (2010) for a detailed discussion. 10% threshold is based on strategy concerns about strategic role of the firm in its multinational network such as control, technological transfer incentives, and global integration.

can be called “domestic firms” sometimes. To make it clear, I would not use the terms such as “local firm” and “domestic firm” in this dissertation. In the case of international joint ventured firm (IJV), if the local partner (i.e., the local parent company) is an indigenous firm and take less than 90% shares of equity in the joint venture, the joint venture firm is also classified as a foreign invested firm.

At the aggregate level, the indigenous technological growth is the overall growth of indigenous firms. While some literature considers the development of foreign invested firms per se a part of achievement that the host country fulfilled, for my purpose in this dissertation, it is assumed that development of host country or its particular industry is determined by the growth of indigenous firms.

3.2 Reconceptualization: Two Fundamental Dimensions

In the context of FDI in developing countries, I classify the dynamics of foreign-indigenous interaction into two dimensions. The first is *technology diffusion*, which refers to the technology flows from one party to another. More specifically, following Keller (2004), in this study I define technology diffusion (or simply “diffusion”) as acquisition of technologies from foreign invested firms. Our concept of technology diffusion here is more in line with Economics literature and Management literature about technology transfer, where the focus in question is the process of understanding, disseminating, and integrating an innovation into operations (e.g., Buckley & Casson, 1976; Cohen & Levinthal, 1990; Kogut & Zander, 1993).

I use “technology diffusion” because it is conceptually more concise and more feasible to operationalize and measure than traditionally used “technology spillover” in literature (e.g., Javorcik, 2004; Kokko, 1994). It is either intentional behavior of the sender (i.e. technology transfer) OR unintentional process from which the sender could not benefit. This approach is also consistent with some literature in technology spillover that actually studied both intentional and unintentional benefits that FDI could bring (e.g., Acharya & Keller, 2009; Keller, 2002; 2004). The major consideration for substituting technology spillover with technology diffusion is that these two are indistinguishable in many cases as, for example, intentional technology transfer may improve the recipients’ (i.e., indigenous firms) technological capabilities as a spillover “residual”, which is very difficult to measure, after the transferors’ (i.e., foreign invested firms in our case) exploitation of that technology.

Depending on the disciplinary differences, the term “technology diffusion” has various definitions and conceptualizations in innovation and technology literature. For example, some innovation literature (e.g., Rogers, 2003) treats diffusion equivalent to “technology adoption”, which refers to the stage that technology in question is chosen and used by an individual or entity. In other word, technology diffusion is the application of an existing innovation. This line of research focuses more on how the characteristics of potential adopters (i.e., receivers), such as motivations, context, and organizational inertia, could influence the use of new technologies being offered but with less focus on the process of identifying, disseminating, acquiring, and integrating the new technologies. Therefore, “diffusion” in this literature implies *an adopter’ perspective* and, if it happens, is an

active and intended process by the adopters. Moreover, the original owner or existing users are assumed a good will or at least a neutral position upon the adoption of the particular innovations by others.

In our context, the focus instead is how the recipients (i.e., “adopters” in above context) to identify, acquire, and integrate the innovations, assuming the strong intention of recipients to learn as well as the challenges of learning due to complexity nature of knowledge. In a word, the diffusion is a process that the technologies flow from the original owner to the recipients. *From the owner’s or existing user’s perspective*, the process could be either initiated intentionally (i.e., intentional transfer) or unintentionally spill over to the recipients. In innovation adoption literature we just discussed, one could not know whether the technology flowing to the recipients is intended or not if we take the owner’s or existing user’s perspective. To this point, our meaning of “diffusion” is somewhat consistent with this stream of literature too, though in our line of literature the owner or existing users are normally reluctant to see the diffusion happen if they could not benefit from the process.

The second dimension of the interaction is *competition*. Competition is the key of the motives for foreign direct investment in Hymer’s theory but, as I will discuss later, the effects of competition brought by multinational firms are not limited to crowding out indigenous firms. The distinction between *competition* and *diffusion* is that the former dimension is not associated with actual knowledge movement from foreign invested to indigenous firms. The competition dimension has not been received independent

treatment in theory development in previous studies on spillover but in my theory competition along with technology diffusion shapes the whole process of foreign-indigenous interaction.

3.3 Possible Effects from Two Dimensions of Interaction

The so-called “spillover” effect in conventional literature is actually the net impact of two dimensions: competition and technology diffusion. We need also put productivity aside and consider first how the two components influence the survival and technological performance of indigenous firms. The effects of *competition* result from the presence of foreign invested firms competing with indigenous firms within the same industry. Different from the “competition effect” in previous literature, competition could include the following three types of effect.

The first type of effects from competition is the market *crowding-out effect*. Hymer (1960) argued that MNCs normally have market power over indigenous firms that were developed in the home market. This ownership advantage would have the tendency to drive out indigenous firms. The indigenous firms could fail because of the poor quality and higher unit cost resulting from laggard technologies or diseconomy of scale due to shrinking market share. The FDIs’ impact on market competition and on domestic investment has been received wide attention since Stephen Hymer (e.g., Caves, 1996; Chang & Xu, 2008). While there is crowding-out effect on indigenous firms in the same industry if indigenous firms are technologically lagged behind (Aghion et al., 2009; Blomstrom et al., 2000; Keller, 2004), some argued a “crowed-in” effect primarily

happened in upstream or downstream industries as the entry of FDI bring more demand or supply and thus stimulate domestic investment (e.g., Romer, 1993). But some recent evidence shows that the overall impact is actually crowding-out rather than crowding-in in developing countries (e.g., Agosin & Machado, 2005). The negative impact of FDI on indigenous firms in the *same* industry is not only reflected in squeezing out the customer base of existing indigenous firms but also impede the new indigenous entries (De Backer & Sleuwaegen, 2003). Aitken and Harrison (1999) proposed a “market-stealing” impact to show that the productivity of domestic firms could decline because of the reduction of their production scale. However, Kosova (2010) found that FDI could have an alternative *demand-creating effect* that could benefit to indigenous firms. The possible explanation for this effect is that foreign invested firms, by exploiting their superior product design and production technology to create more consumer surplus or fulfill the unmet demand, could attract more potential consumers and enlarge consumer base for the whole industry. Nevertheless, why the foreign invested firms could not meet the extra demand they created so that indigenous firms take it over remains a puzzle. As I will touch this issue later, some sub-markets being created could not be fully served by foreign invested firms. And also at least some improvement of indigenous firms is needed to enjoy the market creating effect by FDI.

The second effect of competition is *vertical competition effect*. It is an indirect effect passing through the possible local supplier network of foreign invested firms. When the foreign invested firms source their intermediate goods locally without any significant technology diffusion, the vertical competition effect might be either positive or negative

(Rodriguez-Clare, 1996). If the intermediate products are not too different between foreign invested firms and indigenous firms, the increased demand from foreign invested firms for indigenous suppliers could help the latter to achieve economy of scale and subsequently benefit indigenous firms through the lowered down price for their intermediary input (Markusen & Venables, 1999). This is an example of positive vertical competition effect. However, the achievement of economy of scale might not happen if the FDI is basically market-seeking type as the total demand for the intermediate goods might remain roughly constant. In other word, in our setting of theoretical development, the positive vertical competition effect might not exist. Rodriguez-Clare (1996) also suggested that if foreign invested firms do not source locally or other assumptions are reversed, the FDI could create an “enclave” economy and hurt the indigenous firms. Besides, there might be another source of negative competition effect. If foreign invested firms select incumbent outstanding indigenous suppliers to develop their local supplier network by intentional technology transfer, the possible exclusive contracts (Lin & Saggi, 2007) could actually impede indigenous firms from accessing quality suppliers. This “poaching” effect could exert negative impact on the performance of indigenous firms.

The third effect is *catfish effect*². This effect resembles the conventional meaning of “competition effect” (e.g., Blomstrom & Kokko, 1998) and refers to the active response of indigenous firms to the competition threat from foreign invested firms. The response could include improving their operation efficiency, augmenting their marketing strategies,

² The term “catfish effect” comes from a tale. It is said that in Norway if the fisherman could keep sardine alive until the ship went back to the harbor, the live sardine could be sold at the price several times higher than the dead sardine because normally it would die soon once out of the sea. But for a long time, only one fisherman could make it. He kept the secret until his death. Finally people figured out that the secret was a catfish. When the catfish was put into the group of sardines, it became aggressive, and the sardines were alerted and became active under the threat of being the catfish’s prey. In this way, the sardines kept alive for longer.

upgrading their existing technologies for product and production, and increasing R&D input and innovation effort. Cantwell (1989) well documented how the indigenous firms in UK became alerted by the entry of US firms and revived based on their technological strengths accumulated historically. In the case of developing countries, catfish effect might be only generated in those leading indigenous firms. Although catfish effect has not been treated independently in literature on developing countries, the meta-analysis by Wooster and Diebel (2010) using studies on developing countries imply the existence of catfish effect³.

Catfish effect is not necessarily associated with the real learning (i.e., diffusion) from foreign invested firms as its key determinant is indigenous firms' existing capabilities, especially dynamic capabilities, although, needless to say, the alerted indigenous firms could have higher intention to learn from foreign invested firms and with the relatively strong competencies they could learn more efficiently and effectively.

The second component of the interaction process is *technology diffusion* (or the single term "*diffusion*"). Technology diffusion includes direct learning, which I call it "*horizontal learning*". Drawn from some elements in "demonstration effect" but different from it, horizontal learning refers to the learning from foreign invested firms in the same industry (i.e., competitors). Horizontal learning could be realized through two channels, the first is imitation through observation, reverse engineering, and other non-participating ways. I call it "*learning through observation*". The second channel, "*learning through participation*", is learning behavior happened through strategic alliances and joint venture

³ To see a detailed discussion, please refer to the critique part of Chapter 2.

with foreign firms. For example, the indigenous partners can learn from their foreign partners through their joint ventured firms by sending managers and technicians or collaborating R&D activities. The second method of technology diffusion is *indirect learning* from those suppliers. Previous studies normally found insignificant effect of forward technology diffusion (e.g., Bwalya, 2006; Javorcik, 2004; Kugler, 2006). They suggested that FDI in supplier sectors might not bring technological diffusion for their indigenous clients. The possible reason is that the clients normally set the technological standards for the supplier firms and the foreign invested supplier firms might not provide any alternatives, although they may be better in functioning, due to their incomplete understanding and information about what technological specifications that their clients demand. Another reason might be that the foreign invested suppliers' technologies developed in home market or elsewhere are not fully compatible with what indigenous clients need. However, it could be argued that if indigenous firms having received technology transfer from their foreign invested clients could diffuse the technology from foreign invested or the one developed upon it. Indigenous supplier firms might have the unique ability to localize and modify the technology due to their familiarity with the local needs and their capabilities accumulated from the co-evolution with downstream indigenous firms. In this way, indigenous firms might benefit from foreign invested firms in the same industry through the indirect knowledge flow. Needless to say, this indirect diffusion, which I call "*vertical diffusion*" here, is not without other conditions. I will discuss it in details in Chapter 3 and 4. The diffusion effect, whatever their channels could be, supposedly to have positive effect on the technological development and consequent performance of indigenous firms.

I also need to point out that the competition and technology diffusion is not independent. But rather, they interact with each other to have a more complex effect as well.

3.4 A Net Impact of Competition and Technology Diffusion: A Dynamic Process

The basic idea is that after the time point of foreign entry, the sizes of competition effect and diffusion effect change differently over time. Moreover, the factors determining either effect or their effect size may also change. Accordingly, the overall net impact on indigenous firms might change over time as well. I discuss this model in the following order. First I argue why the two components could generate their impact differently after the entry of FDI in the same industry, and then I discuss the net effect in different settings.

3.4.1 The initial shock and the trend of competition intensity

It is likely that the entry of foreign invested firms would promptly bring competition threats for indigenous firms within the same industries. Using firm level panel data from Czech Republic in the period of 1994-2001, Kosova (2011) found that right after the entry of foreign firms there is an instant negative impact on the mortality of indigenous firms. In other word, there seems to be an “initial shock”. From the market side, the superior technologies that foreign invested firms adopted could create more consumer surplus. In the usually underdeveloped market in developing countries, incumbent indigenous producers could not meet the consumer demand. On the other hand, the higher tariffs that developing countries put on imports make attractive products

unaffordable. The presence of locally produced but with high quality products could quickly take over the market.

The initial shock could also be reflected in the *vertical competition* effect. To save the production cost, the foreign invested firms might source locally from those relatively competent suppliers. As indicated in literature, the technology diffusion normally happens between foreign invested firms and indigenous supplier firms. However, as Lin and Saggi (2007) pointed out, the significant backward technology diffusion (actually intended transfer) could be secured by highly exclusive contracts. This exclusiveness may further hurt the indigenous firms as they lose high quality supplies. Catfish effect as a strategic response to the entry of foreign invested firms takes a significant period of time too because the indigenous firms need to identify the key issues and find solutions for catching-up through trial and error process. Moreover, the resulting relocation of resources and entrepreneurial activities would encounter the problem of organizational inertia. The limited existing capabilities compared to foreign invested counterparts would make the responses (e.g., counterattack) even slower and weaker.

In summary, it would be expected that there would be initial shock and high negative competition effect after the entry of foreign invested firms. However, there might be other forces that could alleviate the pressure from competition. For example, Kosova (2010) detected that the market growth rate of foreign invested firms positively related to that of indigenous firms following the initial shock. This positive demand-creating effect might be explained by the submarket framework (Church & Ware, 2000). Similar to the

approach used in Tong (2007), the industry could be understood as a collection of inactive submarkets. Through the introduction and diffusion of the new technologies to those submarkets, those submarkets inactive previously are activated. However, for some reasons, the foreign invested firms could not meet the increase resulted from activated submarkets. The first reason might be the heterogeneity among submarkets makes it uneconomical for a full entry and the second might be the speed of production is lagged behind the unexpected increase of demand. The third reason might be that indigenous firms might have some competitive advantage in some submarkets. These reasons also imply that the benefits of demand-creating effect brought to indigenous firms might disappear gradually depending on the strategic response of foreign invested firms and capability formation of indigenous firms.

Based on above discussion, it could be argued that the effect size of negative competition effect could be very large at the initial stage of entry, but could decline at later stage. Competition pressure on indigenous firms that are in a relative weak position in market would also negatively relate to their performance and limit their resources for innovative activities. Back to the tradition, we might also expect that the shrinking market share would lower down the productivity measure if economy of scale is crucial. As there is a more complex relationship between catfish effect, diffusion effect, and firm-level capabilities, I visualize the effects from competition as two lines, first of which represents crowd-out effect (and possibly demand-creating effect) and vertical competition effect, and the second catfish effect (See Figure 1a, b, c).

3.4.2 The challenges of learning and non-linear diffusion

The process of technological diffusion is a costly process contrary to generally assumed in some neoclassical models. The effort involves the purposeful and costly investments from recipients (Nelson & Pack, 1996). Even the cooperative technology transfer within the MNCs takes higher cost than one can imagine. Teece (1977) estimated the cost of technology transfer to a foreign subsidiary constitute twenty percent of the total investment cost of the new plant. Sometimes, the cost may be as high as sixty percent of the investment. The high cost for cooperative technology transfer implies even higher cost for technology diffusion without intention. Despite the various factors that influence the potential to learn from foreign invested firms as suggest by previous studies, the learning process is difficult and learning speed is not linear over time.

Paradigm differences. One of the largest barriers to learn is the differences in technological paradigms between foreign invested and indigenous firms. Parente and Prescott (1994) argued that firms typically adopt different production techniques in different countries since the cost structure of resources differs across countries due to differences in factor endowments. They also emphasize the difficulty in accessing technologies from other countries due to differences in legal, regulatory, political, and social factors. Kaplinsky (2011) implies that different orientations of innovation are needed for developing countries where the product reliability and production cost are more important. Evolutionary economics suggests that firms' technology development within a country follows similar trajectory as those firms are shaped by same institutions and other firms within the same locations and institutions are also more easily to learn

from each other (Cantwell, 1989; Kogut, 1991). When multinational companies exploit the existing technologies in host country, the alien nature of the technologies implies a natural obstacle for indigenous firms to learn.

Dilemma of learning. Imitation and innovation are two sides of a same coin. Imitation is not easy since firms need capacity to identify, assimilate, and apply the external knowledge (Cohen & Levinthal, 1990). Firm's R&D activities could enhance capabilities to innovate as well as capacity to learn from others (Cohen & Levinthal, 1989). The learning cost also includes "the creation of the complementary non-codifiable element needed to make the technology work" (Cantwell, 1991). While technological laggards are eager to learn, they may lack sufficient capabilities to achieve their goals. A macro level study, Xu (2000) showed that least-developed countries have not benefited from purposefully technology transfer by US MNEs in 1966-1994 because a country needs a minimum level of education for human capital to benefits from the exposure of technologies. The complexity of technologies even makes learning more difficult as the multi-disciplinary knowledge need a common knowledge base across different domains. Brusoni, Prencipe, and Pavitt (2001) suggest that multi-technology firms, normally as a technology integrator, need know more than what they make. Therefore, the less developed firms need to build their capabilities first through R&D and other innovative efforts in order to gain from the exposure of the advanced technologies brought by foreign invested firms. However, most of them may lack necessary resources for this endeavor.

Bounded and localized learning. Efficient learning and imitation is bounded in the network with a close interaction due to the tacit, partially codifiable, partially irreversible, and context-specific nature of technologies. Face to face interaction and purposeful cooperation can shorten the time for learn and reduce the distortion of knowledge during the transfer. In this sense, imitation by observation or reverse-engineering could barely achieve an efficient and effective learning. In other word, learning from foreign competitors within the same market might be very difficult. In contrast, learning through established concrete supplier relationship with foreign invested firms might be more feasible. Knowledge is also bounded geographically (Jaffe et al., 1993; Storper & Venables, 2004; Von Hippel, 1994). This characteristic suggests the uneven technological gains from foreign invested firms depending on spatial proximity.

Protection of proprietary assets. The challenge of learning also comes from the uncooperative nature of technology diffusion. As Kugler (2006) explained why there is no significant diffusion, “the evidence that there is no diffusion of externalities within sectors (i.e., industries) is important because it indicates that MNCs have some control to exclude use of their technology and thereby appropriate the benefits” (p. 472). The multinationals can secure their proprietary assets from being leaked to other parties or at least slow down the diffusion process. For example, Alcacer and Chung (2007) found that while technologically less advanced firms are keen to locate themselves in areas with high industrial innovation activities, more advanced firms tend to avoid locations with competitors. Alcacer and Zhao (2007) also indicated that multi-location firms try to avoid unintended leakage by engaging in innovation activities that are technologically distant

from any competitors that are in the same location. Even in the case of strategic alliances and international joint venture, the foreign partners tend to protect their technologies from being imitated through modularization of their R&D activities (Zhao, 2006) and importing the most technology-intensive parts and components. In the case of purposeful transfer in order to localize production network, the foreign firms normally have the exclusivity of the supplier contract and ensure that the technologies being transferred will not be exploited by other firms. Therefore, even with a direct relationship such as strategic alliances or joint venture, the concrete linkage does not imply an easy access and utilization of the technologies from foreign invested firms. Movement of human capital is considered an effective way for knowledge diffusion (Almeida & Kogut, 1999) but indigenous firms may encounter the following challenges. First, to effectively transfer knowledge, maybe a group of people who have long term experience (e.g., ten or more years) is preferred. But it may be impossible at initial stage of foreign entry. Second, integrating the knowledge residing in human capital would be costly and time-consuming especially if the foreign invested firms have not localized their operations. Third, foreign invested firms normally can afford higher compensation package to retain talents because of their superior technologies and resulting competitive advantages. Their international management system can also allow them to use expatriate managers to avoid possible outflow of human capital to indigenous firms.

Increasing speed of learning. Despite that fact that learning is difficult given the alien nature of foreign technologies, the need for absorptive capacity, and protection from multinational companies, the diffusion is not totally impossible but rather following a

non-linear and cumulative path if the recipient firms engage in continuous and active learning. Multinational firms need to adapt their technologies to the local environment. This adaptation is also a continuous learning process. Accompanied with the gradual localization process, more “learnable” knowledge might be available to indigenous firms. Moreover, the increasing embeddedness into the host country environment may also broaden the scope and strengthen the intensity of the interaction with indigenous firms.

The theory of absorptive capacity also suggests a cumulative nature of learning. If the absorptive capacity of the firm has positive impact on the speed of learning, a continuous effort in learning from foreign invested firms could be accelerated by itself as current knowledge gains could be accumulated to the existing capabilities and improve absorptive capacity for the future learning. This non-linear relationship suggests an increasing diffusion effect over time.

Although learning is localized, technology will ultimately overcome spatial limit and spread out and at the same time it evolves as well. An interesting study by Knell (2005) found the physical distance from the location of foreign technologies played a greater role initially than later time. It implies that the diffusion of technologies could overcome the physical distance over time. The micro foundation of the phenomenon might be that even though learning is localized and the mobility of human capital is geographically bounded the knowledge could still be transmitted cross adjacent locations by movement of people (like relay race) and, absolutely, with some distortion.

In summary, considering diffusion effect as a whole and the compound effect of abovementioned factors, we would expect that the effect size of diffusion would be small at time of foreign entry, and increase in a non-linear trend over time. I visualize this effect as an exponential curve in Figure 1.

3.4.3 The possible interaction between competition and diffusion

There are some possible interaction between competition and diffusion. In general, competition pressure from competent foreign invested firms on indigenous firms might challenge their learning effort in the same time period. One of the extreme scenarios is that foreign invested firms crowded out all indigenous firms. Obviously there will be no diffusion at all. Another scenario is that if foreign invested firms source intermediate products locally by establishing non-exclusive contractual relationships with indigenous suppliers, the overlap of supplier network between foreign invested and indigenous firms may benefit indigenous firms as discussed in Rodriguez-Clare (1996). In this situation, the negative effect of competition might be smaller than in the case of exclusive contract and the positive effect of diffusion at the same time point might be bigger. In the case of exclusive supplier relationship, the exclusivity might actually bring some benefits for indigenous supplier firms after the contract expires since the supplier exclusivity could encourage foreign invested firms transfer technologies to indigenous suppliers. Obviously, this exclusivity would put indigenous firms within the same industry in a worse situation for a longer period. In the demand-creating effect by competition, its realization is often positively related to the capabilities of indigenous firms partially because only those competent indigenous firms could take a part from the enlarged pie. This scenario implies

that, other factors being equal, the reduced negative competition effect due to demand creation might be associated with increased capabilities of indigenous firms that may be partially formed from technology diffusion. From these general and simplified scenarios, it is possible to observe a negative association between competition and diffusion. In other words, when the impact of competition, which might be negative all the time, is strong, the impact of diffusion, which is positive, might be weak. This loosely coupled association is also implied by Aitken and Harrison (1999).

3.4.4 The role of firm-level technology accumulation

The diffusion process is firm specific by nature. Different firms with different capabilities exposed to same technologies will have different learning outcomes. In research on spillover in developing countries, there is not much literature discussing how indigenous firms' capabilities influence the survival and growth after entry of FDI. A few studies explored the role of absorptive capacity in spillover effect (e.g., Castellani & Zanfei, 2003; Girma, 2005; Girma & Gorg, 2007). However, besides the measurement issue, they did not focus correctly on the impact of absorptive capacity on technology diffusion with a conceptual distinction with competition effect. Here two types of capabilities might be related to indigenous firms' learning: absorptive capacity and dynamic capabilities.

Catfish effect can be considered the responses to the changing competitive environment caused by strong foreign invested firms. The resulting technological change might be radical and even destructive considering the discontinuity due to alien roots of the technologies and the indigenous lagged-behind technological competencies. In this

situation, dynamic capabilities might be critical. According to Teece et al. (1997) and Eisenhardt and Martin (2000), dynamic capabilities could be defined as “the firm’s processes that use resources—specifically the processes to integrate, reconfigure, gain and release resources—to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as market emerge, collide, split, evolve, and die” (Eisenhardt & Martin, 2000: 1107). Dynamic capabilities relate to the firm’s ability to sense, seize, and adapt to exploit existing competences and to address the environmental change (Augier & Teece, 2008). As Collis (1994) and Winter (2003) note, one element of dynamic capabilities is that they govern the rate of change of ordinary capabilities. Obviously, the dynamic capabilities that are accumulated historically and partially path dependent are an important determinant of the size of catfish effect and the key to faster revival/or survival from the threat brought by foreign entry.

The effectiveness and efficiency of learning from foreign firms might be related to another capability of the firm: absorptive capacity. As suggested in Cohen and Levinthal (1990), absorptive capacity depends on the firm’s prior knowledge that is overlapped and complementary to the new knowledge. In other word, indigenous firms’ existing knowledge base that is related to foreign technologies is the key for gain from foreign invested firms. This suggests that to have a certain absorptive capacity, the technology environment must not be changed radically. In that sense, the indigenous firms’ dynamic capabilities and absorptive capacity might play different roles.

3.4.5 The net impact

The “spillover” effect as a total outcome of foreign-indigenous interaction is a net impact from two basic components: the increasing trend of positive diffusion effect, the decreasing trend of negative competition effect, and the different timing they take in effect. Figure 1a, 1b, and 1c illustrate three possible scenarios that are typically reflected in previous studies. The first illustration (Figure 1a) visualizes the situation of “strong-strong interaction”, when strong multinational firms enter a host country industry where indigenous firms are also strong, which resembles the situation discussed in Cantwell (1989) and Liu, Siler, Wang, and Wei (2000). This scenario is mostly likely to happen between developed countries in those historically strong industries. The entry of foreign firms stimulated the traditionally competent indigenous firms that were hibernating and thus a strong catfish effect could be generated. The competition effect initially takes the dominant position but very soon the strong indigenous firms could react by exploiting their unrealized capabilities, such as the superior knowledge of the local market and the ability to meet local demand by adjusting existing marketing strategies. These responses might create a larger market where the indigenous firms could have a satisfying share rather than driving the indigenous firms out. The fast and effective responses endorsed by indigenous firms’ existing competencies make the negative competition impact diminish quickly. Similarly, learning from foreign entries is relatively easy and fast as indigenous firms may have sufficient absorptive capacity to decipher the secret of their foreign counterparts. But it is expected that this diffusion effect is declining quickly when the indigenous firms have a very efficient learning curve according to the following two reasons. First, there is less knowledge to be learned if the indigenous firms

have much overlap of technologies with their foreign competitors. Moreover, the learning process becomes more bi-directional than unidirectional between foreign invested and indigenous firms.

The possible deterrence effect suggests that both parties could intentionally avoid cooperative interaction with each other and thus prevent possible leakage of their own advantageous knowledge. Second, indirect technology diffusion from FIEs to indigenous firms through FDI's enhancement of supporting firms such suppliers might be minimized as the suppliers of the strong indigenous firms might be also technologically competent and have less technology gap to serve foreign invested firms, or in some situations FIEs are actually benefiting from the maturity and advancement of host location infrastructure consisting of supporting sectors.

Therefore, it is expected that in this scenario catfish effect dominates in the interaction and diffusion effect does not take the primary role. The direct driving-out effect might not remain strong for a long time because the indigenous firms could respond to the threats quickly and are capable of fighting back based on their strong inherited capabilities. The total effect, after counting in the different elements of foreign-indigenous interaction, could be negative initially but very shortly the negative impact diminishes, and then the overall impact even turns to positive later. The literature of clustering and agglomeration also echo this argument by suggesting that the entry of foreign firms with associated competence-seeking mandates may create a center of excellence with the indigenous and other foreign firms. In summary, the dynamic outcome of indigenous-foreign interaction

could be described as the green curve line in Figure 1a.

The second and the third scenarios, as illustrated in Figure 1b and 1c, normally happen when MNCs enter developing countries in relatively weak domestic industries. First there is a shock, i.e., crowd-out and vertical competition effect, which dominates the initial period of interaction. The length of the period when overall negative impact of FIEs exhibits depends on the active responses from indigenous firms. In the case illustrated in Figure 1b, indigenous firms are activated promptly and accelerating their own pace of technological development and augmenting their strategies combating FIEs. At the same time, their own active learning effort increases the speed of technology diffusion from FIEs. The combined positive effects being generated compensate the negative effects from competition. In other word, indigenous firms catch up gradually after experiencing the initial shock through their own capability formation processes. The period when indigenous firms receive net negative impact is assumed to be longer than in the case of strong-strong interaction, but along with the active responses from indigenous firms the benefits increases and may even overweigh the negative effects in the later period. Therefore, the overall impact of foreign invested firms on the intra-industry indigenous firms would be negative first, then the negative impact diminishes over time, and finally the total impact turns to positive, as represented by the green curvilinear line in Figure 1b.

In another situation (Figure 1c), the major firms in the industry in question could not survive the fierce competition from foreign invested firms. If their squeezed market share

does not offer them sufficient resources to support their imitation and learning from their foreign rivals or their existing capabilities do not allow them to learn and respond quickly and effectively enough, they would go out of business soon after the entry of the MNCs. In other word, the competition effects outweigh diffusion effect and catfish effect through the whole interaction process. The resulting total impact of foreign invested firms on indigenous firms is constantly negative and the indigenous firms lag more behind gradually and finally would be driven out, as illustrated by the curvilinear green line in Figure 1c.

3.5 Discussions on the Framework and Net Impact

The dynamic framework proposed is rooted in firm level theories and therefore the basic unit of analysis is the firm. In other word, individual indigenous firm may exhibit different outcome from the interaction with foreign invested firms. Moreover, the characteristics of foreign invested firms, such as timing of entry, investment motivation and orientation, location, linkages to local supporting sectors, and their technological capabilities, may also change the sequence and magnitude of those elementary effects outline in previous part and result in different pattern of total effect. We also expect that every indigenous firm has heterogeneous outcome out of the interaction due to its unique firm-specific characteristics and advantages. In that sense, some strong indigenous firms would follow the pattern in Figure 1a, and those lagged behind firms might follow the one in Figure 1c. Moreover, their relationship with foreign invested firms is also among important factors influencing the outcome. For example, being a part of the strategic alliance involved in foreign invested firms, the indigenous firms might have higher

chance to get technology diffusion benefit and shows a positive outcome. Location proximity may also strengthen the knowledge flow from foreign invested to indigenous firms and provide high growth opportunities in some situations.

The framework could be also applied to industry level as well. Although different indigenous firms have different responses and heterogeneous outcomes from interaction with foreign invested firms, the overall industry in a country (or a sub-national region) might exhibit some commonality at aggregated level of analysis. First, firms grown up from the same industry in the same country (location) might share the common origin or similar history. They might have inherited a similar profile of technology expertise and organizational routines due to path dependency. Second, the common resource structure, institutions, and comparable institutional pressures could shape them to a similar evolution direction (DiMaggio & Powell, 1983; North, 1990). When confronting the challenge from foreign invested firms, they might respond in a similar way and get somewhat similar outcomes with some variance due to their firm-specific characteristics. Country level pattern may be identifiable also because the unique position of the country in the regional or world economy attracts inward FDI with similar origin, motivations and even strategies. In a word, at the industry level or even country level, the framework can be adopted in the sense that a group of firms exhibiting country and industry specific characters interacts with foreign invested firms that are also related to the host country or industry specific factors. It is expected that at the industry level, countries may also show different and persistent patterns from each other even though at firm level there are often some firms being driven out (e.g., the case in Figure 1c) and some others surviving and

growing finally (e.g., the case in Figure 1b) within a single country. The differences at aggregated level might be attributed to industry structure, level of technological development industry wide, host country institutions and policies, technological trajectories, national innovation system, and so on. If the inward FDI drives out the major firms in the industry, the overall industry-wide outcome could resemble the situation in Figure 1c. Or, if major firms can respond efficiently and effectively, the outcome becomes negative first and turns to positive later (Figure 1b). The time duration of the transition from negative to positive may be also determined by some industry or country level factors.

The predictions of the dynamic framework fit well into some existing empirical findings. For example, the initial shock suggested by the framework is supported by Kosova (2010). The overall pattern of the total effect in Figure 1b suggests an initial negative shock upon entry of foreign invested firms and later a positive impact. De Backer and Sleuwaegen (2003) found that FDI had crowd out effect (i.e., negative net effect) first in Belgian manufacturing industries and in long term the overall impact turned to positive. If we acknowledge the different effects that the host countries could have, it is also not shocking to learn that scholars reach no consensus on the relationship between FDI and indigenous growth. Besides the fact that this dynamic framework suggests a better theory to unpack the sources of negative or positive overall effect, it also implies another perspective to solve the controversial findings. As Aitken and Harrison (1999) raised in their discussion, the possible reason for a negative impact in the case of Venezuela is that the interaction between FDI and indigenous firms is in the early stage. After some period,

the effect could be positive. When put the foreign-indigenous interaction in a dynamic view, the different effect might be only the temporal outcome of a same dynamic process as identification of the pattern indicated in Figure 1a, b, and c critically depends on the time window of the investigation. One of the possible reasons for those studies indicating a negative impact is the short period of observation window or investigating in the early stage of the entry of FDI. Another reason for the insignificant results might be mis-specification of the models ignoring the dynamic and curvilinear nature of the relationship. Needless to say, the normal reasoning for the discrepancy, such as lacking industry or firm level context factors, apply as usual.

It is worth noting that the outcome of the interaction is primarily the capability formation of indigenous firms. The capability formation could have various indicators, which are not confined to productivity, technology development, or domestic market share. For example, the positive impact might be reflected in increasing expansion into international market, or vertical expansion to related sectors, or non-patentable technology application.

The final note is that although this dynamic framework generated by reconceptualization and theorization of existing research paradigm suggests some overall net impact of FIEs as shown in Figure 1a, b, and c, we need to investigate the components of interaction delineated in previous part rather than simply proposing net curvilinear relationship between presence of FIEs and capability formation of indigenous firms. The so called “spillover” effect can be fully understood only when we unpack various forces driven by different theoretical roots. Our framework of net impact here should be understood as a

time related, sequential process and at any time point, the size of various effects would be related to those factors proposed in previous studies such as those reviewed in the Chapter 2.

-----INSERT FIGURE 1a ABOUT HERE-----

-----INSERT FIGURE 1b ABOUT HERE-----

-----INSERT FIGURE 1c ABOUT HERE-----

4. Hypothesis Development with Respect to China Passenger Car Industry¹

4.1 Research Settings for Empirical Test

I argue in Chapter 3 that the impact of FDI could evolve over time besides its dependence upon the firm and industrial level characteristics. The pattern of dynamics, though identifiable using the new dynamic framework, is embedded in specific context such as industrial environment and policy space. Put it simply, the different curves in Figure 1a, b, c indicating possible relationships between the presence of FDI and various consequences on indigenous firms primarily rely on the indigenous firms or the host country industry *per se*. Therefore, to apply and test the process-based theory suggested by the framework and for the sake of simplification without sacrificing any validity, it is more appropriate to take a specific industry in a host country environment to investigate how those effects change over time and upon other factors and what the total effect looks like than just proposing the general pattern described in the previous chapter. Moreover, on the base of a specific industry a set of testable hypotheses could be developed.

Besides the need for a comprehensive firm-level data within a certain industry, the ideal settings for an empirical investigation are listed in the following.

4.1.1 Ideal settings for empirical test

The ideal setting for testing the impact of MNCs on indigenous firms should meet the following criteria. First, the level of analysis should be the firm. The ideal setting would

¹ This Chapter is based on the following Chinese literature: “The History of China Light Vehicle Industry” edited by Zhao and Tian in 1995; Lu and Feng (2005); China Automobile Year Book (1983-2009); and automobile related internet content on sina.com and sohu.com.

be surveying all the firms within a same industry with a significant penetration of multinational firms. Secondly, since the competition and learning process responding to the presence of MNCs might last for a relatively long time, tracing long-term interactions is necessary to disentangle the full dynamics between MNCs and indigenous firms. Moreover, as our model suggests, the time window of observation is critical in searching for real effects. Therefore, the ideal setting would be a long period of observation including the events of major entry of MNCs. Thirdly, to set a condition letting competition take an appropriate role, an industry with primarily market-seeking type of inward FDI would be suitable. It is also preferred that the major players in the industry including indigenous firms are focusing on domestic market for the following two reasons. First, limited international trade could exclude the alternative channels for technology diffusion. Second, the outcome of the foreign-indigenous interaction could be better captured by measures in domestic market, such as market growth or share (e.g., Kosova, 2010).

4.1.2 China automobile industry as a research subject

China automobile industry, particularly the passenger car industry, is selected for empirical testing not only because its characteristics set a perfect context meeting the requirements in previous session but also the rise of China automobile industry is an interesting and abnormal phenomenon in recent years. Moreover, the comprehensive data at firm level would allow me to do some reliable tests. Last but not least, China passenger car industry leaves some interesting puzzles for practitioners and scholars. By checking the detailed process of foreign-indigenous interaction, this study will also offer some

answers for those puzzles. In this section, I will first give a brief description of China passenger car industry from the perspective of industrial evolution and technology development over a long period to show the properness and uniqueness of this industry as our research subject. For the sake of clarity, I define “carmakers in China” as both foreign invested and indigenous Chinese assemblers. As I will give some details later, in China case, all existing foreign invested carmakers are international joint ventures (IJV). The indigenous Chinese firms can be defined as those firms not directly affiliated with foreign automobile firms and the IJV local partners.

Investors and scholars in USA started to pay attention to Chinese indigenous carmakers probably since Warren Buffet’s endorsement of “BYD” electric car project in early 2009.² China automobile industry is experiencing very fast growth especially for its indigenous brands since 1980s, which are called “*Zi Zhu Pin Pai*” in Chinese. The volume of China made cars has soared from 185,700 in 1979 to 9,345,000 in 2008, ranked the second in the world. From the first quarter of 2009, China surpassed USA, becoming the largest auto market in the world in terms of unit of cars produced and sold domestically and annually³. Indigenous car brands have grown up quickly in China flourishing market since 2000. In 1982, the indigenous brands only produced less than 200,000 units⁴ while in 2008, over three million cars (including passenger cars, commercial cars, and trucks) under the indigenous brands were produced and sold, occupying over 30% of the market.

² http://money.cnn.com/2009/04/13/technology/gunther_electric.fortune/

³ “China passes U.S. as world’s top car market”,
<http://online.wsj.com/article/SB10001424052748703652104574651833126548364.html>.

⁴ Automobile Industry Yearbook, 1983 edition.

-----INSERT TABLE 2 ABOUT HERE-----

The emergence and growth of China automobile industry is closely related to foreign technologies especially in recent three decades. Lacking industrial infrastructure, China was not able to manufacture motor vehicles before 1949. After the establishment of the People's Republic of China, the government devoted significant resources to support automobile industry partly because of its importance in national defense system. Local knowledge accumulation mostly came from repair and maintenance of imported cars. In 1953, to fulfill the ambition of the government, China established the First Automotive Works (FAW) in Changchun, Jilin Province, a heavy industry city close to former Soviet Union. In 1956 FAW made the first truck under the brand name "Jiefang" ("liberation" in Chinese) with the help from the former Soviet Union. In 1958, the first Chinese sedan car⁵, "Hongqi"⁶ ("Red flag" in English), was introduced through imitating the Chrysler "Imperial C69" model to substitute the imports (ZIS model from former Soviet Union) for the commuting needs of government heads and state guests. From 1958 to 1982, China automobile industry has been isolated after the breakdown of China-Soviet Union

⁵ A sedan car (American English, pronunciation) or saloon car (British English) is a passenger car with two rows of seats and adequate passenger space in the rear compartment for adult passengers. (From [http://en.wikipedia.org/wiki/Sedan_\(automobile\)](http://en.wikipedia.org/wiki/Sedan_(automobile))). Please see Appendix 1 for classification of automotive vehicles.

⁶ "First car" means that the car model was commercialized and put into production stage. Actually the first sedan car that FAW has introduced was the unsuccessful model "Dong Feng" ("Wind from East" in English) that was based on French Simca "Vedette" model. Even before 1949, a few ambitious national capitalists ("*Min Zu Zi Ben Jia*" in China) tried to "invent" a car by assembling parts from other imported cars (e.g., Zuolin Zhang in 1920's)

relationship. In these 24 years, the volume of China made passenger cars⁷ has only increased from 132 to 20427 units annually. In contrast, 25 years after the first FDI entered China auto industry (i.e., Chrysler joint ventured with Beijing Automotive Company⁸) in 1983, the number has grown to over 5.6 million units. Currently almost all the large carmakers in the world have invested in China. The contribution of automobile industry to the China gross industrial production (GIP) increased from 2.49% in 1991 to 5.8% in 2009 (China Yearbook, 2009) while the country's GIP increased by nearly 20 times during same period. At the same time, the most powerful indigenous carmakers emerged around 1995. In 2008, their total sales volume increased by 150 times compared with that in the year of 1982 and more extraordinarily, this mass growth was achieved under the rigorous competition from global giants.

Most players in China auto industry focus on China domestic market. In 2009 when there was a largest export since emergence of China auto industry, the total export of China made passenger cars is 153,000 units⁹, which only accounts for less than 3% of the total units made in China in that year. In other word, most players, including foreign invested carmakers, are competing for China domestic market. This sets a good context to make comparable the two fundamental mechanisms, competition and diffusion, within the industry.

⁷ Following the industrial definition, the passenger car refers to the car with at most 9 seats, designed for commuters, and with noncommercial purpose.

⁸ "Beijing Jeep Automotive Company".

⁹ Source: China Association of Automobile Manufacturers. <http://www.caam.org.cn>

Due to the extraordinary comprehensiveness of available data and information sources, the history and technological performance of most indigenous carmakers can be traced since the entry of first foreign carmakers to China. Although 25 years' evolution (1983-2008) of China automotive industry after the first entry of FDI might not determine the future of indigenous firms, but it is relatively long enough to detect the proposed dynamism compared with most existing firm- or industry- level studies on spillover effect. The richness of data source also makes alternative measures possible to ensure the validity and reliability of the findings. At last, the generalizability of the China case might be endorsed by the fact that China is one of the top ranked recipients of FDI and that China automotive industry is becoming the most influential market in the world.

I will primarily focus on passenger car category as research objective since, as I will articulate in the coming part, this category has experienced large entry of FDI, dramatic market change, and fast industrial growth. To be consistent with the data available and Chinese practices, passenger cars (or vehicles) are defined as a car with not more than nine seats and for the purpose of moving people, following the definition for M1 type cars in China industrial standards, GBT15089-2001. As the statistic classification changed dramatically since 1980's, some practical data manipulation issues about inclusion of certain car categories are discussed in the following chapter describing the data we used. Passenger Related categories, such as parts suppliers and other commercial carmakers, will also studied when it is necessary for illuminating the dynamics in passenger car category.

4.2 A Brief History of China Passenger Car Industry

The overall development of China automobile industry since the establishment of first China made sedan car can be traced from different perspectives. Here I basically follow the changes of policy regime based on the fact that China in transition changed its policies significantly for auto industry since 1949 and moreover different development phases can be clearly identified if using policy change as a criterion. Needless to say, government policy has a significant impact on development of auto industry. However, one should not exaggerate the role of government in development of China auto industry since the policy changes are quite often the passive responses to industrial development per se, as we can notice from the following brief history. I summarize the development of China automobile industry using the following five phases.

The *first phase* can be called initiative phase ranging from 1949 to 1959. While foreign direction investment was not allowed by the government, through reverse engineering on imported cars and under the help from former Soviet Union, Chinese technicians produced first truck and then first passenger sedan car in this period. The first sedan car was handcrafted in FAW, under the name of “Dong Feng 71” (“Wind from the East” in Chinese) in May 5th, 1955. In August, FAW crafted another high class car, “Hongqi CA72” (“Red Flag” in Chinese) equipped with inline 8-cylinder engine offering 120 horsepower and maximum speed of 160 kilometers per hour, by imitating Chrysler C69 1955 model. Some parts of the C69 model were directly installed on the Hongqi car. The car body was redesigned primarily in the front and back to incorporate some Chinese elements and with political metaphor as well. In 1959, FAW improved the design for Hongqi CA72 and

manufactured 43 units. The users are officials in central government and later high level of provincial officials was also eligible to be “allocated” a Hongqi car. From 1959 to 1981 when the Hongqi models were discontinued, there were totally around 1500 units produced. In Shanghai, Shanghai Auto Assemble and Repair Factory (later Shanghai Auto Manufacturing Factory or Shanghai Automobile Industry Corporation, “SAIC”) crafted a sedan car under the name of “Fenghuang” (“Phoenix” in Chinese). In September 1959, the model was redesigned and started to manufacture in a small scale in 1964 after being changed to a new brand name and model, “Shanghai SH760”. In Spring of 1958, Beijing First Auto Parts Factory (renamed Beijing Auto Manufacturing Factory later in the same year) cooperated with Tsinghua University made their first car with “Jinggangshan” (the name of a mountain that was an early base of the Chinese communist party during 1920’s) brand by imitating Volkswagen “Beatles” model. Later they also developed two new models under the brands of “Beijing” and “Dongfanghong” (“Red East” in Chinese).

The *second phase* is from 1960-1979, which could be summarized as domestic development phase. FDI was still prohibited. The source of new technologies during this period primarily came from imitating the limited number of foreign imported cars with external body shape being redesigned. The leading companies were early sedan car introducers (e.g., FAW, Beijing Auto Manufacturing Factory, and Shanghai Auto Manufacturing Factory). Another significant trend during this period is that car making technologies were diffused quickly all over the country because of the low cost of

imitation¹⁰. The enlarging market boosted the development of the primitive industrial infrastructure (i.e., parts and component production) especially for truck, bus, and other heavy-duty vehicles. However, the largest annual nationwide volume of production during this period was only about four thousand units in 1980 by several brands that were actually put into mass production, such as “Hongqi”, “Dongfeng”, and “Shanghai”.

The scale of production of passenger car production is very much limited due to the following three factors. First, China government has not listed passenger car industry as development priority since passenger cars were considered luxuries except a few SUV carmakers (e.g., Beijing Auto Manufacturing Factory) who were producing cars for military purposes. Second, those cars made by Chinese firms, especially those coarse copies by small follower firms, lacked quality and reliability. Their production has been more rely on handcrafting, and simple machinery procedures. Third, the demand was limited to high level government officials and thus the market was too small to support the economy of scale or mass production.

In this period, China automobile market was isolated because of the shortage of foreign exchange and the hostile international political environment. Although only government officials can have a sedan car under the command economical system of China, the domestic demand has been barely met because of the very small domestic production capacity and poor quality of the domestically made cars. In the late 1970s, the increasing number of imported passenger cars occupied very high market share.

The period from 1982 to 1993 can be called the *third phase*, i.e., step one of the, “open

¹⁰ All the firms were owned by the state and moreover there was no IPR protection at all.

door” period by China government¹¹. The increasing share of imported cars resulting from growing demand and limited supply and poor quality of domestic producers aggravated the shortage of foreign exchange. One of the policy responses is high import tariff (as high as 100-200% of the import value) but this also created serious smuggling of cars (which continued until 1990’s). To solve these issues, import substitution and export for foreign exchange became the new direction of China automobile industry. In 1978, Shanghai government proposed a plan to import a production line, restructure Shanghai Auto Manufacturing Factory, and export for foreign exchange. This plan stimulated the foreign investment from Volkswagen five later. In the same year, The CEO and Chairman of Ford Motor Company, Henry Ford II, visited China for technology transfer of heavy truck production and had a meeting with Xiao-Ping Deng, the leader of the China central government. Henry Ford II recommended a joint venture method to take part in China heavy truck industry. Xiao-Ping Deng endorsed his recommendation and suggested that in passenger car industry joint venture could be a good method to learn advanced technologies from foreign carmakers. In 1982, China Auto Industrial Company, an entity actually being authorized to supervising the development of the whole auto industry, was established and the central government started to focus on development of passenger car industry. Acquiring technologies through joint venture with foreign carmakers became a standard policy for the industry. Foreign partners can only take at most 50% of the equity share in the new joint ventured company and this policy is still in effect although a debate is in process about abandoning this measure. In other word, all the foreign car assemblers in China are in the form of international joint

¹¹ The industrial restructuring also happened during this period. The government policy was also focused on scale economy and aimed to increase market concentration. The rationale of this policy came from the lessons learned in 1970s and early 1980s, when all the provincial governments rushed to the automotive industry without any consideration about the market potential.

venture.

In the period of 1983-1986, three joint ventured projects for passenger car industry were approved: Beijing Jeep between Beijing Auto Manufacturing Company and American Motor Company (later acquired by Chrysler), Shanghai-Volkswagen between Shanghai Auto Manufacturing Company and German Volkswagen, and Guangzhou-Peugeot between Guangzhou Auto Manufacturing Company (and later Guangzhou Auto Industrial Group, GAIG) and French PSV Peugeot. These three projects were also the top three largest inward FIEs in the history of the People's Republic of China. All the IJV were allowed a limited quota for CKD (complete knock down) production before they primarily purchased parts and components domestically, which was their objectives to save foreign exchange and even to export for profits. In this period, all the IJVs were experiencing a challenging process to increase their local content ratio. Although there is no mandatory requirement for local content ratio, in the tariff directory in 1989, if more than 60% of the total value of parts and components in a car exceeds was imported, the car would be considered an imported car and subjected to much higher import tariffs. If As a result, a large number of China parts and component suppliers have gone through a quick period of technology upgrading and development under the vast demand for those IJVs.

For the demand side, in 1984, the market started to grow exponentially when county-level officials were allowed to have sedan cars. The shortage of domestic supply accelerated the import and led to the soaring price sedan cars. Several firms, especially

those with military background, were punished by the government later because they were assembling and selling cars illegally by importing parts and components at a much lower tariff rate or even smuggling the cars. From 1986, the production scale of domestic firms (including IJVs) increased rapidly. Before 1986 the annual scale of production remained at five thousand units for four to five years, but in 1986, the figure doubled.

Step two of the “open door policy” is the period of 1994-2000, which is the *phase four* of China auto industrial development. In 1994, China government launched its “market for technology” policy after releasing “Industrial Policy for Automotive Industry” (“*Qiche Gongye Chanye Zhengce*”). In this policy, the government encourages international joint venture but only allows not more than 50% of foreign equity share and the local content ratio is an important criterion for import tariff on auto parts and components. The government also explicitly supports large firms to help them achieve economy of scale. During this period, all the major carmakers in the world and major component suppliers have invested in China. Many new indigenous firms, such as Chery and Geely were also established¹². The parts and component sectors were privatized and open to private capital and the ownership structures of automobile industry became diversified. Along with the successful production localization of first high volume mass produced car model in China history, “Santana” of Volkswagen, the parts and component sectors a significant technology upgrading and development. In the 1994 industrial policy, individual purchase was also encouraged and market was expanded quickly. Moreover, the emergence and growth of taxi industry in large and major middle size cities enlarged the market for

¹² Although BYD was established in 1995 as a Lithium battery producer, it was not producing car until 2003 after acquiring an indigenous carmaker.

sedan cars. The increasing market was also associated with the significant price drop of dominant car models in this period, although their prices were still very high in terms of profit margins. Competition was increasingly rigorous but the market still dominated by foreign invested carmakers. In 1994, The largest four carmakers in terms of unit of sales, Shanghai-Volkswagen, TAIC (Tianjin Auto Industrial Company joint ventured with Japan Daihatsu), Beijing Jeep (joint ventured with Chrysler), and state wholly owned Chang'an Machine Factory, occupied 67.9% of the market, which was shared by 45 car assemblers. Shanghai-Volkswagen solely took 36.8% share of the sedan car (i.e., 5 seats regular cars) and SUV sector. In 1999, the largest four are Shanghai-Volkswagen, Changhe Aircraft Industrial Company (wholly owned by the state), TAIC, and Hafei Auto Factory (wholly owned by the state). Their total share of the market sales (in terms of units sold) is 66.9% among 34 passenger car assemblers. SAIC-VW solely took 40.2% share of the sedan car and SUV sector and about 50% in the single sedan car sector.¹³

Besides the fast growing market, the rapid development in this period is also reflected in the entry of foreign investment and emergence of strong indigenous carmakers. At the end of 1998, over six hundred FIEs originated from over 20 countries were established with a total investment of over 20 billion US dollars, among which most investment was in passenger car industry. If we define 1983-1986 as the first wave of foreign entry in China passenger car industry, 1995-1999 is the second wave, when three auto giants, General Motor (GM), Honda, and Toyota established their companies in China partnered with SAIC, GAIG, and FAW, respectively. Another significant event during this phase is the emergence of new indigenous firms. Major indigenous firms that are playing

¹³ Data calculated from CAIY various years by the author.

important role in China auto industry, BYD (“Biyadi”), Chery (“Qirui”), Geely (“Jili”), and Lifan (“Lifan”) were all established during this period. However, they have not taken off until the beginning of 2000’s.

It’s probably suitable to term the phase five from 2001 to now as post-WTO era as *phase five*. The whole industry was moving to a free market regime during this period. China’s joining in WTO in 2001 brought significant impact on the auto industry. Although it is still in debate now whether or the joint venture policy should be abandoned, most of the obstacles on the entry of FDI and private capitals were removed in this period. In 2004 China government released the second version of “Industrial Policy for Automobile Industry” (“*Qiche Gongye Chanye Zhengce*”). The policy continue to drive marketization of whole industry, encourage personal purchase of cars, welcome FDI to parts and components sectors, and also promote the growth of indigenous brands, new-energy technologies, and learning from foreign advanced firms. It also included some policies limiting import of whole cars with rules to identify whole car import and to exert different tariffs. But in 2009, the policies about discriminant tariff rate were abolished as they were contradicting WTO rules about indiscriminant and low tariff.

The freer industrial policies, more market participants, and the increasing purchase power of consumers as a result of China’s fast economic growth made China as the most vibrant market in the world. Intense market competition not only motivated carmakers localized their production and local sourcing of parts and components and forced them to introduce most recent technologies and models, but also significantly reduced the price that

consumers have to pay. The market was turning into buyer market, compared with the second phase (1983-1993) when there was actually a seller's market. During this phase, the whole industry has taken-off. In 2001, 610,100 units of China made passenger cars were sold domestically. In 2007, this number grew to 4,726,600. The phenomenal growth of indigenous cars is another significant character of this period. In 2005, two indigenous carmakers without any background of international joint venture or technology alliance with foreign firms, Chery and Geely, were ranked top ten in China market in terms of units sold. While Chery is a state-owned company, Geely is private company who was first listed in top carmakers in China. In 2007, among the total sale of passenger cars, 26% are indigenous brand cars. The intense competition also triggered a new round of restructuring. For example, FAW acquired Hainan Motor Company and Tianjin Xiali Auto Company and SAIC (Shanghai Auto Industrial Company) acquired NAIC (Nanjing Auto Industrial Company). Indigenous firms also turned to abroad to seek strategic assets. For example, Geely made a billion dollar deal to acquire Volvo; BAIC also purchased technology assets from SAAB; SAIC invested in Korea Ssang Yong Motor; SAIC and NAIC acquired intellectual assets from the British carmaker, Rover. In 2008, the government also launched the market stimulation policy for the compact¹⁴ and low carbon emission cars. Quality and safety standards for passenger cars are also formalizing since 2000.

-----INSERT FIGURE 2a ABOUT HERE-----

-----INSERT FIGURE 2b ABOUT HERE-----

¹⁴ A car with engine displacement smaller than 1.6 Liter.

4.3 The Debate of China Passenger Car Industry

If more details of the story are explored, the phenomenon of China passenger car industry is even more interesting. For a long time after entry of foreign carmakers in 1980s, the market was dominated by MNCs and no indigenous brand sold except “Shanghai”, which was discontinued in 1991 and disappeared since then, and “Red Flag”, which was reproduced in 1995 after being out of production for 11 years. But the “Red Flag” Mark II was actually being manufactured using engines from Nissan or Chrysler and car bodies, chassis, and transmissions from Audi¹⁵ and with very small sales volume. Before 1999, the passenger car category of China reflected some characteristics of driving-out of indigenous carmakers (Figure 1a). Moreover, until around 1998-2000 most foreign carmakers have not introduced the models with competitive technologies parallel to the same models in developed markets. The Germany automaker Volkswagen, the most successful foreign carmaker in China up to now, has once occupied as large as 70% of market share in sedan car sector. Its “Santana” model, the brand name of second generation of “Passat” originally introduced in 1982 in Germany, hit the record of sales volume, over 3.2 million units as for early 2009¹⁶, of a single brand in about 25 years in the history of Volkswagen as well as the history of China auto market. But the model has never experienced radical technological change even the redesign of the car body in

¹⁵ Since FAW has joint venture with Audi, Red Flag used the same assembly line as Audi. They only modified the front fender, hood, and changed the brand logo.

¹⁶ <http://www.chinacartimes.com/2009/05/15/news-shocker-vw-to-kill-of-santana-production-in-2012/>

China till now¹⁷.

Moreover, the fast growth of indigenous carmakers was associated with the fast growth of foreign brands. Although the market share of the latter is declining, the sales volume of foreign carmakers is still going higher at a compound yearly rate of about 20%. In other word, the growth of car market may primarily account for the growth of indigenous brands rather than their competitive advantage over foreign carmakers.

In the past thirty years China allowed direct investments only in the method of jointly venturing with large indigenous firms. The policy maker expected that joint ventures could help the indigenous firms learn the advanced technologies. In 1994, accompanied by the fall of “command-based market system”, “Market for technology” policy was adopted based on the rationale that opening market to foreign carmakers will lead to technological diffusion to indigenous firms. If the technological diffusion happened from foreign investments, we would have observed that IJV indigenous partners would have built their own strong brands faster. However, as a matter of fact, most of the IJV local partners reduced their resource input, even gradually becoming investment or holding companies, after having joint ventured company with foreign firms. About 10 new indigenous car brands were launched since mid-1990s but they were not from the local partners of foreign carmakers.

Another phenomenon is the timing of emergence and the growth pattern of indigenous

¹⁷ Source: <http://www.chinacartimes.com/2009/05/15/news-shocker-vw-to-kill-of-santana-production-in-2012/>

carmakers that have not joint venture relationship with foreign firms (i.e., independent indigenous carmakers). From Figure 3a and 3b and the sales data from China Automobile Year Book, we can clearly find that there is a strong negative impact in terms of market share during the period of 1984-1995. The strong indigenous carmakers, such as Geely, Chery, Great Wall, Lifan, and BYD emerged only after 1995. So if diffusion effect happened between foreign firms and those independent indigenous carmakers, how to explain the fact that all indigenous carmakers emerged over ten years after the substantial entry of foreign carmakers?

-----INSERT FIGURE 3a ABOUT HERE-----

-----INSERT FIGURE 3b ABOUT HERE-----

The lack of effective competition in early time foreign entry, the overall market growth, and the reality of lack of diffusion between foreign indigenous carmakers offers evidence for a plausible argument against to the conventional conclusion that FDI has benefited the growth of China auto industry as well as indigenous carmakers. A seminal book written by Lu and Feng (2005) argued that joint venture policy and “market for technology” policy actually had a negative impact on the growth of indigenous carmakers and brands (i.e., “*Zi Zhu Pin Pai*”). They argue that if there is a spillover effect, the indigenous firms, especially the IJV local partners and those geographically proximate carmakers would have benefited. Moreover, they expect that the indigenous carmakers would have had the “core technologies” to design new models and develop new technologies. On the contrary,

the fact is that the entry of foreign carmakers has exacerbated the market competition for indigenous carmakers and for a long period the JIVs have dominated the market without any technological upgrading. Following this logic, one could naturally conclude that indigenous carmakers could have emerged and grown even earlier and faster if there is no entry of FDI. Similarly, Song & Chai (2008) contended that in recent two decades' development indigenous firms are not capable of substituting JIVs as major players in the market and it is doubtful that international joint venture could improve the capability building of indigenous firms.

Clearly, the debate about the real impact of FDI in China auto industry can be linked to the dynamic framework proposed in Chapter 3. I will try to explain and understand the dynamics between foreign invested and indigenous passenger carmakers in the following session. I try to collect some evidence of industrial dynamics first and related literature and then propose a few hypotheses.

4.4 Hypotheses Development

In this part I disentangle the mechanisms and dynamics underlying the interaction between indigenous and foreign invested firms following the Chapter 3. As discussed at the beginning of this Chapter, effects of FDI are both dynamic and specific to industrial context. Therefore, hypotheses for empirical testing are proposed with a careful theory-grounded justification and in certain focused and specific realms of application with respect to China auto industry. First, the effect of competition from FDI is analyzed. Then the effect of technology diffusion is articulated. The roles of firm-level capabilities

are also investigated. At last, I estimate the overall impact of FDI on China indigenous carmakers.

4.4.1 Effects of competition

A firm takes time to identify and respond to external change because of organizational inertia and the time consuming learning process. It's quite often that the firm could not figure out the effective solution dealing with the change before it is forced to go out of business even though it has the resources to react due to causal ambiguity and social complexity. Therefore, as I proposed in Chapter 3, there may be an initial shock as a consequence of dominating negative competition effects.

The competition effects could have different forms as indicated in 3.3 of Chapter 3. Here more discussion and analysis is given for each component of competition. First, it is expected that there is a significant crowding-out effect on the indigenous firms in the same industry. The technological advantage and marketing skills of foreign invested firms could better fulfill the demand unmet by the indigenous firms whose products might be with low quality and reliability and with high price due to either the low production efficiency or monopoly. The resulting shrinking market instantly caused by the presence of high quality products weakens the resource base of the indigenous firms and inhibits further their ability to respond. The crowding-out effect echoes the theorizations in existing literature such as Aghion et al. (2009), Blomstrom et al. (2000), and Keller (2004). At industrial level, the crowd out effect also reflects the reduction of new indigenous entries (De Backer & Sleuwaegen, 2003). Similarly, Aitken and Harrison

(1999) suggested that the lowered scale due to loss of the market could make the firm's position on the production function move away from the "equilibrium" point and thus not efficient any more. This "market-stealing" effect might also apply to their suppliers if the demand for parts and component decreases accordingly and leads to increased production cost. The lowered efficiency and increased cost could aggravate their competitive disadvantage.

The competition effects are not confined to crowding-out. As Kosova (2010) suggested, there might be a demand-creating effect emerging gradually after the entry of foreign advanced firms. First, intensifying competition could make the industry more attractive to customers than possible substituting products in other industries and thus create a larger consumer base. Second, submarket theory (Church & Ware, 2000) could also explain the market-creating effect as I argued in Chapter 3. The submarkets created by the introduction of new technologies and competition between indigenous and foreign owned firms are heterogeneous to each other. Some of the submarkets may be activated by the downward positioning of indigenous firms as a consequence of their endeavor to avoid direct competition with the foreign invested firms at high end submarkets. However, over a relative long time, the foreign invested firms, i.e., the MNCs, might be able to enter those low end submarkets after they learn from the local competitors and localize their product offerings. Under this situation, the competition between indigenous and foreign invested firms becomes direct again.

The competition effect is not only generated from direct rivalry, but also the *vertical*

competition effect through the production network. As proposed in Chapter 3, indirect competition effect happens if foreign invested firms source locally from those relatively competence suppliers. A standard theory of possible indirect non-technology benefits from FIEs is the latter could help the suppliers to achieve economy of scale and in turn provide low cost input for indigenous firms (Markusen & Venables, 1999). However, this positive effect could only happen when 1) FIEs do source locally and otherwise they could create an enclave economy (Rodriguez-Clare, 1996); 2) the entry of FIEs could enlarge the scale of domestic final market as discussed in previous paragraph, or they are export-oriented¹⁸; and 3) the supplier sectors are not under-developed and economy of scale is not achieved in their existing technological solutions. While the validity of the second assumption depends on the development status of relevant industries, the first and third assumptions rely on the specific market characteristics and motivation of FDI. The nature of the FIEs' partnership with local suppliers suggests an alternative mechanism: if the FIEs source from indigenous suppliers but even those leading suppliers still lagged far behind in terms of technology and quality standards, they might choose to transfer technology purposefully and make exclusive contract with those suppliers to avoid knowledge leakage and exploit the knowledge transferred (Ling & Saggi, 2007). This scenario, which I call "poaching" or "supply-stealing", implies a negative impact on indigenous firms as they lost leading suppliers.

Overall, we would expect that if either of the mechanism of works in the indigenous-foreign interaction, there would be a high negative competition first and then

¹⁸ In this dissertation I only focus on those FDIs with motivation of market seeking rather than export platform, as I defined in the part of scope of research.

a moderate effect. If submarket explanation applies, later on the competition might become intense again.

Turning to our particular case of China passenger car industry, I argue that due to the fast transition nature, market competition is not comparable longitudinally. Before mid-1990s, the high demand of the cars, limited supply, and highly regulated car market make it difficult to apply direct competition theory articulated above. For example, the entry of foreign carmakers might not reduce the market base for indigenous carmakers because of the large unmet demand. The domestically made foreign cars were only a substitution for import and smuggling cars. As another fact, only government officials and firm leaders (most of whom are also government employees as well) were allowed to buy cars using the government fund before mid-1990s and until 2001 the individual consumption has not thrived. The buyers were primarily not sensitive to the displacement of the car limited by the central government rather than the price, quality, and reliability. When high technology and high quality cars were available, they were assigned (with purchase quota) to high level officials, and lower level officials could still purchase indigenous made low quality cars, certainly, using tax money paid by the citizens. Tracing the process after the market became mature (around 2001) is feasible but it will narrow down the observation window and distort the whole dynamic of competition effect.

Based on above analysis specific to China passenger car industry, in hypothesis development I would focus on the impact of vertical competition, which is not dependent on market mechanism. Another rationale of this focus is the significant strategic role of

parts and component sector in development of automobile industry and competitive advantage of individual automakers (Hyun, 1994). Moreover, the vertical competition effect as an important mechanism constitutes the initial shock, which is a key argument of theory proposed in this study.

Production network can be defined as a set of supplier firms contracting with the focal carmaker and producing parts and component for it. The relationship between the supplier firm and the carmaker could be arms-length transaction, long-term contract, strategic alliance, or equity sharing type. The successful car manufacturing results from a highly integrated and localized network (Hyun, 1994). In Geely's supplier conference held in 2008, its CEO, Mr. Shufu Li, said that the suppliers contributed 60% of the innovations of Geely. At the initial stage after entry of FDI to China, local parts and component producers are lagged behind the standards of the carmaker (i.e., assembler). Taking the example of Santana model of Shanghai-Volkswagen, after two years of production localization, the only parts used on Santana from China indigenous suppliers are the four tires, car radio, horn, and plate. Intentional transfer of technology became necessary if the IJVs source parts and component locally. To ensure the effective transfer and to avoid leakage, the IJV might prefer those firms with ownership relationships with the local parent company or choose geographically proximate suppliers. At the same time, because of the intentional technological transfer and knowledge sharing from foreign carmakers to the local suppliers in 1980s and early 90s, the indigenous carmakers' access to the qualified parts and component providers was largely blocked as the result of supplier exclusiveness. Indigenous suppliers with cooperation with foreign invested

carmakers may also have minimal incentive to support indigenous firms if they have substantial technology gain, prosperous market future, and the possible premium price they can charge (Belderbos, Jie-A-Joen, & Sleuwaegen, 2002). The exclusiveness was also reinforced by the ownership linkage between most suppliers and the IJV local partners. For the IJV local partners, they could take off earlier than other indigenous firms only when they can also access to the IJV supplier network. During this stage, it was quite often the case that some leading local suppliers with relative advantages were chosen by the IJVs for intentional technology transfer. For most indigenous automakers, localization of FIEs' production network posed them a negative impact since they were isolated from quality suppliers. Therefore, in the early period of foreign entry, we may propose a negative "vertical competition" effect. The degree of localization of FDI's production may be captured by local content ratio in foreign branded cars made by IJVs in China, which has been the focus of China government policy motivating sourcing locally. It is argued that the effect of local content ratio is reflected in its direct impact on the competition pressure on indigenous carmakers. Moreover, it may have moderating effect on the relationship between presence of FIEs and capability formation of indigenous carmakers because if foreign carmakers rely more on local suppliers, the presence of those carmakers would bring more vertical competition resulting in more negative impact. Although we *could not* hypothesize the main effect of presence of foreign carmakers on indigenous carmakers due to the immature market in early period, we can argue the main effect of local content ratio of foreign firms as well its moderating effect that with higher local sourcing, presence of FIEs brings less positive or more negative impact.

Capability formation of the indigenous firms might be captured by the conventional productivity measure, innovation, and market performance. These three measures are normally used in previous spillover research (e.g., Cheung & Lin, 2004; Kosova, 2010; Wei & Liu, 2006) but none of existing studies adopted these three measures simultaneously. These constructs actually represent the different aspects of capability formation. Productivity might indicate the acquisition and adoption of technologies from existing users or owners. Innovation could be a proxy of the capabilities to create new technologies and to remain competitive in a longer term. Market growth reflects the firm's ability to transform their technological strength into the ultimate outcome with more consideration of market rivalry although it is more sensitive to the competitive environment and more fluctuate in a short term.

Based on the above analysis and discussion, I propose H1a and H1b related to the competition effects between foreign invested indigenous carmakers.

Hypothesis 1a: In the process of the foreign invested carmakers' localizing their production, there is a negative relationship between the local content ratio of their cars and the capability formation of indigenous carmakers, namely, labor productivity, innovation, and market growth.

Hypothesis 1b: In the same period, the relationship between presence of foreign invested carmakers and the capability formation of indigenous carmakers, namely, labor productivity, innovation, and market growth, will be less positive or more negative if the

abovementioned local content ratio is higher.

4.4.2 Effects of diffusion: Vertical diffusion

Most existing literature detected a positive effect through backward linkages (See Smeets, 2008 for a review) although most of them did not acknowledge the different mechanism of competition and diffusion. For example, from firm-level data from Lithuania's manufacturing industries ranging from 1996-2000, Javorcik (2004) detected both a strong positive horizontal (i.e., within industry) and backward (i.e., FDI's linkage to suppliers) gains of indigenous firms in terms of productivity but no productivity gains through forward linkages (i.e., FDI's linkage to indigenous customers). Using firm-level data from 1993 to 1995 in Zambia, Bwalya (2006) found that FDI has a negative effect on the productivity of indigenous firms within the same industry and a positive impact on that of supplier industry. Using plant level data in manufacturing industries in Columbia census data since 1974 until 1998, Kugler (2006) showed no intra-industry technological spillover (decomposed from total factor productivity) but a significant technological spillovers from FDI to upstream supplier industry and suggested further that "without local outsourcing my MNCs, for example if all subsidiary inputs were either imported or produced in-house, widespread FDI spillovers would not materialize" (p470).

In history of China passenger car industry since early 1980s, the diffusion of technologies from foreign invested carmakers to indigenous suppliers is evident, especially in late 1980s and early 1990s when the government set a target for localization ("*Guo Chan Hua*" in Chinese) of production of Beijing-Jeep, Shanghai-Volkswagen, and

Guangzhou-Peugeot, the three pioneering foreign invested carmakers to China. The difficulty in local sourcing of parts and components came from the extremely underdeveloped parts and components sector. Production localization of Shanghai-Volkswagen's first and its only model before mid 1990s--Santana is a typical example of this purposeful technology transfer process involving Shanghai-Volkswagen, almost all leading suppliers nationwide, and even the central government. In a book by Guangming Yan, a reporter and expert of China automobile industry, he described the process in some details. After introduction of the Santana model in 1985, China government set a CKD quota of 89,000 units to force its localization. If the local content ratio could not reach 60% before reaching the quota limit, Shanghai-Volkswagen would face extremely high import cost (which is also depleting the country's limited foreign exchange) and a bleak prospect. But if the ratio target was achieved, Shanghai-Volkswagen would have its own discretion to determine their production volume to meet the vast market demand. Both SAIC and Volkswagen were aware of the importance of localization but unfortunately due to the weak industrial infrastructure in Shanghai there was no significant progress made (with local content ratio of 2.7%) two years after the model's introduction to China. In Jun 1987, the central government sent a team led by Rongji Zhu (Vice Director of National Economic Development Committee, and later Mayor of Shanghai and then Prime Minister of China) to help Santana's production localization. Zhu suggested a special nationwide team, which was called "Santana Production Localization Community" that had about 130 founding organization members in 1988 including Shanghai government departments, Shanghai Auto and Truck Group, Shanghai Aircraft Industrial Company, major parts and

component producers for domestic carmakers, firms from China air and aero industry, and 16 research institutions from universities. Shanghai government also established a localization fund (“*Guo Chan Hua Zhuan Xiang Ji Jin*”). By depositing 28,000 Chinese Yuan from every sold Santana car, the fund accumulated ten billion China Yuan during the period of 1986-1994. The fund was specifically used to upgrade production equipment and technologies for supplier firms.

Under government support and the close cooperation and joint learning between Shanghai-Volkswagen and indigenous suppliers, technology transfer process from Shanghai-Volkswagen and its original suppliers in Germany was ensured a high efficiency and effectiveness. At the end of 1990 the local content ratio in a China mode Santana was 60.09% and by 1991 the ratio is 70%. The main components, including car body, engine, and transmission, were all made locally. In August 1991, Shanghai-Volkswagen terminated CKD production¹⁹.

In October, 2000, Santana Production Localization Community changed its name to “Shanghai Santana Community” and in 2004 it had 176 firms and research institutions. Most of them became leading supplier firms serving the whole China automobile industry.

Production localization is not only driven by the government policy. Generally speaking, local sourcing may save production cost especially sourcing from locations with cost advantage. Moreover, for the technology intensive products, the close interaction between

¹⁹ Sources: 1. “The challenging process of Santana project”, interviews with three former leaders of Santana project. By Bangning Ge. Auto Business Review, September 11, 2009 (In Chinese). 2. Yan (2010). 3. “Shanghai Santana community”, <http://www.people.com.cn/GB/qiche/25959/38991/38993/2804428.html> (In Chinese). Accessed in December, 2010.

firms and their suppliers are very important. In the automobile industry, a close network ensuring effective coordination between car assemblers and suppliers are critical to the efficient organization of production (e.g., Just-in-time inventory system in Toyota production) as well as innovativeness and advantage creation of car assemblers (Hyun, 1994). In the case of production localization of Santana, Volkswagen actually believed that Shanghai-Volkswagen should localize the production of parts and components to stay competitive in the market and was actively involved in transfer of technology by initiating exchange and learning programs between its Germany supplier firms and potential supplier firms in China²⁰. As China market grew and further industrial development, the intensive market competition became a major factor driving foreign invested carmakers localize their production of parts and components.

Following the theory and the scenario that foreign invested carmakers purposefully transfer their knowledge to indigenous supplier firms in China, we could propose two diffusion effects (main effect and moderating effect) added to the first set of hypotheses. The first relates to the main effect on supplier industry (the backward linkage effect) and the second relates to the moderating effect generated by the local linkage. The moderating effect suggests that if there is supplier-assembler linkage between foreign invested carmakers and indigenous supplier firms, the presence of foreign invested carmakers would have more positive impact.

It's quite often the case that the suppliers and assemblers form a strategic alliance to

²⁰ Source: "The challenging process of Santana project", interviews with three former leaders of Santana project. By Bangning Ge. Auto Business Review, September 11, 2009 (In Chinese).

maintain good cooperation and therefore the market share of the suppliers normally is dependent on the performance of car assemblers. Therefore, the market share of supplier firms might not directly reflect the competitive advantage of the suppliers with respect to our supplier firms. Thus, in proposing the outcome of supplier firms in parts and component sector, the market performance is excluded. Without the market performance as a measure for capability formation, the productivity and innovation could be considered reflecting relative advantage over the firm's own historical capabilities instead of their absolute advantage horizontally over other firms that is indicated in market-based measures.

Hypothesis 2a: There is a positive relationship between presence of foreign invested carmakers and capability formation, namely, labor productivity and innovation, of indigenous supplier firms.

Hypothesis 2b: The effect size of positive relationship between presence of foreign invested carmakers and capability formation, namely, labor productivity and innovation, of indigenous supplier firm will be larger if the supplier firm has supply relationship with foreign invested carmakers.

4.4.3 Effects of diffusion: Horizontal learning and IJV

As I discussed in Chapter 3, the difficulty in learning attributes to the paradigm difference, nature of learning, and MNCs' protection of proprietary assets.

The nature of technologies in automobile industry adds to the challenge for learning horizontally from foreign invested carmakers.

Since car manufacturing is an extremely complex process and related to ten thousand of parts and components that need technologies from multiple disciplines, the carmakers are multi-technology firms. They need to know not only the knowledge of integrating the parts and components together but also of major parts and components (Brusoni et al., 2001). As suggested by Brusoni et al. (2001) and Brusoni and Prencipe (2001), because the interdependence across parts and components and their uneven rate of technological changes, multi-technology firms (e.g., carmakers and aircraft makers) need to invest in research and development in those parts and components and keep in house the technological knowledge to “accommodate changes in one field that may cascade effects on others” (Brusoni et al., 2001: 608) even though they outsource the production of those parts and components. In a word, as an integrator, they need to know more than how to assemble various parts and components into a final product. Given the high complexity of the technologies in auto manufacturing and the lagging behind technological base of indigenous carmakers, direct horizontal diffusion from foreign invested carmakers seems extremely costly, if not impossible.

Although I argue that general horizontal diffusion effect is not significant, testing this effect is difficult as it is difficult to tease out other effects discussed in previous chapter such as various competition effects and vertical diffusion effect. One ideal approach is to consider a set of variables specific to the theory of horizontal diffusion and include all of them into a theory deducted model and test the true diffusion effect after minimizing the possible confounding effect or alternative explanations of the effect. Moreover, during

different period, the interaction mechanism between foreign invested and indigenous firms could be different, as I suggested in previous chapters. Another approach, though not perfect and comprehensive, is to partially test the proposition by focusing some specific scenarios. In the China passenger car industry, we can focus on the impact of mode of joint venture on the learning and diffusion of the IJV indigenous partners from their foreign partners.

Due to the limited contribution of indigenous firms in the IJV, it is less likely that the IJVs operations could inhibit the production because of the limited resources or because the contract with foreign partners does not allow them to produce cars. More importantly, all the major indigenous partners have the task of learning from foreign partners under the explicit policy of “market for technology” set by their owner-the Chinese state government. Therefore, if horizontal diffusion is present, it is very likely that the form of IJV could have significant positive impact on diffusion because of the following reasons. First, from above analysis it is less likely that joint venture with foreign partners will put the indigenous partners in a less advantageous position in learning than other indigenous carmakers unrelated to IJVs. Second, joint venture could offer a more intense interaction and flow of knowledge between joint venture partners. As I argued in previous chapter, this type of learning by participation is more effective than learning by observation, which describes the horizontal diffusion between foreign partners and unrelated indigenous carmakers.

As a solution, even though here we could not offer a comprehensive model to detect the

pure diffusion effect, we can expect that IJV mode brings in a significant and positive impact on learning and diffusion *if* it is assumed that horizontal diffusion is present and positive. In other word, if we argue that horizontal diffusion is difficult and could be insignificant, IJV mode might not bring any significant add-on to the horizontal diffusion.

Proposing the effect of IJV on horizontal diffusion is also a response to the debate about joint venture policy in China. As an example of non-significance of horizontal diffusion through IJV, Shanghai Auto Factory (now SAIC) has developed a detailed plan for learning and technology transfer jointly with Volkswagen²¹ but there is no indigenous brand from this company that is based on technologies they learned from their joint venture experience. Obviously, their ambitious plan (as well as probably the government's plan) ran aground. On the contrary, their own brand, "Shanghai", made and continuously developed by SAIC and is considered the best mass produced cars before FDI entered passenger car industry, was discontinued in November 25, 1991 to give the way to upgrading production facility for Shanghai-Volkswagen. But "Shanghai" brand was actually number one sedan cars in 1980s in terms of quality and reliability, market share, and financial performance. This ironic outcome of IJV might have never been anticipated by those firms and government leaders who were supporting joint venture policy such as Peng Li, former Prime Minister of China, and Xiaoping Deng.

Therefore, I proposed another hypothesis arguing that no significant diffusion effect happened directly between indigenous and foreign partners in IJVs.

²¹ Source: "The challenging process of Santana project", interviews with three former leaders of Santana project. By Bangning Ge. Auto Business Review, September 11, 2009 (In Chinese).

Hypothesis 3 (H3): Joint venture partnership with foreign carmakers has no significant relationship with capability formation, namely, labor productivity, innovation, and market growth, of indigenous carmakers.

4.4.4 Effects of diffusion: Indirect channels

Most existing studies in spillover effect made direct and simple linkages between FDI and indigenous firms (for example, either horizontal or vertical). But it is also possible, especially when a longer period is investigated, that the technology diffusion through backward linkages to indigenous suppliers in turn could promote indigenous firms in their downstream industries through forward linkages. Put it straightforward, the supplier firms benefiting from technology diffusion from their foreign invested client firms might provide a better technology input to their indigenous client firms. The total effect might exhibit an intra-industry or horizontal diffusion, though in an indirect way. However, this diffusion route takes in effect through a more complex mechanism and relies on the characteristics of the industry and the technologies used.

To be possible for this indirect diffusion, the linkages between indigenous and foreign invested cars must be established. The indirect linkage has been highlighted by some studies such as Rodriguez-Clare (1996) and Markusen & Venables (1999) that discovered the possible vertical competition effect. The effects they discussed are that the overlap of supplier network between foreign invested and indigenous firms could help the supplier firms to achieve economy of scale and as a result lower the input cost for indigenous

firms. But if we focus on the actual knowledge flow probably happened through supplier network, the following factors need to be considered: the exclusivity of the supplier network, compatibility of the parts and components between indigenous firms and FIEs, and the significance of possible technology input from supplier firms for indigenous firms.

As I discussed earlier, the importance of supplier network and intentional vertical technology transfer could encourage the FIEs to establish exclusive suppliers through contracting or, in an extreme case, acquisition. More generally, the form of the cooperation between FIEs and indigenous suppliers depends on industrial structure and the nature of technologies involved. Besides the source of technologies of indigenous suppliers, the compatibility of the parts and components between different assembler firms also influence assets specificity and resulting inter-dependence between suppliers and assemblers. The higher specificity of the suppliers upon a particular assembler, the less likely it is that the linkage to indigenous assemblers would be established. On the other hand, high specificity also lowers the incentive for the indigenous assemblers to develop the linkage and learn from the supplier firms in question as the usefulness of the technologies embodied in the parts and components being offered and the feasibility to incorporate those technologies into existing production of the whole product decreases dramatically. The third factor might be economy of scale concerns raised by Rodriguez-Clare (1996) and Markusen & Venables (1999). If the minimum scale of economy of the supplier firms is far larger than the existing demand of the associated foreign invested firm, the foreign invested firm could probably benefit from the sharing

of the same supplier with indigenous firms since it can lower their purchasing cost. These three factors might influence the possibility of technology diffusion through sharing of supplier firms in which that foreign invested firms have invested their strategic assets.

For the firms with multi-disciplinary technologies, sharing parts and components and resulting technology diffusion is more meaningful than learning directly from the integrated final products. Multi-disciplinary technologies incorporate knowledge from different disciplines and thus have high complexity. The complexity increases the difficulties in understanding, diffusion, and integration into a firm's existing technological capabilities (Cohen & Levinthal, 1990; Rogers, 2003; Tornatzky & Klein, 1982). As each parts and component embodies simpler level of technologies, learning at parts and component level might be more feasible. When indigenous supplier firms digested and incorporated the foreign sourced technologies, it might be easier to deliver to other indigenous firms as the paradigm difference diminished during the integration process in the supplier firms. On the other hand, the actual linkage between supplier and assembler firm would make the diffusion through "learning by participation" more efficient and effective than through "learning by observation." Accordingly, it is arguable that sharing of supplier network has significant diffusion opportunities for the indigenous firms.

In the case of automobile industry, there was a significant evolution trend of standardization and modularization (Takeishi & Fujimoto, 2003). Various factor in marketing, production, finance, and technology could be responsible for automobile

industry going “modular” (Sako, 2003). Ulrich (1995) defined the concept of architecture as “the scheme by which the function of a product is allocated to its physical components.”

A modular architecture includes “a one-to-one mapping from function elements in the functional structure to the physical components of the product, and specifies decoupled interfaces between components. (p. 422)” Obviously, the biggest advantage of

standardization and modularization is that the resulting increasing interchangeability could help achieve economy of scale and thus save production cost significantly.

Moreover, accumulated production experience on the module may also increase its reliability (Ramdas & Randall, 2008). While modularization may reduce overall product performance by sacrificing integrity (Ramdas & Randall, 2008; Robertson & Ulrich, 1998), Modularity strategy improves the design flexibility to meet heterogeneous demand by offering a wide selection of different choices (Kotabe, Parente, & Murray, 2007).

Modularization and standardization accelerates the globalization of supplier chain of the auto industry and help it enjoy economy of scale at the global level. Echoing this trend, since 1990s the supplier-assembler relationship also evolved from network style of production organization to either arm-length contracting or internalization of outsourcing (Ahmadjian & Lincoln, 2001). Modularization and Standardization reduced assets specificity and thus it might be unnecessary any more to maintain a long term and exclusive relationship with particular supplier firms since the choices for assemblers are vastly enlarged and remaining flexible without any long term commitment might be a better solution from the perspective of transaction cost economics.

Following the modularization strategy initiated in European and US carmakers in mid-1990s (Takeishi & Fujimoto, 2003), the similar evolution happened in China as well since then. Those changes decoupled the long term and exclusive contracting relationship between indigenous suppliers and foreign invested carmakers, making indigenous carmakers' overlap or sharing of supplier network possible. Top indigenous suppliers may have multiple car brands and models to serve. In late 1980s, the number of indigenous supplier firms that are simultaneously serving two or more different carmakers was only three, who were in tire and radio set industries. By the end of 2009, the number turned to around 200, a significant proportion of whom are engine and transmission parts producers. As a consequence of the historical change of supplier-assembler relationship, indigenous carmakers might have the opportunities to benefit from those leading indigenous suppliers as well as those foreign invested suppliers previously served foreign carmakers exclusively.

The input from those technologically advanced modules could enhance the capability formation of indigenous carmakers by the following ways. First, through close interaction with advanced supplier firms, they could get the knowledge about how the particular parts and components are working within the function unit and probably also the knowledge about the interface with which the focal module connect and co-function with other parts and components. Knowledge about parts and component could improve the ability of indigenous carmakers as a system integrator as well (Brusoni et al., 2001). Second, according the typology of innovation by Henderson and Clark (1990), advanced modular input could encourage firms to concentrate on architectural innovation. Wang

(2008) reported that China indigenous carmakers adopted a “quasi-open module architecture” to develop their cars. In his case study on Geely, on its first car model “Haoqing”, 70% of the parts and components came from the suppliers for Charade model from Tianjin-Xiali, which was a result of technology transfer from Daihatsu, a wholly owned company by Toyota. Wang (2008) further argued that quasi-open module architecture by sourcing parts and component from elsewhere could drive down the production cost and equip the indigenous carmakers with power in competing with foreign invested carmakers.

While some literature suggest that as an integrator, one cannot build a reliable and quality product without knowing the more complex integrating knowledge and the components and parts technologies (e.g., Brusoni et al., 2001; Robertson & Ulrich, 1998), some China indigenous carmakers did move from purchase, learning, to self-designing, and gradually concentrate more on their role of integrator of the module architecture and finally develop an integrated product focusing on overall design and the joint performance of different parts and components. As Wang (2008) also reported, Geely first purchased the engine for its “Haoqing” model from a Toyota invested company, “Tianjin Toyota Engine Company”, in China as a strategy of its quasi-open modularity development of cars but then gradually Geely was manufacturing their own engines based on the reverse-engineering of Toyota engine and some core parts still outsourced from Toyota and other firms. Through Geely’s own R&D, Geely’s quasi-open engine system was evolving towards a closed integral model (Wang, 2008: p. 525). In 2008, Geely released “GeTec” series eight types of gasoline engine and one type of they developed after three

years' self-development²². One of these engines is the China first all-aluminum engine adopting CVVT technology designed and made by indigenous carmakers²³.

In the evolution of China automobile industry, decoupling of the supplier-assembler relationship also triggered the new pattern of geographic clustering of the industry. Supplier firms previously concentrated around car assemblers now evolved into multiple locations each of which is specializing in a certain parts and component. This trend of evolution of parts and component sector was strengthened by China's ownership reforms in large automobile groups, the emergence of private owned suppliers through new start-ups as well as spin-offs, and the entry of other global parts and component suppliers. Large carmakers in China were historically co-located by suppliers particular for the focal carmakers. Those suppliers originally were also state-owned and even under the affiliation of the large carmaker group. As economic reform went on, those suppliers gradually became independent from those carmakers through privatization or de-grouping. Those suppliers previously had unlimited contracting relationship with the focal carmakers were forced to search their market nationwide because of the loosened relationship with carmakers and the latter's broadened scope of search of qualified suppliers. Gradually specialized supplier clusters emerged after mid-1990s. Those clusters are mostly located in the former leading suppliers, including those indigenous suppliers who received technology transfer and remain close partnership with foreign invested carmakers. According to data from Wang (2008), three provinces located in

²² Source: <http://www.pcauto.com.cn/news/changshang/0904/826562.html>

²³ Source: <http://lzb.gansudaily.com.cn/system/2008/08/20/010810585.shtml>

Southeast China, Shanghai, Jiangsu, and Zhejiang, are the major locations for China automobile industrial clusters. The three largest Chinese automobile groups, FAW, SAIC, and Dong Feng Motors, purchased about 50% of their parts and component, most of which are actually for their IJV firms, in this area.

In summary, I propose through learning the relatively simple technologies from suppliers that were serving foreign invested carmakers, indigenous carmakers are able to learn effectiveness and moving to higher ladder of technology development. More specifically, I hypothesize this indirect diffusion method emerges through the following three ways. The first is through sharing of current suppliers of those foreign invested carmakers and the second is through cooperation with those supplier firms that have been serving foreign invested carmakers. I incorporate these two arguments into one hypothesis (H4a) and consider both situations in methodology part. The third way is through the supplier firms that are collocated with those supplier firms currently serving foreign invested carmakers. The rationale for this argument first lies in the agglomeration reflects the knowledge sharing and commonality between collocated firms through spin-out and spinoffs (Klepper, 2007; Klepper and Thompson, 2006). Moreover, as learning is localized (Jaffe et al., 1993; Storper & Venables, 2004; Von Hippel, 1994), those supplier firms are more easily to acquire knowledge from those firms with partnership with foreign invested carmakers through mechanism such as movement of experts and technicians (Almeida & Kogut, 1999). Hence, I have two more hypotheses drafted as following.

Hypothesis 4a (H4a): The share of suppliers with foreign invested carmakers is positively related to capability formation, namely, labor productivity, innovation, and market growth, of indigenous carmakers.

Hypothesis 4b (H4b): The ratio of suppliers from the same locations as suppliers of foreign invested carmakers is positively related to capability formation, namely, labor productivity, innovation, and market growth, of indigenous carmakers.

4.4.5 The role of technological accumulation

Following our discussion in Chapter 3 regarding the role of firm-level technology accumulation, I also investigate the role of history of those indigenous carmakers in their emergence and revival as new strong players in passenger car industry. The diffusion through possible supplier relationship is only a part of the story of capability building. Accumulative nature of technological capability suggests that the historical advantage could persist for a long period of time, even after a radical technological change (Cantwell, 1989; Klepper & Simons, 2000a, b).

In this part, the history of indigenous carmakers is retrieved to investigate if and how the technological accumulation of relatively weak indigenous firms²⁴ could still lead to more effective learning from FDI and higher growth after the entry of foreign automakers. There are some good reasons to argue that some China indigenous carmakers have had unrevealed capabilities. The indigenous technological accumulation could be reflected in the following aspects. First, the experience in manufacturing trucks, buses, and military

²⁴ “Existing firms” here refer to the firms already existed before the entry of the MNCs.

vehicles, on which China indigenous firms are not lagged behind too much²⁵, could largely improve their capability to make passenger cars. Second, before 1984 the competition for scarce state resources and limited demand was intense given the excessive number of indigenously automakers²⁶. This type of competition in planning system also gave the firms incentive to innovate and learn. Third, the state ownership²⁷ of all carmakers before 1984 made it feasible and active for the carmakers to cooperate with research institutes (e.g., universities) within the same region. The cumulated capabilities might be only "latent potentials" that have not been fully exploited in a non-market system. More substantially, the volatile political and economic environment before 1980s has trained and selected those firms with strong dynamic capabilities reflecting the firm's inherited capability to learn, to respond, and to revive in the new competitive environment. Following this argument, the firm-level accumulated capabilities could be the foundation of the "Catfish effect".

Previous literature in spillover research focus more on the role of absorptive capacity (e.g., Castellani & Zanfei, 2003; Girma, 2005; Girma & Gorg, 2007) and studied the moderating effect of absorptive capacity. While absorptive capacity can be consider a type of capability, it emphasizes more the need of redundant and complementary knowledge in order to identify, assimilate, and apply the external knowledge that is

²⁵ It is can be shown by the evidence from patent data and the current market share of indigenous brands in heavy-duty vehicles.

²⁶ Certainly this type of competition is not purely market competition. It was involved the competition among central and local governments.

²⁷ "State ownership" here includes the central government owned and local government owned (i.e., province or city level).

partially tacit by nature. Compared with those capabilities historically accumulated from continuous interaction with dynamic environment, absorptive capacity focuses more on the existing scope of knowledge. Therefore, I argue that both absorptive capacity and historical capability accumulation play a significant role. Hence, I propose the following two hypotheses.

Hypothesis 5a (H5a): Indigenous carmakers' technological accumulation before entry of foreign invested carmakers moderates the relationship between presence of foreign invested carmakers and the capability formation, namely, labor productivity, innovation, and market growth, of indigenous carmakers. The stronger technological accumulation is, the more positive effect that presence of foreign invested carmakers would have.

Hypothesis 5b (H5b): Indigenous carmakers' absorptive capacity moderates the relationship between presence of foreign invested carmakers and the capability formation, namely, labor productivity, innovation, and market growth, of indigenous carmakers. The stronger absorptive capacity is, the more positive effect that presence of FDI would have.

4.4.6 A net overall effect

Now I turn to the net impact of the foreign invested carmakers on indigenous carmakers. According to our discussion in Chapter 3, the net impact is a composite effect from the abovementioned impacts from different theoretical roots. Those impacts step in in different stages of the development of the industry and its firms and the evolution of the whole economic and institutional environment. When adding the time dimension into the

dynamics of interaction between foreign invested and indigenous firms, we could argue that there is initial shock after entry of foreign invested firms because of the negative crowding-out effect. And along with the coming localization of production network, the exclusivity of the suppliers might bring more negative impact because the vertical competition effect. During initial period of entry, technology diffusion through various channels is still very limited. The fierce competition that indigenous firms are encountering may also weaken their resources to respond effectively. Therefore, it is arguable that in the initial period of foreign entry, there is a net negative impact. Put into China passenger car industry, the argument suggests that during mid-1980s and mid-1990s when major foreign carmakers entered China the net impact on indigenous carmakers might be negative.

As the foreign carmakers localized their production network due to government policies and later rigorous market competition, indigenous supplier firms may have benefited the technology transfer from foreign invested carmakers first. At the same time, specific to automobile industry is the evolution of the organization of production of the industry as a whole. Supplier-assembler relationship was becoming more arms-length type than the previous close network relationship due to the modularization and standardization of the world automobile industry. The negative competition effect may also be alleviated by the possible market-creating effect. More significant effect would be the possible diffusion effect that could enhance the capability formation of indigenous carmakers. As the diffusion channels established especially through sharing of the supplier network, the indigenous firms might eventually learn from foreign invested carmakers. During this

diffusion process, I also emphasize the importance of existing capabilities of the indigenous carmakers in absorbing the foreign knowledge and dealing with the dramatic industrial technology change. This also implies the heterogeneous nature of how much can be learned from foreign invested carmakers.

However, it is unknown if the net impact after taking-off of diffusion effect is positive or negative. On one hand, the evidence may suggest that indigenous carmakers have learned from foreign carmakers by sharing their supplier network and may also benefit from the enlarged market partially stimulated by competition between foreign invested carmakers. Moreover, if we take a historical view, the failed protectionism regime before 1983 could also offer another evidence of the positive role of FDI in auto industry. From the point of view, we may expect that FDI eventually helped indigenous carmaker to grow and prosper.

On the other hand, in the context of China market, there are also some reasons to argue that the fast market growth resulting from phenomenal economic growth is the key factor of the success of indigenous carmakers. From the successful experience of South Korea, one can also endorse the benefits of temporary protection and non-FDI type of learning. In the debate on the “market for technology” policy, Lu and Feng (2005) argued that the core technologies of indigenous carmakers would be never ever obtained from foreign invested carmakers first because of the strict protection by their foreign owners, and also because of firm-specificity of the technologies. They further suggested that if there was no foreign direct entry into China market, the strong indigenous carmakers could have

emerged much earlier. Therefore, following this logic, the impact of FDI actually will be negative although the whole period after the entry of foreign firms.

Therefore, here I propose two competing hypotheses, whereas first is arguing a curvilinear relationship and the second a pure negative relationship. It is worth noting that these two hypotheses are only the simple summation of various effects based on their different sequences along with time. This type of hypothesis is comparable to treatment of spillover effect in most existing literature. However, they are not suggested by one single theory and therefore this type of pattern could be specific to a certain industry in a particular context and consequently may be not generalizable.

Hypothesis 6 (H6): The relationship between the presence of foreign invested carmakers and the capability formation, namely, labor productivity, innovation, and market growth, of indigenous carmakers is curvilinear along with the length of entry of the foreign invested carmakers. In other word, the relationship is negative first, and then turns to positive along with time.

Hypothesis 6alt (H6alt): The relationship between the presence of foreign invested carmakers and the capability formation, namely, labor productivity, innovation, and market growth, of indigenous carmakers is negative.

5. Data Sources and Compilation

In this Chapter I introduce the sources of data, and how I compile those dataset for testing each set of hypotheses. The secondary raw data from four various sources were collected and compiled into five different datasets to test six sets of hypotheses. Measurement and model specification for hypotheses testing will be described the next chapter.

5.1 Sources and Description of Raw Data

5.1.1 China Automotive Industry Yearbook (1983-2008) (CAIY)

The yearbooks were compiled by China Automotive Industry Corporation (CAIC)¹ under the Bureau of Automotive Industry of Ministry of Machinery Building (MMB) before 1998 and by the independent publisher (“CAIY House”) affiliated to China Automotive Technology & Research Center (CATRC) and authorized by the Ministry of Industry and Information Technology (MIIT) since 1998. The annually published yearbooks summarize and report the development in China automobile industry, including car and motorcycle assembling and parts and component manufacturing. The former publisher CAIC was state-owned and primarily engaging to investment governance, data collection, and consulting support for those state-owned firms in the automobile industry². Because of the endorsement of the central government and their partial administrative role, the previous and current publisher collected the data from the

¹ As a product of planning economy, CAIC (“*Zhongguo Qiche Gongye Zong Gongsi*” in Chinese) was authorized by former Ministry of Machinery and Electronics to play an administrative role (“*Hangye Guanli*” in Chinese) in development of automotive industry. It didn’t produce any products. CAIC was established in 1990 and its operations were formally suspended in 2004. Its assets were then reallocated to Shanghai Automotive Industrial Corp. (SAIC).

² Before 1995, most firms in automobile industry and all the auto assemblers are state-owned.

following two sources. The first is directly from the firms through their specified “contact person” (“*Lianluo Yuan*” or “*Tongji Yuan*” in Chinese) in each firm or in provincial associations of auto industry (“*Qiche Gongye Xiehui*” in Chinese) and all the firms have the obligation to provide authentic data in time³. After 2000, because of the booming of automobile sectors, a small proportion of the firms, especially small firms in parts and component sectors, are excluded in the firm level data. The second is from National Bureau of Statistics (NBS) and Ministry of Industry and Information Technology (MIIT, formerly Ministry of Machinery Building) for all industry level data such as the production and sales as well as the firm level data such as number of vehicles sold and registered⁴. The CAIY is the most reliable and comprehensive data source for automobile industry and cited frequently by government as the base of policy making⁵.

The CAIY consists of the following content. The first part normally is a brief report analyzing the *status quo* and the future directions that are often based on state policy perspective. The major government policies were also summarized (sometimes in the form of the state officials’ speeches). The second part is the major events in the previous year (“*Da Shi Ji*” in Chinese) such as the achievements in technological development, market structure and growth, new entries and exits, and mergers and acquisitions (M&A). The major transactions of technologies and equipment are also recorded in this part. The third part consists of the aggregated information about production and sales (at regional,

³ However, there is no law enforcement for that, especially after 2000. Given the fact that the yearbook is also a good opportunity for public exposure, most the firms still have the incentives to report.

⁴ The details regarding compilation of CAIY are provided by Mr. Zenghui Cui, current director of the CAIY House.

⁵ From the website of CAIY.

i.e., provincial, level or product category level). The fourth part reports the firm level information for major assemblers and parts and component producers, including firm size, type and model name of products, production volume and total value, and the growth rate relative to previous year. From this part of data, the supplier-buyer network for parts and components can be constructed for each carmaker. The last part is the major technological advancements and awards in previous years made by firms.

5.1.2 China patent database

The patent database from State Intellectual Property Office of China (SIPO) is used as one of the measures for technological development. Although China patenting system has been established quite lately (1984), it provides more comprehensive innovation behavior of Chinese firms than US Patent and Trademark Office (USPTO) recorded. Moreover, there are an increasing number of studies based on SIPO data (e.g., Cheung & Lin, 2004; Guan & Liu, 2005; Liu & White, 2001). Similar to USPTO database, in the SIPO system, there are three types of patents: inventions (“*Fa Ming*”), utility models (“*Shi Yong Xin Xing*”), and appearance designs (“*Wai Guan*”)⁶. According to the criteria for three types, the latter two are less new technology embedded⁷. Therefore, the first kind of patent, “invention”, is believed to reflect the technological knowledge creation and accumulation process and is used in this study.

⁶ For an overview of China patent system, please refer to <http://ezinearticles.com/?China-Patent-System---An-Overview&id=607852>

⁷ And the latter two types are given shorter protection period (10 years) than invention type (20 years).

5.1.3 New model release database

China central government requires all the new car models be registered and be issued permission before launching. This regulation formerly was enforced by National Development and Reform Commission (NDRC) and now by Ministry of Industry and Information Technology (MIIT). This database, available on the government websites, includes the category, model number, producer's name, and vehicle specifications. Based on interviews with industrial experts, the release of new model can be considered reflection of technological development. The database is not released annually, but rather, once if there are any new models reported and approved, the government will release a list for those models. I compile the model release database based on the year when the new model was listed.

5.1.4 The History of China Light Vehicle Industry

This book compiled by Zhao and Tian in 1995 and published by China Machine Press as a request from China Automobile General Company (actually also a state-owned organization supervising the development of whole industry). This book traces the history of China light car (e.g., light truck, SUVs, passenger cars, etc.) and introduces the development of whole industry at the firm-level. It covers the period from 1931 to 1989.

5.1.5 China Statistic Yearbook

Some of the control variables are measured using data from China Statistic Yearbook for various years, such as FDI in auto industry in each year and GDP data.

5.2 Data Processing for Hypotheses Testing

Datasets for testing hypotheses are compiled from the abovementioned raw data sources.

In the following I will discuss manipulation and compilation methods.

5.2.1 Unit of analysis.

Firm-level analysis is adopted in hypotheses testing to avoid possible bias at aggregated level and to acknowledge the heterogeneous nature of “spillover” effect. The ownership and governance structure of China auto firms has changed dramatically in past five decades. Before the early 1960’s, all the several China automobile factories (assemblers) were established and owned by the nation and operated by state assigned officials. Supplier firms were also state-owned and clustered around the assemblers but many for periphery parts and components were administered by provincial or county governments. The central government also established a company, “China Automobile Company” (*Zhongguo Qiche Zong Gongsi*), to monitor and control the operations of all car assemblers. However, this company primarily took the role of administration and coordination instead of business operation. In 1970’s, many provinces and even cities have established their own car assemblers by copying successful car models from those large factories to meet their own need for cars and promote their own region’s economic growth. During this period there were more than 50 car factory assembling cars, besides those refitting factories⁸ for special needs. The China Automobile Company was dissolved as it could not take the role of administration any more as more and more players owned by different levels of the state government emerged. The central

⁸ “*Qiche Gaizhuang Chang*” in Chinese. Those factories adopt engine, chassis, and transmission, and even cockpit from other manufacturing company and primarily make external or interior modification or add more equipment and functions to meet special needs, for example, from fire station, police office, post office, or hospital. The modified cars are called refitting cars in this dissertation.

government intended to change the problem of high fragmentation and low scale of the whole industry by establishing the China Automobile Company again in 1982. Because the command and planning nature of economy of China before 1991 and common ownership of those investments, China normally assigned the assets of one firm to another firm so that they can have more integration and coordination following the government policy but even though a firm acquired assets of another firm it will not involve itself in the latter's business operations. Nor have they headquarter-subsidary relationships. China Automobile Company now is only a state institution collecting market and production data, doing some research and development, and also offer service to auto firms and at the same time, assist central government to monitor their assets in automobile factories. It does not have the right to assign or managers in automobile firms. The industrial reform changed some firm's legal affiliation by assigning assets of existing companies to large corporate groups but normally those firms' operating autonomy did not change. FAW, SAIC, TAIC, and Dongfeng Motor normally have more legally owned firms and subsidiaries than specified in their own organization chart and under their control because those firms and subsidiaries are actually not related to these auto companies in terms of business operations. In more recent reform in corporate governance, many major carmakers established "holding company" or "assets management company" to distinguish those assets and those related to actual business operations.

The ownership structure of major firms in China automobile industry is now largely diversified. Since mid-1980s, foreign joint ownership was allowed from major carmakers

and also parts and component sectors. Private investments were also encouraged for parts and components sector. However, because the government policies explicitly encouraged economy of scale, the country all the new entrants into auto assembling sector were controlled and merger and acquisition of existing firms are desired by the government. For foreign car assemblers, they can only make a joint venture with existing car assemblers. It is much more difficult for private capital to enter the assembling sector. But since mid-1990s, private capital entered through alternative ways, such as acquisition or privatization of existing small or mid-size car assemblers that belonged to province or city level (e.g., BYD through acquisition of Qinchuan Auto, and Great Wall Auto through reforming Great Wall Industrial Company, a collective carmaker). Moreover, as the fast development of domestic capital market, all the former state-wholly-owned and most private-owned car assemblers are listed in Shanghai, Shenzhen, or Hong Kong stock markets.

Because China only allowed FDI to have IJV with only limited number of indigenous state-owned large carmakers, one indigenous carmaker might have multiple IJVs with different foreign partners (e.g., SAIC with Volkswagen and General Motor; FAW with Mazda, Toyota, and Volkswagen; GAIG with Honda and Toyota). Many foreign carmakers, probably with the concern about the uneven bargaining power and contribution, also established a few IJVs with different indigenous partners (e.g., Volkswagen with FAW and SAIC; Toyota with GAIG and Tianjin FAW Xiali; Honda with Dongfeng Motor and GAIG).

Considering the unique character of ownership structure and governance in China auto industry, I adopt the following operational rules to identify passenger carmakers. First, here a firm is defined as an entity who at least has its own discretion to make strategic decisions such as their R&D, new model release, and marketing strategies. Second, the firm identified should be directly related to auto production. Investment or holding companies or assets management companies are not counted. Third, each firm has its own brands (or sub-brands) and models not being shared with other firms. If a foreign carmaker or indigenous carmaker has more than one IJV company but those joint ventures are producing different sub-brands and models, they are considered different companies. Fourth, when identifying the affiliation of a firm, only its direct parent firms are identified and compared. This approach is reasonable in testing for possible technology transfer through partnership if it is assumed that efficient technology diffusion could be initiated by geographic and organizational proximity.

The following case about passenger car industry joint ventures among FAW, TAAIC, Volkswagen, Toyota, and Mazda illustrates an application of above rules (See Figure 4). FAW is more like a holding company now that is not directly involved in the business operation of passenger car production and marketing. It has a listed company, “FAW Car Co., Limited” for which it holds majority of the stock shares. FAW Car Company produces Hongqi brand, which was created by FAW. At the same time, FAW has a joint venture with Volkswagen, FAW-Volkswagen where FAW holds 60% of the equity share. FAW-Volkswagen primarily produces Volkswagen "Jetta" brand sedan cars. FAW Car Company and FAW also jointly invested with Mazda with an equity share of 50% for the

former two companies. The jointed ventured company, FAW-Mazda, is making and selling Mazda cars. A little more complicated is the relationship between FAW and Toyota. In 2002, From TAIC, FAW accepted the around 761 million shares of stock (about 47.48% of the total shares as of 2008) of "Tianjin Xiali Auto" owned by TAIC and listed in Shenzhen Stock Market. The deal was arranged and led by the Government and FAW group did not really pay for the stocks. Tianjin Xiali Auto is manufacturing "Xiali" branded car, which is developed based on the technologies from Daihatsu, now a wholly owned affiliate of Toyota. Toyota established a joint venture in June 2000 with Tianjin Xiali Auto, producing Toyota compact passenger cars. After FAW acquired the stock shares of Tianjin Xiali Auto, the international joint venture was renamed "Tianjin FAW Toyota Motor"(TFTM).

In our identification of passenger carmakers, FAW Car Company, Tianjin Xiali Auto, FAW-Mazda, TFTM, and FAW-Volkswagen will be recorded as independent carmakers. And others firms, such as FAW, and TAIC will not be included. As for the relationship between indigenous carmakers, two possible linkages will be recorded as potential direct linkages because of IJV partnership. The first is two carmakers are manufacturing different cars but their common indigenous parent(s) does not have production facilities. The other situation is both indigenous parent company and its IJV subsidiary produce cars. All other situations will not be coded as a potential channel for diffusion through IJV partnership. In other word, in this case two pairs, FAW-Volkswagen, FAW-Mazda, and FAW Car Company, Tianjin FAW Xiali Company and TFTM, could have direct linkage due to partnership. The linkage between TFTM and FAW Car Company, in

contrast, will not be considered a direct linkage for technology diffusion. I also will not use plant-level data. If a firm has different manufacturing plants under the same hierarchical system, those plants will be merged together.

In my main data source, China Automobile Industrial Yearbook for various years, most of the statistics are following my identification criteria for carmakers. Several large carmakers, such as FAW Car Company and Dongfeng, included their production and sales data for their IJVs. Therefore, I subtract those figures according to the independently reported data for their IJVs.

-----INSERT FIGURE 4 ABOUT HERE-----

5.2.2 Identification of indigenous vs. foreign cars

Identification of foreign invested and indigenous carmakers is easy. For the purpose of this dissertation, all the International joint venture carmakers are treated as foreign invested carmakers because no carmakers in China are wholly-owned by foreign carmakers. All the carmakers with 100% indigenous source of investment are identified as indigenous carmakers. There is no such situation that foreign ownership or indigenous ownership is below 10% in a joint ventured firm.

Based on the theme of this dissertation, I identify indigenous vs. foreign cars according to the ownership of brand name and the source of major technologies adopted for those cars manufactured in China.

Generally, four types of technology sources and ownership of brand can be identified in existing models in China passenger car industry. The first is introduction of new car models without any intellectual property rights, and without the ownership of the brands. Most IJVs are manufacturing this type of cars under brand names of foreign partners. The second is introduction of technologies and core parts and component, and manufacture by indigenous firm and selling under foreign partner's brand or both brands (i.e., joint branding). For example, Beijing Jeep has once introduced Mitsubishi brand SUV using this method. The third is purchase of property right of design and relevant technologies and manufacture under indigenous firm's brand name. The indigenous firm has the right to modify and improve the design without noticing or paying original owner of the model and related technologies. For example, Hongqi's new models introduced since late 1990s are using technologies sourced from Chrysler and Audi but Hongqi owns the all intellectual property right and related technologies. The last is in-house self-development of design and technologies based on imitation and learning. The focal indigenous firm creates the original design and the car is made and sold under the indigenous brand. Some of the indigenous firms, such as Chery and BYD, are introducing this type of cars.

Following this typology, I will classify the first two as foreign cars, and the last two as indigenous cars. In the recent versions of China Automobile Industrial Yearbook, the sources of technology for all passenger car models were also specified. For models in previous years when the source of technologies was not specified, I use the following two criteria to distinguish between indigenous and foreign cars. The first is the brand name. If the brand name is existing name belonging to the foreign parent and the IJV, the car

model will be recorded as foreign cars. The second is checking the both the brand and technology source by searching for the product release information on their official website. If the IJV owns the brand and the brand is new to the foreign parent but it is primarily using technologies from foreign parent and made in the IJV, I still consider it a foreign car. In recent years, several IJVs were trying to introduce such new models with new sub-brand or even brand to meet the taste of central government crying for indigenous brand (“*Zi Zhu Pin Pai*” in Chinese) but actually the whole design and even brand are still controlled by the foreign parent and have nothing related to the indigenous firms.

5.2.3 Vehicle classification and compilation

Some of our passenger carmakers also make other types of vehicles. To trace their operations in passenger car industry, we need first identify their data in the production of passenger cars, such as the brands, models, and number of units produced and sold. Our definition of passenger cars follows the newest classification effective since 2005 in China auto industry, which is based on China national standards GB/T3730.1-2001 and GB/T15089-2001. This classification is also largely consistent with classification scheme in US and most European countries. All vehicles were classified into passenger cars and commercial cars. Passenger cars are defined as vehicles with at most nine seats and primarily designed for passenger commute purpose. Within passenger car category there are regular passenger cars, multi-purpose vehicles (MPV), sport utility vehicle (SUV), and crossover passenger vehicles. Regular passenger cars cover all traditional sedan cars⁹. In the observation period China modified its classification standard for vehicles twice.

⁹ In USA terms, the sedan cars category includes sedan, coupe, and hatchback cars.

Before 1988, vehicles were classified into trucks, cross country vehicle, chassis, bus, sedan car, minibus, and others. Light cross country vehicles, which are mostly for passenger rather than goods use, are also specified in the cross country vehicle category. In the period of 1988-2005, following the national classification standard, GB/T3730.1-88, new vehicles were classified into trucks (heavy, middle, light, mini trucks), bus (large, middle, light, mini bus), and sedan cars (high class, mid-high class, middle class, regular, and compact cars). Light cross country vehicles were classified into trucks category but specifically identified. In late 1990s some of the sedan car models from new established indigenous carmakers such as Geely and Nanjing Yuejin Car Group, were classified in light bus category due to the policy for sedan car production permission was inconsistent with other related policies.

To make the data consistent across all years in our observation window, I included different categories in the old classification schemes based on the following approaches. First, after reviewing the definitions of different categories, I included sedan car, minibus, and light cross country vehicles in the raw datasets before 1988 into our datasets. For the raw datasets from 1989 to 2004, I included sedan car, minibus, and light cross country vehicles (from category of trucks). Second, I checked those models in passenger car category in the period after 2005 and also appeared before 2005 to see if their pre-2005 record was also included in the compiled datasets following the first approach. If they were not, I also included them into the compiled datasets. This method can fully trace the emergence of a carmaker by correctly identifying their first introduction of passenger cars to the market.

5.2.4 Treatment for longitudinal changes of firms

Since China is experiencing reform and transition since late 1980s, many carmakers changed their names because of the ownership change, restructuring, or simply responding to modern corporate terminology. The firms that changed their names in our databases will be considered the same firms as long as there still was continuity in product brands and models. The ownership of the firms was recorded annually, so ownership changed will be reflected if there was. Occasionally there were merger and acquisition (M&A) cases happened among carmakers (i.e., assemblers). In this case, I basically take the actual change of business operations as the major criterion for creating a new firm record. Overall there are three situations according to the raw datasets. The first is the ownership structure and governance change because the company was listed in stock market. I considered those capital changes primarily unrelated to the business operations and thus will not create a new firm record for it. The second is the assignment of equity shares between state-owned carmakers, for example, SAIC's acquisition of NIAC assets. As long as their business operations are still independent to each other and reflected independently in the China Automobile Industrial Yearbooks, they will be treated as different individual firms. The third case is a firm's acquisition of another existing carmaker to enter auto industry. After acquisition the brand names were changed. In this situation, the existing carmakers will be considered terminated once its own brands and models discontinued. The entering firm will be recorded as long as a new brand was launched associated with the new firm. For example, BYD first purchased major shares of Qinchuan Motor, a former state-owned carmaker, in 2003 and acquired it

later to enter auto industry. The firm's data are still recorded under Qinchuan Motor until the new brand, BYD F3, was launched in 2005.

However, as we also investigate historical capability accumulation and absorptive capacity and their consequences, in the merger and acquisition cases, their history, even under the former firm names, will be recorded. In some very rare cases where one or more firms involved in M&A were making cars formerly, all of their productive history will be summated and considered for the new firm after M&A.

5.2.5 Data preparation for testing hypotheses

Hypotheses 1a and 1b capture the impact of initial shock due to negative vertical competition. The challenging part is how to identify the length of production localization of early entries. Based on historical documents, the early major entrants are Volkswagen, Chrysler, and PSV Peugeot, which formed IJVs in mid-1980s. The production localization happened after their entry until mid-1990s. Therefore, I use the period of 1985-1995 as the time window to test these two hypotheses. The dataset for this set of hypotheses was compiled from CAIY various years for data about local content ratios for each foreign firms. While the capability formation variables were measured for all indigenous firms at firm-level, the independent variables about the presence of foreign invested carmakers and localization ratio were calculated at industrial level. From CAIY I got the firm level data on units of cars sold for all years within the period and each firm's information such as year of establishment, ownership types, firm size, labor productivity, and so on. CAIY also offer very detailed supply-assembler relationship by providing

units of parts produced for a specific car brand and model for all major supplier firms. I searched for the brand name and model number of a particular car and then searched for the supplier firms according to their production description with the name and model numbers in an abbreviated way coded by CAIY. Because only the supplier firms operating in China were included in CAIY, the share of the parts produced domestically for a specific year and a particular car model was calculated based on the total demand calculated from the number of units of the particular model produced. Details will be given in the following chapter.

Another source of data is model release database. Using all the firm names obtained from CAIY to search in model release database will get the number of models released in the defined period. All China passenger carmakers including indigenous foreign invested carmakers are included in CAIY. All the firm names then received careful investigation to see if they were the same company but with different names or can be considered same company following the rules describe in previous session. The third data source is China patent database. Similarly, I use the firm names to search for all patents owned by these firms and counted the number of patents. At last, all the firms information across different years are combined together to get a time series panel data.

Hypothesis 1b argues a moderating effect between local content ratio and the overall effect of presence of foreign invested carmakers and capability formation of indigenous carmakers. I use the interaction term between the local content ratio and the presence of foreign invested carmakers to detect the moderating effect.

Hypothesis 2a and 2b proposes the positive effect of foreign invested carmakers on indigenous supplier and thus I compiled data at firm-level for parts and component sectors. Because the supplier sectors differ significantly in terms of product categories, technology content, and competition pressure, I only use two relatively high-technology embedded sectors: engine-related parts and component and drivetrain-related suppliers. The parts and component firms were also listed in the CAIY for various years and I included all supplier firms in the abovementioned sectors. I also check the production offering of each supplier firm to see if it has manufactured parts or component for any foreign invested carmakers in China in a particular year. Again, data for presence of foreign invested carmakers were obtained from CAIY, car model release database, and China patent database.

Although Hypotheses 2a and 2b are closely relate to the production localization process of foreign invested carmakers, I also argued that diffusion process still persists for the whole period, as also predicted by previous studies. Therefore we use data ranging from 1983 to 2008. Consequently, time series data from 1983 to 2008 in engine related and drivetrain related supplier firms listed in CAIY were compiled.

Hypothesis 3 stresses the difficulty in learning from IJV partnership and Hypotheses 4a and 4b propose the indirect diffusion effect from supplier firms. These two sets of hypotheses are tested using a same dataset. The joint venture information is obtained from CAIY and individual firm's official website. The dataset is compiled from CAIY for

firm-level data about basic information of the firm and performance data such as units sold and labor productivity, and China patent database, and model release database. The whole dataset is similar to that for Hypotheses 1a and 1b except that in testing H3 whole data ranging from 1983 to 2008 are included. CAIY in various years has the detailed data about parts and component providers and the quantity for each model of car that was domestically made. I then establish a spreadsheet for each carmaker (including IJVs) each year for their supplier basic information (e.g., name, address, and zip code) and the product name and quantity they manufactured for the carmaker. The overlap of supplier network for each year will be calculated based on the spreadsheets. The location of the supplier firms are identified as China six-digit zip code. If two firms engaging the production of same product have same first four digits, according to rules of China codification, the two firms are in the same city or same county. In this case I considered them are in the same geographic location. The determination of common region firms follows this method. The share of common geographic location is calculated based on the percentage of supplier firms of two different carmakers located in the same location.

Dataset for Hypotheses H5a and 5b is compiled from CAIY, China patent database, Model Release Database, and *The History of China Light Vehicle Industry* edited by Zhao and Tian (1995). As usual, basic information, production and sales, and so on about each indigenous carmaker are obtained from CAIY. Innovation data are searched for each indigenous carmaker from China patent database. CAIY also has comprehensive information about introduction of new technologies from foreign carmakers or related equipment providers. That part of information then is codified to operationalize and

measure the absorptive capacity of the indigenous carmakers. The history of all firms producing light cars, which was defined as cars with capacity of 1000 to 3000 kilograms (Zhao & Tian, 1995: 1), was comprehensively traced in the book “The History of China Light Vehicle Industry”. Following the firm list from CAIY, I search the history for each of the firms in the book and obtain the information about their production of light cars before 1984 for the measurement of historical accumulation of capabilities.

Hypothesis H6 tests the net impact of foreign invested carmakers. Therefore I use the full range of the data available from the initial entry in 1983 to the latest year of 2008. The dataset is compiled from CAIY, China patent database, and Model release database for all indigenous passenger carmakers.

6. Variables, Measurement, and Model Specification

This chapter describes the variables used in testing hypotheses and how to measure them based on available data sources. And later, I will discuss the model used in hypothesis testing.

6.1 Variables and Measures

I first list all variables that would be used in hypothesis testing. In the model specification part, I will give a table for variables used for each hypothesis.

6.1.1 Major variables

Capability formation of indigenous firms is operationalized as three variables, *labor productivity, innovation, and market growth*. These three variables have been used widely to measure the effects of FDI on indigenous firms in existing literature (e.g., Cheung & Lin, 2004; Kosova, 2010; Wei & Liu, 2006). Although these three variables were not used previously in the same studies, they could reflect different aspects of capability formation. Change of productivity might indicate the learning of technologies adopted from elsewhere in both their production process and the product enhancement. According to previous studies (Markusen & Venables, 1999; Rodriguez-Clare, 1996), the productivity may also reflect temporary shifts because of the competition. For example, when a firm's market share is squeezed by competitors, the scale of its production may decrease its productivity. Therefore, the change of labor productivity might not reflect the pure technology factors but in the relative long term such as in our case this fluctuation might be alleviated. Innovation of indigenous firms could be a proxy of new knowledge

creation of a firm. Market growth also as a performance measure might reflect the outcome of the firm capabilities. If a firm owns advantageous capabilities, they could bring competitive advantage in the market and high market performance in turn.

Labor productivity (LABPROD). China Automobile Industrial Yearbooks (CAIY) reported labor productivity for each passenger carmakers. By default it was calculated using the value added for a firm in a particular year divided by the number of employees recorded at the end of that year. To make the data comparable during our data window, I also adjusted productivity data for various years for inflation rates according to the CPI (composite price index) for each year from China Yearbooks and all the labor productivity were based on 1990 constant price.

Innovation (INNOVATION). The innovation data, particularly patent data, as a measure of technological capabilities has been widely discussed by Cantwell and his colleagues (e.g., Cantwell, 1989; 1995; Cantwell & Mudambi, 2005). In this study, China patent database is used. Although China patenting system has been established for only several decades, it provides more comprehensive patenting behavior of Chinese firms than any other databases. The invention type of patents, which reflects the technological knowledge creation process, that were assigned to each of the indigenous carmakers listed in CAIYs in each year are recorded. In measuring the innovation output of an indigenous carmaker, I calculate the *share* of the total patents that carmaker has over all carmakers in China have in the current year and the next two years. Using consecutive three years' patent first to acknowledge that learning from foreign invested carmakers might take a few years to

benefit to the creation of new technologies. Second, use summation of more years of patent count can average the heterogeneity between patents and wash out the dramatic impact of small change of the number of patents when overall patent count is small.

While three years summation is arbitrary, I do not want to sacrifice the length of observation years to use the summation of more years' patent for each firm as length of observation window is more critical to this study.

The technology domain of patent belonging to a carmaker could include different disciplines but, to simplify, I also use the simple summation methods as long as those patents are related to automobile industry. After first check for the patents for indigenous carmakers using the name list from CAIY, several firms, such as BYD who switched their business to auto industry, were received specially treatment by excluding their patents are neither related to automobile industry nor it is mentioned in the patent content that the technology could be used in automobile industry.

To measure innovation outcome of a supplier firm, I use similar approach as in carmaker's case. After search for all patent counts for each supplier firm, the total patent counts of that firm are divided by the total patent counts of all other firms in the same category (i.e., either engine category or drivetrain category). A close check for the patented technology was also conducted to make sure all those patents are related to automobile industry.

Simple patent count is not a good choice because the rate of technological change and

new technology creation might differ in different period of time especially in our relatively long 25-year period. Also because the patent law in China has been significantly revised three times since first establishment in 1985, the number of patents might not be comparable longitudinally. The patent growth rate compared with the firm's previous innovation outcome might be an alternative measure. However, I exclude this measure because the shifts in technology paradigm in China automobile industry and also the significant revisions of China patent law make the longitudinal calculation not ideal.

Market growth (MKTGROW). Market growth is measured as the increase (or decrease) of sales income) relative to the previous year divided by previous year's sales income as a base year. Needless to say, there are several other variables, such as market share or financial variables to measure a firm's performance. For the indigenous carmakers who have IJVs I calculate their market growth only based on their sales income for their own brand cars excluding any sales income from foreign car brands under their names. I consider market share a better proxy first because existing literature has used this variable (e.g., Kosova, 2010) and also because when we calculate possible gains from other peers in the market a relative measure to the firm's own historical data is better than the measures to other peers data (e.g., market share). Financial data are less reliable and valid in our automobile in our case as large expenditure for developing new car models or other large innovation projects could change the annual financial data. Moreover, because in China, listed companies, foreign invested companies, and state-owned companies often have slightly different financial reporting system and also different approaches to reduce taxes, their financial data are less comparable. In the following part, measurement of

three variables is described in details.

Presence of foreign invested carmakers (PRESENCE). Theoretically, what matter in the presence of FDIs are actually their technology-related activities. Thus previous size-based measures are mostly problematic. The size-based measures could not measure the activities and viable content reflecting the possible exposure of technologies. For example, the value of invested capital-based measures could remain constant for several years but actually the technologies exposed to indigenous carmakers through productive activities do not remain constant over time. Market-share based measure also has the problem of tautology because it could automatically indicate a negative relationship with the growth measure of indigenous carmakers. See Smeets (2008) for a summary of the various measures of FDI presence and other variables. R&D might be an alternative measure but unfortunately R&D data are not available in our datasets or any other available data in China as there is no policy for reporting R&D data. Use patent-based measure is also questionable as MNCs might not file their patents under the weak IPR protection system of China. A preliminary search in the whole patent database found less than twenty patents filed under the name of IJVs in China. In this study, I use the total number of unit cars (divided by 100,000) produced in all the foreign invested carmakers as the measure of presence by assuming the production and marketing activities would give more chance to expose technologies to the market. The original data come from CAIY. An alternative measure is the release of new car models. As I described in data source part, China government has a regulation that all the new car models should be reported to central government and get permission before releasing to the market. I

assume that new model release suggests the introduction of new technologies and correspondent technological activities. This measure would be also used to test the robustness of the measurement.

Local content ratio (LCR). Local content ratio is normally calculated at firm level based on the value of parts and component manufactured locally and the total value of the total product. One of the issues with this type of calculation is the pricing difference between individual parts and component and the total car as a whole because the value of the whole car reflects the value added in assembling process and also the pricing of a whole car might also takes into consideration the possible benefit of internalizing parts and component production or economy of scale. Moreover, the price of local made content is normally valued lower than those parts and component imported in our case of FDI production in developing countries. We probably should also consider the issue of transfer pricing or other charges for intellectual property rights. Another problem of adopting this measure in this study is the shortage of explicit data for real price of various parts and component and actual cost of cars made by IJVs. Using sale price as a proxy of cost is invalid because in the early years the pricing was more dependent on market demand rather than the manufacturing cost.

I calculate of local content ratio for a firm based on the following approach. First, I use the classification of parts and component of suppliers in the CAIY into about 120 detailed categories. If the supplier firms in any one of these categories produced products for any car models for a particular foreign invested carmaker under the foreign brand names, I

assume that the foreign invested carmaker has localized the parts or component in that category. Second, the total local content ratio of the foreign invested carmakers in a particular year would be the share of the number of parts that were produced by local supplier firms across the 120 categories. The local content ratio at industry level for each year was calculated by the following formula:

$$LCR = [\sum_{k=1}^n (LCR_k * Q_k)] / \sum_{k=1}^n (Q_k),$$

where Q_k is the unit of total production of passenger cars by foreign invested carmaker k , and LCR_k is local content ratio of the foreign invested carmaker in that year. n is the total number of foreign invested carmakers in China in that year. Needless to say, this type of calculation of local content ratio has some limitations. However, considering the detailed classification of parts and component, and the difficulty in obtaining other types of data, the current measure is the best available method.

Supplier relationship with foreign invested carmakers (FDISUPPLIER). This variable is measured using dummy variable. I use this variable to check the impact of linkage to foreign invested carmakers on supplier firm's capability formation. If a supplier firm has produced parts and component for any foreign invested carmakers in current or previous two years, the value would be one and zero if else. I use three years' range since it is arguable that benefits of partnering with foreign invested carmakers might not diminish so quickly. Again, using three year's range is somewhat arbitrary but because most of the suppliers have relative long term relationship with carmakers once it was established changing to two years or four years would not alter the value of the data very much. A longer range may not be proper considering the fast changing technologies in China

automobile industry.

Joint venture partnership (IJVPARTNER). Dummy variable is used to measure joint venture partnership. If the focal indigenous carmaker, or its direct parent company, has formed an IJV with foreign partner, the value of this variable will be one from the year of establishment of IJV. Otherwise, the value will be zero. In the identification of foreign or indigenous carmaker described in previous chapter, more details were given regarding the definition of direction relationship due to IJV.

Share of the suppliers (OVERLAP). I first listed all the supplier firms for each indigenous carmaker in each year in CAIY and then search if any of the supplier firms have current supplier-assembler relationship with any of the foreign invested carmakers or have had the relationship in previous two years. The overlap ratio is calculated as number of supplier firms having current or previous supplier relationship with any foreign invested carmakers divided by the total number of supplier firms of the indigenous carmaker. The value of this variable will range from 0 to 1, theoretically.

Ratio of suppliers from the same locations as the suppliers of foreign invested carmakers (COMMLOCAT). This variable is operationalized as the share of units of parts and components that are produced in suppliers who are located in the same location as those suppliers who are suppliers producing same products for any foreign invested carmakers. To measure this variable, based on the list of supplier firms for each carmaker including indigenous and foreign invested carmakers, I compare the location for the supplier firms

for a particular indigenous carmaker with other supplier firms in the same location and in the same category defined by the CAIY (i.e., totally about 120 categories). If any of the other supplier firms have current supply relationship with any of the foreign invested carmakers, the focal indigenous carmaker is identified to have one supplier firm that has common geographic origin with foreign invested carmakers' supplier. Therefore, the common geographic origin of an indigenous carmaker in a particular year is also a ratio variable and measured as the share of the supplier firms that are in the same location as those supplier firms that are in the same category and have current supply relationship with any foreign invested carmakers to the total number of supplier firms that the indigenous carmaker has in a certain year. To avoid possible overlap with another variable, the overlap ratio of supplier network, the case of overlap of supplier firms between the focal indigenous carmaker and other foreign invested carmakers will not be counted in calculating this variable. In other word, the situation of the overlap operationalized in previous paragraph will not be considered for this variable. For the definition of "same location", I exploit the six-digit zip code system in China. I consider an area as the same location if the first four digits are the same. According the rules of China zip code, an area with first four digits is mostly county or small city level. In middle and large cities, that could be district level (which is parallel to county level in China's administration system). Use county level or sub-city level is reasonable when considering the possible geographic distance for learning as well as the complexity of data processing.

Absorptive capacity (ABCAP). Measuring absorptive capacity is challenging. In previous

studies, absorptive capacity has been operationalized and measured using the similarity of technology profile between firms using patent counts, the level of productivity or productivity difference to target firms (See Smeets, 2008 for a review), or even firm size (e.g., Zhang, Li, Li, & Zhou, 2010). My understanding is that knowledge overlap and redundancy measure is closer to the original concept in Cohen and Levinthal (1990). To measure the overlap, I count the number of technology transfers through equipment purchase, licensing, joint projects, and other arms-length transactions with foreign firms in automobile industry. For example, the transaction of advanced production equipment, or outsourcing of model design could be counted. The underlying rationale is that learning from foreign firms, instead of those lagged-behind indigenous counterparts, could establish a meaningful absorptive capacity. To avoid small number bias and reflecting cumulative nature of this capacity, I use total number of transactions and projects in previous ten years. In CAIY there is a part about the introduction (purchase) of new technologies or imports of key equipment. For the recent years, I also supplement the CAIY data with information I searched from the website of those indigenous carmakers. Needless to say, the activities of trade of technology or equipment or strategic cooperation are not equally significant in nurturing absorptive capacity of indigenous carmakers. But by using ten years' cumulated data, the issue of heterogeneity might be alleviated. Because the starting year for calculating absorptive capacity is 1983, the valid value of this variable is available from 1992. As a result, dataset for hypothesis testing for H5 has smaller year range than other datasets.

Technological accumulation before entry (TECHACCUM). To measure historical

accumulation before entry of foreign carmakers, I compile a dataset of total unit of light vehicles produced before 1984 for each indigenous firm from the History of China Light Vehicle Industry. Because of the weak innovative ability, in the period before 1984, the major technological challenge for indigenous carmakers is how to maintain high productive reliability through incremental improvement rather than the number of wholly new models introduced. Moreover, there are few firms before 1984 having manufacturer passenger cars. Therefore, the total number of units produced and sold in relating product category might reflect their major capabilities.

Length of entry of foreign carmakers (FDIENTRY): I use length of entry of first foreign carmaker as the length of entry of FDI for the China passenger car industry. In 1983 Volkswagen established its joint venture with Shanghai Auto Factory (later SAIC). Therefore 1983 will be the base year. In other word, the value of length of entry for the year 1984 would be one, and for the year 2000 would be seventeen.

6.1.2 Control variables

I also include a few control variables as following.

Industry level control variables. I first include two *policy dummy* variables to control for the impact of policies on the industry. As I discussed in Chapter 4, China government has explicit policies toward automobile industry, including local content requirement, encourage market for private owners, and the WTO entry. In model specifications, I add two dummies to acknowledge the different before and after those policies were

implemented. One is “*POLICY_94*”, which represents the “market for technology” policy released in 1994, “Industrial Policy for Automobile Industry”. The other is “*POLICY_00*”, which captures policy impact of the entry of WTO. Second, *market potential (MARKET)* is also added to the model specification. It is operationalized as GDP per capita. Because carmakers in China largely compete with each other at nation level, the GDP per capita for the whole nation is included. GDP per capita data come from China Statistic Yearbook.

While the FDI in supplier sectors is not our focus in this study, the possible effect from foreign invested supplier firms should be controlled. Although China government was encouraging foreign investment in parts and components sector since early 1980s, FDI in supplier sector has been developed much slower than FDI in car assembling as a result of lacking sufficient demand. Only after 2000, along with the taking-off of China passenger car market, the FDI is soaring in supplier sector. To control its possible impact, I added two variables into hypothesis testing when applicable. The first is *Supplier FDI Capital Stock (SUPPFDI)*, which is the capital stock of FDI in whole supplier sector. The data come from China Statistic Yearbook for various years. The second is *Number of FIEs in Same Supply Category (SUPPFIENO)*, i.e., the number of foreign invested firms in the same supply category as the focal supply firm. The supply category follows the classification method in CAIY (i.e., around 120 categories on car parts and components). The data also come from CAIY.

Firm level control variables. Firm level control variables include *employee numbers*

(*EMPLOYEE*), *firm total assets (ASSETS)*, and *ownership (OWNERSHIP)*. All the data come from CAIY. For some of the supplier firms who don't have ownership data, I search on their official website or other authorized websites to find their ownership. If the firm is state-owned, ownership will be one and otherwise the value of ownership is set to zero.

Location dummies. Besides above industry and firm level control variables, I also added dummy variables to control the firm location reflecting some location-specific heterogeneity in terms of economic activities and possible agglomeration and specialization within the firm's location. Traditionally, China has six general regions representing different geographic locations and sub social-cultural heterogeneity. In the late twenty years, the six regions also differ in terms of economic development due to the geographic difference. Five dummy variables are used to distinguish between regions. Because the provinces within a same general region are quite homogeneous geographically, the province dummy is not included.

Table 3 gives a list for major variables, their names, and measurement.

-----INSERT TABLE 3 ABOUT HERE-----

6.2 Model Specification

All hypotheses are tested using an unbalanced panel dataset compiled from the various sources described in the previous Chapter because from CAIY we could not get longitudinal data for each firm. CAIY is the most comprehensive dataset on China auto

industry. Although it is census type of dataset and all the firms are required to report to the editorial press of CAIY but there were still some *supplier* firms missing from the yearbook. However, special treatment for the unbalanced dataset is not needed because of the following reasons. First, after check with the editor of CAIY, it is confirmed that some of the missing data are due to various reasons such as forgetting to report. In this case, the missing of data is quite random. Second, some of the firms were missing especially after 2000 because they are very small firms occupying very small share of the total production of the industry. Normally this part of firms totally accounts about 5-10% of the market. Due to the special ownership structure of firms in China and lack of exit mechanism for state-owned firms, most state-owned firms actually would have gone bankrupt based on their profitability and debt but they still maintain their business operation by producing at a very small scale. Exclusion of those firms might not hurt the reliability of the results. Moreover, I will not conduct event history analysis such as survival analysis. Similar type of dataset and approach has been also adopted in Chang and Xu (2008).

The second consideration is the survival bias in the time period. As the mortality of indigenous firms (especially those private-owned supplier firms) could also be attributed to the effect of FDI, a survival bias would appear as a consequence of not treating those subjects specially. In the case of indigenous carmakers, this bias might not be an issue because there was no indigenous carmaker having exited the market during our observation window. Even though several of state-owned carmakers had negative profits and didn't have any production in a whole year, they are still recorded as active firms due

to the governance system of state-owned firms. For parts and component supplier firms, however, there is a possible bias because the dataset is unbalanced and we do not have full information about when the supplier firms were established or out of business if they were. In dealing with the issues caused by non-exit carmakers and missing observations for some subjects, the market growth value is set to missing if calculation of market growth involves zero numbers.

Previous studies normally use rationale of production function to specify regression model (e.g., use log form and add product factor-related variables). As I mentioned in Chapter 2, this neo-classical approach is less meaningful because each firm, especially firms from different country of origin, may have heterogeneous production function. To simplify model specification, I use the following regression model with OLS estimation method.

$$y = \beta_0 + \sum_{n=1}^k (\beta_n x_n)$$

A further check for the data found a non-stationary character of labor productivity¹ (Ewing & Thompson, 2007). So I used one year lagged value of independent variables and added Y_{t-1} in all models using productivity measure. The third consideration is model selection. For all datasets for hypothesis testing, Hausman test revealed that the independent variables are correlated with the unobserved effects and thus fixed effect specification is preferred. The modified Wald test also suggested a serious heteroscedasticity. Therefore, I use HC3 option in STATA program to correct heteroscedasticity according to MacKinnon and White (1985). To overcome the possible

¹ i.e., ADF/DF test.

issue of multicollinearity, I used mean-centered solution suggested by Aiken and West (1991) for those regression models with VIF value higher than 10. After men adjustment, all the VIF values are smaller than 3. As fixed effect model only captures time-invariant differences between subjects, I also included a set of control variables to correct the possible bias in estimation.

Table 4 gives details about the dataset and variables to be included in testing each set of hypotheses.

-----INSERT TABLE 4 ABOUT HERE-----

7. Findings and Discussion

This Chapter reports the findings based on the hypothesis testing in previous two chapters. I will give descriptive analysis of the data and then interpret the statistic results based on the model specification following the methodologies introduced in previous chapters. A robustness check was conducted using an alternative measure of presence of foreign invested carmakers. After the results part, a discussion about the empirical testing and more broadly about issues and implications for China passenger industry is given. A more general discussion concluding the whole dissertation will be provided in the Chapter 8.

7.1 Descriptive Analysis

More description of the data besides those provided in Chapter 4 is given in this section. First, China passenger car industry is highly fragmented compared with USA. The number of carmakers in passenger car industry increased quickly since early 1980s and reached the peak in late 1990s. After 1990s the number of firms decreased slightly. In 1985, there are only five passenger carmakers, and in 1995, there were 29 firms in passenger car industry. In 2000 and 2005, the number is 54 and 49, respectively. In 2008 there are 50 carmakers in passenger car industry. Table 5a gives a list of all passenger carmakers appeared in our panel data from 1983 to 2008. Some of the firms exited the industry under the intense competition triggered by foreign brands in the market. At the same time, some of the new indigenous firms, or those existing firms through acquisition of other carmakers, entered the market.

-----INSERT TABLE 5a ABOUT HERE-----

The second trend is the increasing size of China passenger car market and the changing market structure. Since 1983, the market size increased quickly, especially after 2000. In 1985, total number of units sold (including imported cars) in China market was approximately 42,000, and in 1995, the number was 750,000. After year 2000, the market was even soaring faster. In the year 2000, 2005, and 2007, the number was about 1,050,000, 4,100,000, and 5,930,000. In the total sales, majority of the market was taken by the IJVs. Before 2000, the IJVs as a total has taken as high as 90% of the China passenger car market. After 2000, some strong indigenous firms emerged such as Geely, Chery, Great Wall, Lifan, and BYD and the market share of IJVs decreased slightly. But overall, most of the carmakers operating in China were experiencing a general growing trend of the sales.

The entry of IJV in passenger car industry has two waves. The first wave was during 1983-1986, when Chrysler, PSV Peugeot, Volkswagen, first entered. This wave could be considered an import substitution type of FDI. Although China government had a strong intension for exporting, the vast domestic demand and the interest of foreign investor made this intention an impossible mission. The second wave of entry was during 1997-2003. These later entrants were also market seeking but they are more reliant on the benefit of WTO on their operation flexibility about outsourcing of parts and components globally because WTO requires the elimination of tariffs on parts and component imported to China. The global outsourcing network emerged in late 1990s also gave these

latecomers competitive advantage in China market. Table 5b gives a list of all IJVs in China and their parents, and the year of establishment.

-----INSERT TABLE 5b ABOUT HERE-----

Table 6 offers a correlation matrix of major variable used in model specification. There are high positive correlations (between 0.47 and 0.53) between three dependent variables, labor productivity, innovation, and market growth, showing that technological capabilities might be a common latent source of production efficiency, technological competence, and competitive advantage in the market. These high positive correlations may also suggest a good validity of using the three interrelated variables to proxy the capability formation of a firm. We also found significant positive relationships among share of supplier firms between indigenous firm and foreign invested carmakers (OVERLAP), ratio of suppliers in the same location as those for foreign invested carmakers (COMMLOCAT), and the three dependent variables, indicating that the capability formation of indigenous carmakers positively associated with the direct or indirect linkage through supplier network. Consistent with theory about continuity and path dependence of technological development, absorptive capacity is also significantly and positively related to pre-1983 technological accumulation. Interestingly, local content ratio (LCR) of the foreign invested firms is not significantly correlated with the three dependent variables. This could be partially explained as the indirect relationship between LCR and capability formation of indigenous carmakers. When foreign invested carmakers were localizing their production network but using exclusive partnership with

the supplier firms, there would be no significant diffusion effect and a negative competition effect. Indirect linkage through technology diffusion among parts and component sector might be more timing consuming than the direct linkage to supplier firm and therefore, the postponed possible positive effect might not be reflected in the correlation between these variables using values in the same years. Overall the correlation matrix indicates some pretty high correlations between variables, implying a possible multicollinearity issue and mean-centered solution is legitimate.

-----INSERT TABLE 6 ABOUT HERE-----

7.2 Statistical Findings and Discussion

Table 7 reports the results for hypothesis testing. Hypotheses 1a and 1b was tested using firm level data about indigenous carmakers and industry level measure of presence of foreign invested carmakers and local content ratio. The data from 1985 to 1995 were used as most of early entrants were localizing their production within that period. For the regression model using labor productivity as dependent variable, the coefficient of local content ratio (LCR) is negative significant (Beta=-1.602, $p<0.1$), suggesting a negative relationship between local content ratio and labor productivity. When using innovation as dependent variable, the coefficient of LCR is negative but not significant. In the model with market growth (MKTGROW) as a regressor, the coefficient of LCR is negative but also insignificant. Put the results for three regression models together, the Hypothesis 1a is partially supported.

-----INSERT TABLE 7 ABOUT HERE-----

Another set of coefficients of the three models using different regressors is the coefficients of the interaction term, $LCR*PRESENCE$, which tests hypothesis 1b. For the labor productivity as dependent variable, the coefficient is negative and significant ($\beta = -.243, p < 0.1$). For innovation and market growth as dependent variable, the coefficient is $-.001$ ($p \geq .1$) and $-.146$ ($p < 0.05$), respectively. The negative interaction terms imply that if local content ratio is higher, the presence of FDI would bring more negative impact on indigenous carmakers. Thus, hypothesis 1b is also partially supported.

The partial support that hypotheses 1a and 1b has received could be explained as following. First, the competition effect on indigenous carmakers due to the production localization of foreign invested carmakers might not instantly jeopardize the innovation ability of the indigenous carmakers. But for labor productivity, there are two potential effects of foreign carmakers, the first is that direct competition and the resulting decreased market share will shift the production function to less efficient point and thus decrease the labor productivity. The second effect is that loss of leading supplier would increase the cost for parts and component, and in turn decrease the labor productivity. Second, the production localization may lower the overall quality and reliability of the final products and raise the final price for indigenous carmakers. The market growth is thus negatively influenced. Therefore, even with partial support, the testing results for Hypotheses 1a and 2b are not totally unexpected.

It is interesting that from the results the presence of FDI is significantly and negatively related to labor productivity, innovation, and market growth in the period of 1985 to 1995. The negative coefficients might be explained as a partially net negative impact during this period. Compared with the arguments regarding local content ratio, this negative relationship is not theoretically endorsed and should not be accepted without more concise modeling. The coefficients of IJVPARTNER are also negative but two of them are insignificant. This might suggest that as indigenous partners of JIVs, they might have dedicated more resources to the joint ventured companies by reducing the input for their own indigenous brands actively or passively. It is also worth noting that the joint venture strategy also negatively (significantly) relates to innovation of indigenous carmaker (Beta=-.051, $p < 0.01$). The reason might be the substitution of efforts in innovation for efforts in learning in the IJV to make a better technology transfer from foreign parent to JIVs. In the case of Shanghai-Volkswagen, after establishment of new IJV firm, about 2000 of 3000 totally employees in Shanghai Auto Factory (the indigenous parent of Shanghai-Volkswagen) were switched to the IJV. The movement of skillful employees and especially those R&D technicians would weaken the innovation capability of the indigenous firms. Not surprisingly, the market size is positively related to the capability formation of indigenous carmakers, suggesting a market-led growth trajectory for China automobile industry.

A dataset compiled from engine- and drivetrain-related supplier firms from year 1983 to 2008 is used to test hypotheses 2a and 2b. The results show a full support when labor productivity is the dependent variable and a partial support when innovation is the

dependent variable. The main effect of presence of FDI is significant and positive (Beta=.106, $p<0.01$) in the model where labor productivity is the dependent variable. FDISUPPLIER, measuring if the focal indigenous supplier firm has supplier relationship in current or the past two years, is positive and significant (Beta=3.197, $p<0.0001$). The interaction term between FDISUPPLIER and PRESENCE testing Hypothesis 2b is also significant and positive (Beta=.091, $p<0.01$). The positive coefficient of interaction term suggests that if the supplier firms have or recently had supplier relationship with foreign invested carmakers, the supplier firms would benefit more from the presence of foreign invested carmakers. In the model with innovation as the dependent variable, the main effect of presence of FDI has no significant effect. Although the significant and positive coefficient of FDISUPPLIER (Beta=.026, $p<0.05$) suggests that innovation output would be higher if the focal supplier firm has or recently had supply relationship with foreign invested carmaker, there is evidence about the moderating effect of supply relationship on the relationship between presence of FDI and innovation outcome of indigenous supplier firms. In a word, hypotheses 2a and 2b are not supported when using innovation as the dependent variable. One of the possible reasons responsible for the insignificant results for innovation is that learning from foreign invested carmakers can drive a significant technology growth of indigenous supplier firms but most indigenous supplier firms have not developed to a higher level of creation of new technologies. An alternative explanation is that for most indigenous suppliers who are producing less technology intensive parts and component they may focus more on process and production based innovation to create cost-related advantage. This type of innovations normally could not be properly patented. In a word, the capability formation of supplier firms may not be

captured by patent-related variables.

The control variables for firm size (number of employees and total assets) also have significant positive coefficients for both dependent variables. This may suggest a higher benefit of economy of scale in supplier sector compared with car assemblers. This result is plausible considering the practices of supplier firms in auto industry.

I use the same dataset on indigenous carmakers to test hypotheses 3, 4a, and 4b.

Hypothesis 3 argues an insignificant relationship between IJV partnership and capability formation of indigenous carmakers. The coefficients of IJV partnership (IJVPARTNER) for labor productivity, innovation, and market growth are non-significant but their signs are different (Beta=.021 for labor productivity, Beta=-.001 for innovation, and Beta=-.005 for market growth). Although the insignificant coefficients could result from various reasons, H3 is virtually supported or at least not violated in our analysis. H4a and 4b propose an indirect diffusion channel for indigenous carmakers. From the statistic results, these two hypotheses received full support. The coefficient of OVERLAP, measuring the share of supplier firms who are also currently (or have been recently) suppliers for foreign invested carmakers, is positive and significant for all dependent variables, namely, labor productivity (Beta=3.793, $p<.001$), innovation (Beta=.375, $p<.01$), and market growth (Beta=.025, $p<.05$). A case mentioned in Lu and Feng (2005) illustrates the share of supplier firms: the Chinese brand, Chery, was sued by Shanghai-Volkswagen (SHVW) around 2000 because SHVW found VW logos on some parts and component installed in a Chery model. From Lu and Feng (2005)'s view point,

the type of imitation and sharing supplier network is a not a bad method to catch-up. Similarly, the ratio of suppliers from the same location as those for foreign invested carmakers also has significant and positive relationship with innovation (Beta+.294, $p<.05$) and market growth (Beta=.010, $p<.05$) but not labor productivity.

In testing Hypotheses 5a and 5b, a dataset for indigenous carmakers ranging from 1992 to 2008 is used. The results generally show a significant impact of the indigenous firm's absorptive capability and self-accumulation of technology capabilities. These significant impacts are not only reflected in their importance in forming the outcomes of their capabilities represented by labor productivity, innovation, and market growth, but also in their positive role in accelerating learning from foreign invested carmakers. The main effects of both absorptive capacity and historical technology accumulation are positive and significant for all three dependent variables (please see Table 7 for the coefficients and p-values). At the same time, hypotheses 5a and 5a are largely supported. For example, the coefficient of interaction term between presence of FDI and technology accumulation is positive and significant for labor productivity (Beta=.0023, $p<.05$), innovation (Beta=.0004, $p<.05$), and market growth (Beta=.0002, $p<.1$). These results strongly support the vital role of historical accumulation. Considering the radical technology changes happened in past fifth years in China auto industry, the finding that pre-1984 capabilities still matter actually implies that the dynamic capabilities associated with the technology accumulation have taken pivotal role rather than the accumulated technologies *per se*, which may have been outdated during the radical technological changes.

The coefficients of interaction term of absorptive capability for testing its moderating role in enhancing learning efficiency from presence of foreign invested carmakers indicate a partial support for H5b. The coefficient for innovation as the dependent is positive and significant ($\text{Beta}=.0023$, $p<.05$) and thus supports the argument that the higher absorptive capacity of the firm, the more positive benefits are received from presence of FDI. However, the coefficients are not significant for the other two dependent variables, although the signs are following predicted ($\text{Beta}=.013$ for labor productivity and $\text{Beta}=.001$ for market growth).

From the findings about two types of capabilities of the indigenous firms, we could also have the impression that compared with absorptive capacity, historical accumulation is more important in pursuing benefits from FDI. One of the reasons, as noted above, is that historical accumulation actually reflects the dynamic capabilities of the firm and becomes the fundamental factor to respond, to learn, and finally to innovate under the dramatic change both in industrial environment and technology paradigm. This finding is also consistent with previous literature about how early experience could have impact on the survival and performance long time later (e.g., Klepper & Simons, 2000b). The other reason might be that the knowledge could be outdated quickly and prior knowledge might not be very helpful to decipher and digest more recent technologies from foreign carmakers, or that there is still heterogeneity between what the indigenous firms have learned from foreign firms and those foreign invested carmakers have released in China auto market.

The last set of hypotheses (H6 and H6alt) was tested by importing a time based variable, entry of FDI. I conducted two models for each dependent variable. The first model is based on the pure negative assumption and the second model on negative and then positive assumption by adding an interaction term, PRESENCE*FDIENTRY_sq, i.e., the product of presence and the squared length of entry of FDI. If the presence of FDI first bring negative net impact, and then bring positive impact, the outcome variables should decline first along with the length of entry of FDI. And also the presence of FDI will also be influenced by this curvilinear relationship. But if the presence of FDI is purely negative through the whole observation window, this interaction term should be insignificant, and composite effect of PRESENCE and FDIENTRY during the observation window should be negative.

In Table 7, the results show that for innovation and market growth as dependent variables, the coefficients of the interaction term are positive and significant (Beta=.00017, p<.1 for innovation, and Beta=.0040, p<.01 for market growth), suggesting a more complex relationship of FDI along with the time of entry. After transformation, the regression models with interaction term can be rewritten as the following equation:

$$y = a_0 + a_1x_1(x_2 + a_2)^2 + \sum_{n=3}^k (a_nx_n),$$

where y is dependent variable, x_1 is PRESENCE, and x_2 is FDIENTRY. After using mean values of the variables in the transformed model for the regression results using market growth as dependent variable, we can get the curve in Figure 5, resembling a

U-shape type of curve, which supports H6 original argument about the first negative and later positive impact of FDI. The turning point from negative to positive is around the year when $FDIENTRY=15$. In other world, after about the year 1999, the FDI has a positive net impact on indigenous carmakers.

As a reminder, we should be cautious about the findings for testing hypothesis 6 as it just tried to capture the pure statistic relationship between FDI and growth of indigenous firms. The coefficients are less meaningful because no theoretical conclusions could come from the results, following the critique of literature and the theoretic framework proposed in early part of this dissertation.

-----INSERT FIGURE 5 ABOUT HERE-----

7.3 Robustness Check

In the empirical testing part, I only used the units of production as the proxy of presence of FDI. The reliability and validity of this measure might cause some measurement issues for hypothesis testing. Therefore, I used an alternative measure, the new model released for all foreign invested carmakers in a certain year, as a proxy of presence of FDI to test the robustness of the whole testing. The data for released models come from Car Model Release Database described in previous chapters.

I replaced the current measurement of PRESENCE with the number of new car model released for all foreign invested carmakers and conducted the regression analysis again

for those regressions using innovation as the dependent variable. The coefficients for related major variables are recorded in Table 8 as a comparison. Generally, most of the signs and significant level were not changed. Some of the significance levels did change but the signs are quite consistent. But overall the number of new models as a measure of presence of FDI is not a better measure than units of production. For example, in testing hypotheses 1a and 1b, the regression model using number of new models yielded no significant results (See Table 8). The following reasons might explain why number of new models is not a better measure. First, although there is some requirement for new model application, there are no such limits as the minimum content of new technologies. So the number of new models reflects more about the marketing strategy of the foreign invested carmakers rather than the technological activities. Second, in the early period of FDI entry, the small size of the market made offering many new models economically infeasible. For these reasons, the results from the dataset ranging from 1985-1995 does not significantly support our hypotheses 1a and 1b. The overall high convergence of the results using different measures of presence of FDI provides extra robustness of the model specification and statistic results.

-----INSERT TABLE 8 ABOUT HERE-----

7.4 Conclusions, Implications, and Limitations

The section offers some discussions directly related to the empirical setting—the China passenger car industry. In general, the theory proposed in Chapter 3 is successfully applied to the case of China passenger car industry, which provides a perfect setting to

test the theory. We are able to show how the various effects from competition and diffusion have been shaping the interaction between FDI and capability formation of indigenous firm within the same industry.

Through findings, we may find some clues for the debate on China automobile industry. As we can make clear now, international joint venture is not a good policy to encourage knowledge transfer between joint venture partners. The failure of learning can be understood in technological and behavioral factors. On one hand, learning from partners might have natural obstacles because of the nature of technologies or intended protection by the foreign partners of IJVs. On the other hand, the high profits that indigenous partners are sharing may also reduce the incentive to actively learn. As a final impact, IJV could hardly be a good method to encourage technology transfer.

However, our findings suggest indirect technology diffusion happened through the share of supplier network. In other word, foreign invested carmakers benefited indigenous firms through developing a competent supplier network. From this viewpoint, FDI did contribute the growth of indigenous firms both in a horizontal and vertical way. However, different means of technology diffusion are obviously associated with different time frame to realize besides their various efficiency and effectiveness. The indirect way of diffusion also implies that the local content requirement policy launched in early 1980' could effectively drive foreign invested firms to localize their production network, even though the local content requirement might not be the sole driving forces. From this dissertation we might conclude that open door policy is obviously a right decision but IJV

policy has not achieved its original goal. Moreover, the negative side of the policy only allowing IJV with large indigenous carmakers is that indigenous partners were blocked from some learning opportunities such as reverse-engineering and other non-cooperative learning methods.

The interesting finding about the role of absorptive capacity and historical accumulation also has some implications. First, solely relying on FDI may not be a good method to learn and catch-up. As the positive role of absorptive capacity implies, indigenous firms need to learn from somewhere else to obtain the knowledge background so that they can learn effectively, especially when the indigenous firms are initially lacking the base knowledge. Diversification of learning channels besides inward FDI will help the indigenous firms learn faster. To this extent, one might expect that there are possible multiplying effects between different types of diffusion, such as import, export, and FDI. Second, the finding about historical accumulation suggests that even after a radical technology change, the pre-change technology history still has positive and significant impact on revival of firms. So the critical issue becomes how to survive the initial shock from the entry of FDI. China is a special case as its major carmakers before 1984 were all state-owned and lacked exit mechanism. The continuous operation of these indigenous carmakers might have reserved some capabilities and therefore the key issue is how to survive the short term “bad time”. As the CEO of Lifan Motor, Mingshan Yin, said in AutoMedia 2011 Forum (“*Quanqiu Qiche Meiti Fenghui Luntan*”), “as long as we keep ourselves from falling-down, we will catch-up someday.” This might be the role of government policy or domestic capital market to support indigenous firms.

The importance of government role is obvious in our results. In the results of most regression models, the government policy encouraging industrial development and market growth launched in 1994 has a positive impact. After joining in WTO, there is also a significant positive impact. The policy role does not necessarily have direct intervention on market players. The possible mechanism for the government policy to take effect is that by encouraging more foreign entries, the market turns to more competitive, then the foreign invested firms have to import more advanced technologies and, at the same time, try to establish a local production network to augment their cost structure to keep competitive advantage. Subsequently, the potential to learn from foreign firms might be increased.

Needless to say, there are some limitations for the study on China passenger car industry. First, the study has not distinguished between different sources of FDI. Instead, this study treated FDI as a whole. As different countries have different trajectory of technological development and also with different technology distance and paradigm differences with recipient countries, the different country of origin of those foreign invested firms might bring different impact on indigenous players. Because very limited number of firms initially entered China passenger car industry, their country effect and even firm-specific characteristics could have significant impact on the resulting route of indigenous firms. So the next step for research on China passenger car industry might be the country of origin effect of those foreign invested firms.

Another limitation rose from the results for innovation as the dependent variable.

Innovation measured by patent data in this study was found to be not significant for some major independent variables. One of possible reason is that innovation as a new knowledge creation maybe takes longer time to happen in indigenous firms as a result of learning from FDI. This reason might lead to another issue on observation window but it is not clear if we could detect the long term effect on innovativeness of indigenous firms by enlarging the observation window. As we already have quite long period of investigation (25 years), more studies might needed by looking at even longer period.

The last but not the least limitation is about the insignificant relationship between IJV partnership and capability formation of indigenous firms. While the hypothesis is well supported, one could not ignore other possible factors confounding the relationship. For example, as majority of IJVs in China enjoy a good profit and their local partner have contributed a little to the JIV¹, the IJV local partners are satisfied with their status and may have no incentive to learn (Liang, 2004).

¹ In 2003 Tokyo Motor Show, The CEO of Nissan Motor, Carlos Ghosn, said that except for the low cost labor and distribution channels that Chinese partners of IJVs are offering, their actual contribution to the operation and management was near zero.

8. Concluding Remarks

In this dissertation, I focus on the impact of foreign invested firms on indigenous firms in the same industry (i.e., in a competition relationship). Free from dynamics, no distinction between actual diffusion-related or competition-related effects, and the lack of sufficient focus on firm capabilities are three significant limitations in previous studies. To address these deficiencies, two dimensions, competition and technology diffusion, are first introduced. I further argue that the “spillover” effect is actually the net effect of competition and diffusion, each of which has its own set of determinants and consequences. Using data from China automobile industry, I received some support on the proposed U-shape type of net impact. In other word, at the initial stage of opening doors, there might be a competition effect but accompanied with intense interaction and localization of production network, learning (i.e., diffusion) could be achieved slowly but with an increasing effectiveness. In the next stage, the net impact might turn to be positive.

There are two elements in my dynamic model, one is theory of diffusion, and the other is theory of competition. The theory of technology diffusion is rooted in the theory of technological competence by Cantwell (1991). Under the context of inward FDI in developing countries, the investigation into the role of historical accumulation is actually an extension of Cantwell (1989), which was drawn from the case in developed countries.

While my model might be interesting and stimulating, as it is dynamic and process-based,

it should be understood in a right way. First of all, there are not any two firms that exhibit exactly the same response pattern under the presence of foreign investment. The pattern differences are not merely the magnitude of “coefficients” in regression analysis but the whole structure of different determinants interwoven at different stages of evolving. This heterogeneity brings some risk in test using aggregated sample. If a pattern at industry level might be detectable after some simplification, in contrast, a general theory on all countries and all industries on the base of static theorization is quite challenging (if not impossible). The investigation of the dynamism should be based on specific industry and especially on its history and evolution during a long term. For example, in our empirical testing, while the initially negative and consequent positive effects and the curvilinear type of net impact are justified in different sets of specifications, these models *per se* are a static analogy of the different stages of a same dynamic process because the detailed mechanism and processes could not be fully collected by the current available data. Another related warning is that the pattern identified in China automobile industry may not be generalizable to other industries or other countries, although the dynamic framework in Chapter 3 still applies to these different situations.

As Nelson (1994) identified, there are two types of theories. The first is “appreciate theory”, which is close to empirical work and offers guidance and interpretation. Most of appreciate theorization is expressed verbally and “is the analyst’s articulation of what he or she thinks really is going on.” The other type of theorization is called “formal theory”, which almost always “proceeds at some intellectual distance from what is known empirically and where it does directly appeal to data for support it generally appeals to

‘stylized facts’.” “If the hall mark of appreciative theory is story-telling that is close to the empirical nitty-gritty, the hallmark of formal theorizing is an abstract structure set up to enable one to explore, find and check, logical connections.” (Nelson, 1994)

The theory proposed in this dissertation might be an appreciate theory. The appreciate theorization is due to the dynamic and complex nature of the theoretic content, just as what Nelson and Winter (1982) did. Previous research on spillover effect skipped the theorization part by simplifying the outcome, mechanism, and modeling approach. In the theory part of the dissertation, I broadened the outcomes of “spillover” effect and also filled the input-outcome logic with a rich and dynamic process consisting of the elements of competition and diffusion. In the empirical testing part, I extended the outcomes of FDI impact by exploring three various but complementary reflections of capability formation. For the modeling approach, I adopted a trade-off between modeling accuracy and mathematic challenge by splitting the whole process into different components according to their different theoretic roots. My understanding is, if regression models represent a certain relationship predicted by theory, it is improper to test multiple theories using one single regression model. The previous studies either adopted a “multi-theory” approach into one statistic modeling or simple treated the regression models as a pure mathematic instrument. In contrast to the “package plan” by throwing all possible variables rooted from different and even incompatible theories into one single model, we should adopt multiple models each of which has a comprehensive set of theory-specific and unique variables. In that way we can also obtain a better estimation against alternative explanations. In sum, an overall test by linking presence of FDI and

consequences of indigenous firms may not yield a consistent and powerful theory because of the dynamic nature and different theoretical roots of the interaction processes.

As I discussed in previous chapters, one ideal approach for testing the dynamic model proposed in this dissertation is to consider a set of variables specific to the theory of diffusion and include all of them into a theory deducted model, possibly an evolutionary modeling, and test the true diffusion effect after minimizing the possible confounding effect or alternative explanations of the effect. Unfortunately, due to social complexity and causal ambiguity, it might be extremely challenging to compose that “perfect” model. My approach of multiple regression models, though with some limitations, is sufficient to catch the different faces and moments of the interaction between indigenous and foreign invested firms.

Second, the current model is not a substitute but a complement to existing literature. In line with previous studies, there is still a need to find the underlying factors that can alter the effect size or even the direction of the impact. But finding more contextual and contingent variables would not achieve a full understanding of the spillover process. The role of my dynamic model would add to the endeavor of searching for underlying mechanism to reach a more powerful theory of spillover. Third, the duration of the process could range from a few years to several decades depending on the level of analysis, intensity of FDI flows, and characteristics of indigenous firms. As in the case of China automobile industry, many indigenous passenger carmakers by average took more than twenty years to become a significant player in the market. As indigenous firms

perform better and better either from catfish effect or from knowledge acquisition from foreign counterparts, and as the foreign invested firm is integrated into local research and production network, the spillover effect is actually turning to bi-directional.

The theory in this dissertation also puts the spillover research back to the fertile soil of broader domains of technology diffusion and competition. The complex dynamic process will definitely enrich the future directions of spillover research. On the other hand, more empirical evidence is needed to fit into the dynamic process and more studies are necessary to investigate possible industry or nation level patterns.

The dynamic model of effect of FDI has important implications to policy makers.

Previous studies found mixed evidence about the role of FDI in improving indigenous growth. One of the solutions, as scholars have been done, is to acknowledge contingencies by introducing more contextual or firm-specific variables upon which policy making might be based to intervene in the FDI impact. Our dynamic approach suggests another dimension of policy making and implementation: timing. A good timing of government policies address the process of foreign-indigenous interaction, for example, by protecting indigenous firms from initial shock, encouraging localization of production, and establishing solid intra-industrial linkages between foreign and indigenous firms, at different points of time. As for China auto industry, the government currently could encourage local production by motivate specialized supply center and also increase the competition intensity and force them to seek local production by introducing more market players instead of implementing IJV policy.

There are more to develop for the theory proposed in this dissertation as well. First, the relationships between various competition and diffusion effects and how they could be interrelated sequentially are the promising direction of next step of this line of research. For example, we could ask under what industrial and firm situations the crowding-out effect would outweigh the market creating effect. Second, the detailed theories about the antecedents of those effects are also worth investigating. For example, the sub-market dynamism suggests a market creation effect and then maybe FDI is capable of occupying these sub-markets later. This dynamics might also in turn shift the interaction between foreign and indigenous firms by altering the content and direction of learning between indigenous and foreign invested firms.

9. References

- Abernathy, W. J. 1978. *The Productivity Dilemma: Roadblock to Innovation in the Industry*. The Johns Hopkins University Press: Baltimore.
- Acharya, R. C., & Keller, W. 2009. Technology transfer through imports. *Canadian Journal of Economics*, 42(4): 1411-1448.
- Aghion, P., Blundell, R., Griffith, R., Howitt, P., & Prantl, S. 2009. The effects of entry on incumbent innovation and productivity. *Review of Economics & Statistics*, 91(1): 20-32.
- Agosin, M. R., & Machado, R. 2005. Foreign investment in developing countries: Does it crowd in domestic investment? *Oxford Development Studies*, 33(2): 149-162.
- Ahmadjian, C. L., & Lincoln, J. R. 2001. Keiretsu, governance, and learning: Case studies in change from the Japanese automotive industry. *Organization Science*, 12(6): 683-701.
- Aiken, L. S., & West, S. G. 1991. *Multiple Regression: Testing and Interpreting Interactions*. Newbury Park, CA: Sage.
- Aitken, B. J., & Harrison, A. E. 1999. Do domestic firms benefit from direct foreign investment? *American Economic Review*, 89(3): 605-618.
- Alcacer, J., & Zhao, M. 2007. Global competitors as next-door neighbors: Competition and geographic concentration in the semiconductor industry. *Ross School of Business Working Paper*.
- Alcacer, J., & Chung, W. 2007. Location Strategies and Knowledge Spillovers. *Management Science*, 53(5):760-776.
- Almeida, P., & Kogut, B. 1999. Localization of knowledge and the mobility of engineers in regional networks. *Management Science*, 45(7): 905-917.
- Augier, M., & Teece, D. J. 2008. Strategy as evolution with design: The foundations of dynamic capabilities and the role of managers in the economic system. *Organization Studies*, 29 (8/9): 1187-1208.
- Belderbos, R., Jie-A-Joen, C., & Sleuwaegen, L. 2002. Local content requirements, vertical cooperation, and foreign direct investment. *De Economist*, 150(2): 155-180.

- Blomstrom, M., & Kokko, A. 1998. Multinational corporations and spillovers. *Journal of Economic Surveys*, 12(3): 247.
- Blomstrom, M., & Persson, H. 1983. Foreign investment and spillover efficiency in an underdeveloped economy: Evidence from the Mexican manufacturing industry. *World Development*, 11(6): 493-501.
- Blomstrom, M., & Sjöholm, F. 1999. Technology transfer and spillovers: Does local participation with multinationals matter? *European Economic Review*, 43(4-6): 915-923.
- Bottazzi, L., & Peri, G. 2003. Innovation and spillovers in regions: Evidence from European patent data. *European Economic Review*, 47(4): 687-710.
- Buckley, P. J., & Casson, M. C. 1976. *The Future of the Multinational Enterprise*. Homes & Meier: London.
- Buckley, P. J., Clegg, J., & Wang, C. 2002. The impact of inward FDI on the performance of chinese manufacturing firms. *Journal of International Business Studies*, 33(4): 637-655.
- Buckley, P. J., Clegg, J., & Wang, C. 2007a. The impact of foreign ownership, local ownership and industry characteristics on spillover benefits from foreign direct investment in China. *International Business Review*, 16(2): 142-58.
- Buckley, P. J., Clegg, J., & Wang, C. 2007b. Is the relationship between inward FDI and spillover effects linear? An empirical examination of the case of China. *Journal of International Business Studies*, 38(3):447-459.
- Buckley, P. J., Clegg, J., Zheng, P., Siler, P. A., & Giorgioni, G. 2007. The impact of foreign direct investment on the productivity of china's automotive industry. *Management International Review (MIR)*, 47(5): 707-724.
- Brusoni, S., & Prencipe, A. 2001. Managing knowledge in loosely coupled networks: Exploring the links between product and knowledge dynamics. *Journal of Management Studies*, 38 (7): 1019-1035.
- Brusoni, S., Prencipe, A., & Pavitt, K. 2001. Knowledge specialization, organizational coupling, and the boundaries of the firm: why do firms know more than they make? *Administrative Science Quarterly*, 46:1185-1200.

- Bwalya, S. M. 2006. Foreign direct investment and technology spillovers: Evidence from panel data analysis of manufacturing firms in Zambia. *Journal of Development Economics*, 81(2): 514–26.
- Cantwell, J. A. 1989. *Technological Innovation and Multinational Corporations*. Oxford: Basil Blackwell.
- Cantwell, J. A. 1991. The theory of technological competence and its application to international production. In D.G. McFetridge (Ed.), *Foreign Investment, Technology and Growth*, Calgary: University of Calgary Press.
- Cantwell, J. A. 1993. Corporate technological specialisation in international industries. In Casson, M.C., Creedy, J. Eds., *Economic Inequality and Industrial Concentration*. Edward Elgar, Aldershot.
- Cantwell, J. A. 1995. The globalisation of technology: What remains of the product cycle model? *Cambridge Journal of Economics*, 19(1): 155-174.
- Cantwell, J. A., Dunning, J. H., & Lundan, S. M. 2010. An evolutionary approach to understanding international business activity: The co-evolution of MNEs and the institutional environment. *Journal of International Business Studies*, 41: 567-586.
- Cantwell, J. A., & Janne, O. 1999. Technological globalisation and innovative centres: the role of corporate technological leadership and locational hierarchy. *Research Policy*, 28: 119–144.
- Cantwell, J. A., & Mudambi, R. 2005. MNE competence-creating subsidiary mandates. *Strategic Management Journal*, 26: 1109-1128.
- Cantwell, J. A., & Smeets, R. 2008. FDI motives and host country productivity effects of US MNEs. Rutgers Business School (RBS), Newark, NJ.
http://uk.cbs.dk/content/download/93106/1222029/file/Smeets_Cantwell.pdf
- Castellani, D., & Zanfei, A. 2003. Technology gaps, absorptive capacity and the impact of inward investments on productivity of European firms. *Economics of Innovation and New Technology*, 12(6): 555–576.
- Caves, R. E. 1974. Multinational firms, competition, and productivity in host-country markets. *Economica*, 41(162): 176-193.
- Caves, R. E. 1996. *Multinational Enterprise and Economic Analysis*. Cambridge: Cambridge University Press.

- Chang, S. J., & Xu, D. 2008. Spillovers and competition among foreign and local firms in china. *Strategic Management Journal*, 29(5): 495-518.
- Cheng, S. 2006. The role of labour cost in the location choices of Japanese investors in China. *Papers in Regional Science*, 85(1):121-138.
- Cheung, K.-Y., & Lin, P. 2004. Spillover effects of FDI on innovation in China: Evidence from the provincial data. *China Economic Review*, 15(1):25–44.
- Chung, W., & Alcácer, J. 2002. Knowledge seeking and location choice of foreign direct investment in the united states. *Management Science*, 48(12): 1534-1554.
- Church, J., & Ware, R. 2000. *Industrial Organization: A Strategic Approach*. Boston: Irwin McGraw-Hill.
- Cohen, W. M., & Levinthal, D. A. 1989. Innovation and learning: The two faces of R & D. *Economic Journal*, 99(397): 569-596.
- Cohen, W., & Levinthal, D. A. 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1):128–152.
- Cohen, W. M., Nelson, R. R., & Walsh, J. P. 2000. Protecting their intellectual assets: Appropriability conditions and why U.S. manufacturing firms patent (or not). *NBER Working Paper* No. 7552.
- Cyert, R. M., & March, J. G. 1963. *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice Hall.
- De Backer, K., & Sleuwaegen, L. 2003. Does foreign direct investment crowd out domestic entrepreneurship? *Review of Industrial Organization*, 22(1): 67.
- Depner, H., & Bathelt, H. 2009. Exporting the German model: The establishment of a new automobile industry cluster in Shanghai. *Economic Geography*, 81(1): 53-81.
- DiMaggio, P. J., & Powell, W. 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48: 147-160.
- Dierickx, I., & Cool, K. 1989. Asset stock accumulation and sustainability of competitive advantage. *Management Science*, 35(12): 1504-1511.
- Dimelis, S., & Louri, H. 2002. Foreign ownership and production efficiency: A quantile regression analysis. *Oxford Economic Papers*, 54(3):449–469.

- Djankov, S., & Hoekman, B. M. 2000. Foreign investment and productivity growth in Czech enterprises. *World Bank Economic Review*, 14(1): 49-64.
- Driffield, N., & Love, J. H. 2005. Who gains from whom? *Scottish Journal of Political Economy*, 52(5): 663-686.
- Driffield, N., & Love, J. H. 2007. Linking FDI motivation and host economy productivity effects: Conceptual and empirical analysis. *Journal of International Business Studies*, 38(3): 460-473.
- Egger, P., & Pfaffermayr, M. 2001. A note on labour productivity and foreign inward direct investment. *Applied Economics Letters*, 8(4): 229-232.
- Eisenhardt, K. M., & Martin, J. A. 2000. Dynamic Capabilities: What are they? *Strategic Management Journal*, 21(10/11): 1105-1122.
- Ewing, B., & Thompson, M. 2007. Symmetric and asymmetric stationarity tests of productivity. *The Engineering Economist*, 52(4): 355-365
- Fagerberg, J. 1994. Technology and international differences in growth rates. *Journal of Economic Literature*, XXXII: 1147-1175.
- Findlay, R. 1978. Relative backwardness, direct foreign investment, and the transfer of technology: A simple dynamic model. *Quarterly Journal of Economics*, 92(1): 1-16.
- Girma, S. 2005. Absorptive capacity and productivity spillovers from FDI: A threshold regression analysis. *Oxford Bulletin of Economics and Statistics*, 67(3): 281-306.
- Girma, S., & Gorg, H. 2007. The role of efficiency gap for spillovers from FDI: Evidence from the U.K. electronics and engineering sectors. *Open Economies Review*, 18(2): 215-232.
- Girma, S., Gong, Y., Gorg, H., & Yu, Z. 2009. Can production subsidies explain china's export performance? evidence from firm-level data. *Scandinavian Journal of Economics*, 111(4): 863-891.
- Girma, S., Gorg, H., & Pisu, M. 2008. Exporting, linkages and productivity spillovers from foreign direct investment. *Canadian Journal of Economics*, 41(1): 320-340.
- Girma, S., Greenaway, D., & Wakelin, K. 2001. Who benefits from foreign direct investment in the UK? *Scottish Journal of Political Economy*, 48(2): 119-133.

- Globerman, S. 1979. Foreign direct investment and 'spillover' efficiency benefits in Canadian manufacturing industries. *Canadian Journal of Economics*, 12: 42-56.
- Gorg, H., & Greenaway, D. 2004. Much ado about nothing? do domestic firms really benefit from foreign direct investment? *World Bank Research Observer*, 19(2): 171-197.
- Gorg, H., Hanley, A., & Strobl, E. 2008. Productivity effects of international outsourcing: Evidence from plant-level data. *Canadian Journal of Economics*, 41(2): 670-688.
- Gorg, H., Henry, M., Strobl, E., & Walsh, F. 2009. Multinational companies, backward linkages, and labour demand elasticities. *Canadian Journal of Economics*, 42(1): 332-348.
- Gorg, H., & Strobl, E. 2001. Multinational companies and productivity spillovers: A meta-analysis. *Economic Journal*, 111(475): 723-739.
- Gorg, H., & Strobl, E. 2005. Spillovers from foreign firms through worker mobility: An empirical investigation. *Scandinavian Journal of Economics*, 107(4): 693-709.
- Guan, J., & Liu, S. 2005. Comparing regional innovative capacities of PR China-based on data analysis of the national patents. *International Journal of Technology Management*, 32(3/4): 225-245
- Haddad, M., & Harrison, A. 1993. Are there positive spillovers from direct foreign investment? Evidence form panel data for Morocco. *Journal of Development Economics*, 42: 51-74.
- Hale, G., & Long, C. 2006. What determines technological spillovers of foreign direct investment? Evidence from China. *Yale Economic Growth Center Discussion Paper* 934, New Haven, CT.
- Henderson, V. 1997. Externalities and industrial development. *Journal of Urban Economics*, 42: 449-470.
- Henderson, R. M., & Clark, K. B. 1990. Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 35(1): 9-30.
- Hymer, S. H. 1960. *The International Operations of National Firms: A Study of Direct Foreign Investment*. PhD Dissertation. Published posthumously. The MIT Press, 1976. Cambridge, Mass.

- Hyun, J.-H. 1994. Buyer-supplier relations in the European automobile component industry. *Long Range Planning*, 27(2): 66-75.
- Jaffe, A. B., Trajtenberg, M., & Henderson, R. 1993. Geographic localization of knowledge spillovers as evidenced by patent citations. *Quarterly Journal of Economics*, 108(3): 577-598.
- Javorcik, B. S. 2004. Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review*, 94(3):605-627.
- Javorcik, B. S., & Spatareanu, M. 2005. Disentangling FDI spillover effects: What do firm perceptions tell us? In Theodore H., Moran, Edward M. Graham, and Magnus Blomstrom (eds.), *Does Foreign Direct Investment Promote Development?* 45-71. Washington, D.C.: Institute for International Economics and Center for Global Development.
- Javorcik, B. S., & Spatareanu, M. 2008. To share or not to share: Does local participation matter for spillovers from foreign direct investment? *Journal of Development Economics*, 85(1-2): 194-217.
- Javorcik, B. S., Saggi, K., & Spatareanu, M. 2004. Does it matter where you come from? Vertical spillovers from foreign direct investment and the nationality of investors. *Policy Research Working Paper* 3449. World Bank, Washington, D.C.
- Kaplinsky, R. 2011. Schumacher meets Schumpeter: Appropriate technology below the radar. *Research Policy*, 40 (2):193-203.
- Kholdy, S. 1995. Causality between foreign investment and spillover efficiency. *Applied Economics*, 27:74-749.
- Klepper, S. 2007. Disagreements, spinoffs, and the evolution of Detroit as the capital of the U.S. automobile industry. *Management Science*, 53(4):616-631.
- Klepper, S., & Simons, K. L. 2000a. The making of an oligopoly: Firm survival and technological change in the evolution of the U.S. tire industry. *Journal of Political Economy*, 108(4): 728.
- Klepper, S., & Simons, K. L. 2000b. Dominance by birthright: Entry of prior radio producers and competitive ramifications in the U.S. television receiver industry. *Strategic Management Journal*, 21(10): 997.

- Klepper, S., & Thompson, P. 2006. Spinoff entry in high-tech industries: Motives and consequences. In F. Malerba, S. Brussoni (eds.) *Economic Perspectives on Innovation*. Cambridge University Press, Cambridge, UK.
- Kneller, R. 2005. Frontier technology, absorptive capacity and distance. *Oxford Bulletin of Economics & Statistics*, 67(1): 1-23.
- Kogut, B. 1991. Country capabilities and the permeability of borders. *Strategic Management Journal*, 12: 33-47.
- Kogut, B., & Chang, S. J. 1991. Technological capabilities and Japanese foreign direct investment in the United States. *Review of Economics and Statistics*, 401-413.
- Kogut, B., & Zander, U. 1993. Knowledge of the firm and the evolutionary theory of the multinational corporation. *Journal of International Business Studies*, 24(4): 625-645.
- Kokko, A. 1994. Technology, market characteristics, and spillovers. *Journal of Development Economics*, 43: 279-293.
- Kokko, A., 1996. Productivity spillovers from competition between local firms and foreign affiliates. *Journal of International Development*, 8: 517-530.
- Kokko, A., Tansini, R., & Zejan, M. C. 1996. Local technological capability and productivity spillovers from FDI in the Uruguayan manufacturing sector. *Journal of Development Studies*, 32: 602-611.
- Konings, J. 2001. The effects of foreign direct investment on domestic firms: Evidence from firm-level panel data in emerging economies. *Economics of Transition*, 9(3): 619-633.
- Kosova, R. 2010. Do foreign firms crowd out domestic firms? evidence from the czech republic. *Review of Economics & Statistics*, 92(4): 861-881.
- Kotabe, M., Parente, R., & Murray, J. Y. 2007. Antecedents and outcomes of modular production in the Brazilian automobile industry: A grounded theory approach. *Journal of International Business Studies*, 38: 84-106.
- Krugman, P., 1991. Increasing returns and economic geography. *Journal of Political Economy*, 99(3): 483-499.
- Kugler, M. 2006. Spillovers from foreign direct investment: Within or between industries? *Journal of Development Economics*, 80(2):444-477.

- Levin, R., Klevorick, A., Nelson, R. R., Winter, S., Gilbert, R., & Griliches, Z. 1987. Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity*, 3:783–831.
- Liang, G. 2004. *New Competition: Foreign direct investment and industrial development in China*. Doctoral dissertation at Erasmus University Rotterdam.
- Lin, P., & Saggi, K. 2005. Multinational firms and backward linkages: A critical survey and a simple model. In Theodore H., Moran, Edward M. Graham, and Magnus Blomstrom (eds.), *Does Foreign Direct Investment Promote Development?* 159–174. Washington, D.C.: Institute for International Economics and Center for Global Development.
- Lin, P., & Saggi, K. 2007. Multinational Firms, exclusivity and backward linkages. *Journal of International Economics*, 71(1): 206–220.
- Liu, X., Siler, P., Wang, C., & Wei, Y. 2000. Productivity spillovers from foreign direct investment: Evidence from UK industry level panel data. *Journal of International Business Studies*, 31(3): 407-425.
- Lipsey, R. E., & Sjöholm, F. 2005. The impact of inward FDI on host countries: Why such different answers? In Theodore H., Moran, Edward M. Graham, and Magnus Blomstrom (eds.), *Does Foreign Direct Investment Promote Development?* 23–43. Washington, D.C.: Institute for International Economics and Center for Global Development.
- Liu, X., & White, S. 2001. An exploration into regional variation in innovative activity in China. *International Journal of Technology Management*, 21(1/2): 114-130
- Lu, F., & Feng, K. 2005. Fazhan WoGuo Zizhu Zhishichanquan Qichegongye de Zhengcexuanze. (*The Policy Choice to Develop Our State's Automobile Industry with Independent Intellectual Property Rights*). Beijing: Peking University Press. (In Chinese)
- Luo, Y., Sun, J., & Lu Wang, S. 2011. Emerging economy copycats: Capability, environment, and strategy. *Academy of Management Perspectives*, 25(2): 37-56.
- Makino, S., Lau, C., & Yeh, R. 2002. Asset-exploitation versus asset-seeking: Implications for location choice of foreign direct investment from newly industrialized economies. *Journal of International Business Studies*, 33: 403-421.

- Markusen, J. R., & Trofimenko, N. 2007. Teaching locals new tricks: Foreign experts as a channel of knowledge transfer. *NBER Working Paper* 12872. Cambridge, Mass.: National Bureau of Economic Research.
- Markusen, J. R., & Venables, A. J. 1999. Foreign direct investment as a catalyst for industrial development. *Journal of International Economics*, 43(2):335–356.
- Meyer, K. E., & Sinani, E. 2009. When and where does foreign direct investment generate positive spillovers? A meta-analysis. *Journal of International Business Studies*, 40(7): 1075-1094.
- Murakami, Y. 2007. Technology spillover from foreign-owned firms in Japanese manufacturing industry. *Journal of Asian Economics*, 18(2): 284-293.
- Nelson, R. R. 1981. Research on productivity growth and productivity differences: Dead ends and new departures. *Journal of Economic Literature*, 19(3): 1029-1064.
- Nelson, R. R. 1994. What has been the matter with neoclassical theory? In G. Silverberg & Soete, L. (eds) *The economics of growth and technical change: technologies, nations, agents*. Edward Elgar: Aldershot.
- Nelson, R. R., & Pack, H. 1999. The Asian miracle and modern growth theory. *Economic Journal*, 109(457): 416-436.
- Nelson, R. R., & Winter, S. 1982. *An Evolutionary Theory of Economic Change*. Belknap Press of Harvard University Press: Cambridge MA.
- Nelson, R. R., & Winter, S. G. 2002. Evolutionary theorizing in economics. *Journal of Economic Perspectives*, 16(2): 23.
- North, D. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.
- Pack, H., & Saggi, K. 1997. Inflows of foreign technology and indigenous technological development. *Review of Development Economics*, 1(1): 81-98.
- Parente, S., & Prescott, E. C. 1994. Barriers to technology adoption and development. *Journal of Political Economy*, 102(2): 298–321.
- Perez, T. 1997. Multinational enterprises and technological spillovers: An evolutionary model. *Journal of Evolutionary Economics*, 7(2): 169.

- Poole, J. P. 2007. Multinational spillovers through worker turnover. *Working paper*, Department of Economics, University of California, Santa Cruz.
- Protsenko, A. 2003. *Vertical and Horizontal Foreign Direct Investments in Transition Countries*. Ph.D. dissertation, Ludwig-Maximilians University, Munich.
- Ramdas, K., & Randall, T. 2008. Does component sharing help or hurt reliability? An empirical study in the automotive industry. *Management Science*, 54(5): 922-938.
- Robertson, D. and Ulrich, K. 1998. Planning for product platforms. *Sloan Management Review*, 39: 19-31.
- Rodriguez-Clare, A. 1996. Multinationals, linkages and economic development. *American Economic Review*, 86(4):852-873.
- Rogers, E. M. 2003. *Diffusion of Innovations* (5th Edition). New York: Free Press.
- Romer, P. M. 1993. Two strategies for economic development: Using ideas and producing ideas. *Proceedings of the World Bank Conference on Development Economics 1992* (Washington, D.C.).
- Saggi, K. 2002. Trade, foreign direct investment, and international technology transfer: A survey. *World Bank Research Observer*, 17(2): 191.
- Sako, M. 2003. Modularity and outsourcing: the nature of co-evolution of product architecture and organisation architecture in the global automotive industry. in: Prencipe, A., Davies, A., & Hobday, M. (Ed.), *Business of Systems Integration*: Oxford University Press, 2003.
- Schoors, K., & van der Tol, B. 2002. Foreign direct investment spillovers within and between sectors: Evidence from Hungarian data. *Working Paper* 157. Department of Economics, Ghent University, Belgium.
- Schumpeter, J. 1934. *Capitalism, Socialism, and Democracy*. New York: Harper & Row.
- Sinani, E., & Meyer, K. E. 2004. Spillovers of technology transfer from FDI: The case of Estonia. *Journal of Comparative Economics*, 32(3): 445-466.
- Smeets, R. 2008. Collecting the pieces of the FDI knowledge spillovers puzzle. *World Bank Research Observer*, 23(2): 107-138.
- Song, H., & Chai, Y. 2008. Yi Kao Wai Zi Yu Du Li Fa Zhan: Zhong Guo Qi Che Chan Ye Fa Zhan De Zhan Lue Dui Bi Fen Xi. (Dependence on foreign investment or

- independent development: Comparative analysis of development strategy of China automobile industry). *China Academy of Social Science International Trade and Investment Series*. Working Paper No. 08003. (In Chinese)
- Storper, M., & Venables, A. J. 2004. Buzz: Face-to-face contact and the urban economy. *Journal of Economic Geography*, 4(4): 351-370.
- Teece, D. 1977. Technology transfer by multinational firms: The resource cost of transferring technological knowhow. *Economic Journal*, 87: 242-261.
- Tong, J. 2009. Explaining the shakeout process: A 'Successive submarkets' model. *Economic Journal*, 119(537): 950-975.
- Tornatzky L. G., & Klein, K. 1982. Innovation characteristics and innovation implementation: A meta-analysis of findings. *IEEE Transaction in Engineering Management*, 29(1): 28-45.
- Von Hippel, E. 1994. "Sticky information" and the locus of problem solving: Implications for innovation. *Management Science*, 40(4): 429-439.
- Wang, H. 2008. Innovation in product architecture—A study of the Chinese automobile industry. *Asia Pacific Journal of Management*, 25: 509-535.
- Wang, J. Y., & Blomstrom, M. 1992. Foreign investment and technology transfer: A simple model. *European Economic Review*, 36(1):137–155.
- Wei, Y., & Liu, X. 2006. Productivity spillovers from R&D, exports and FDI in China's manufacturing sector. *Journal of International Business Studies*, 37: 544–557.
- Winter, S. G. 2003. Understanding Dynamic Capabilities. *Strategic Management Journal*, 991-995.
- Xu, B. 2000. Multinational enterprises, technology diffusion, and host country productivity growth. *Journal of Development Economics*, 62: 477-493.
- Yan, G. 2010. Production localization does not tolerate flaws (“Guo Chan Hua Bu Yun Xu ‘Gua Cai Dai’”). *Auto in Great Nation (“Da Guo Qi Che”)*, Chapter 8. Shanghai Jiaotong University Press: Shanghai. (ISBN: 7313067704/9787313067708) (In Chinese)
- Zhang, Y., Li, H., Li, Y., & Zhou, L. 2010. FDI spillovers in an emerging market: The role of foreign firms' country origin diversity and domestic firms' absorptive capacity. *Strategic Management Journal*, 31(9): 969-989.

- Zhao, F., & Tian, Z. 1995. *The History of China Light Vehicle Industry* (Eds.) China Machine Press: Beijing. (In Chinese)
- Zhao, M. 2006. Conducting R&D in countries with weak intellectual property rights protection. *Management Science*, 52(8): 1185-1199.
- Zhou, D., Li, S., Tse, D. 2002. The impact of FDI on the productivity of domestic firms: The case of China. *International Business Review*, 11(4): 465-484.
- Zukowska-Gagelmann, K. 2000. Productivity spillovers from foreign direct investment in Poland. *Economic Systems*, 24(3): 223-256.

Table 1. Summary of Recent Representative Empirical Studies

Paper	Focus	Level of analysis	Country (subjects)	Data Used	Main findings
Aitken and Harrison (1999)	Intra-industry	Firm	Venezuela manufacturing sectors	Plant-level Panel data (1979-89, excluding 1980)	Positive on small FDI recipient plants but negative on indigenous plants, the net impact of FDI is quite small
Blomstrom and Persson (1983)	Intra-industry	Industry	Mexico Manufacturing sectors	Industry-level (1970)	Positive spillovers of technical efficiency between indigenous plants and the foreign participation of various industries
Buckley, Clegg, and Wang (2002)	Intra-industry	Industry	China	130 industry level data in 1995 in China	overall positive although the effect size are different in terms of sources of capital and ownership type of indigenous firms
Buckley, Clegg, Zheng, Siler, and Giorgioni (2007)	Intra-industry	Sub-industry	China automotive industry	five Sub-sector level in China automobile industry (1995-1999)	positive for FES modeling
Bwalya (2006)	Forward/backward linkages	Firm	Zambian manufacturing	125 firms (1993-1995)	Positive effects through backward linkages; no effects through forward linkages
Caves (1974)	Intra-industry	Industry	Canada and Australia Manufacturing sectors	Industry-level (1965-67 for; Canada and 1962, 1966 for Australia)	lagged FDI positively affected value-added per worker in indigenous firms while changes in FDI had a negative impact

Table 1. Summary of Recent Representative Empirical Studies (Cont'd)

Paper	Focus	Level of analysis	Country (subjects)	Data Used	Main findings
Djankov and Hoekman (2000)	Intra-industry	Firm	Czech Republic	Firm-level (1992-1996)	Positive on TFP growth of FDI recipient firms but negative on firms that do not have foreign partnerships.
Egger and Pfaffermayr (2001)	Intra-industry	Industry	Austria Manufacturing sectors	Panel data (1981-94)	positive impact on general and labor-augmenting productivity
Girma, Greenaway, and Wakelin (2001)	Intra-industry	Firm	UK Manufacturing sector	Firm-level panel data (1991-1996)	higher productivity of foreign firms raise aggregate productivity but on average no productivity spillovers to indigenous firms.
Globerman (1979)	Intra-industry	Firm	Canada Manufacturing sectors	Plant-level (1972)	Negative relationship between FDI and indigenous firm labor productivity because of any positive spillovers may be offset by the negative impact of greater competition.
Gorg and Strobl (2005)	Movement of human capital	Firm	Ghana manufacturing firms	1991-1997	Positive

Table 1. Summary of Recent Representative Empirical Studies (Cont'd)

Paper	Focus	Level of analysis	Country (subjects)	Data Used	Main findings
Haddad and Harrison (1993)	Intra-industry	Firm	Moroccan manufacturing sectors	Firm-level (1985-89)	The dispersion of productivity is smaller in the sectors with more foreign firms. No evidence of FDI accelerated productivity growth or technology spillovers in indigenous firms.
Hale and Long (2006)	Movement of human capital	Firm	China	1,500 firms in 2000	Positive
Javorcik (2004)	Forward/backward linkages	Firm	Lithuania	4000 Firm-level (1999)	Positive effects through backward linkages; no effects through forward linkages
Javorcik and Spatareanu (2008)	Forward/backward linkages	Firm	Romania	13,129 firms (1998-2003)	Positive effects through backward linkages but for wholly owned foreign firms no effect)
Kholy (1995)	Intra-industry	Industry	Mexico, Brazil, Chile, Singapore, and Zambia Manufacturing sector	Industry-level (1970-90)	No evidence of spillover efficiency as defined by higher labor productivity and capital formation in the host developing countries merely as a result of the presence of FDI
Kokko (1994)	Intra-industry	Industry	Mexico Manufacturing sectors	industry-level (1970)	positive spillovers from competition between indigenous firms and foreign affiliates but excludes suspected "enclaves"

Table 1. Summary of Recent Representative Empirical Studies (Cont'd)

Paper	Focus	Level of analysis	Country (subjects)	Data Used	Main findings
Kokko, Tansini, and Zejan (1996)	Intra-industry	Firm	Uruguayan manufacturing industries	Plant-level (1988)	positive in the sub-sample of plants with moderate technology gaps with foreign firms
Kugler (2006)	Forward/backward linkages	Firm	Colombian manufacturing plants	All plants (1974-1998)	Positive effects through backward linkages; no effects through forward linkages
Markusen and Trofimenko (2007)	Movement of human capital	Firm	Colombia	Manufacturing establishments (1977-91)	Positive
Poole (2007)	Movement of human capital	Firm	Brazil	Formal sector workers in Brazil (1996-2001)	Positive
Schoors and van der Tol (2001)	Forward/backward linkages	Firm	Hungary	1,084 firms (1997-1998)	Positive effects through backward linkages; negative effects through forward linkages
Zhou, Li, & Tse (2002)	Intra-industry	Firm	China Manufacturing sectors	Firm-level (1992-1995)	Indigenous firms in regions that attract more FDI or have a longer history of FDI tend to have higher productivity while indigenous firms in industries that have more FDI or have a longer history of FDI tend to have lower productivity
Zukowska-Gagelmann (2000)	Intra-industry	Firm	Poland Manufacturing sectors	Firm-level (1993-97)	Higher foreign presence in an industry affects indigenous firms negatively while positive impact on performance of the whole domestic industry including foreign firms

Table 2. China Major Car Makers and Sales in 2008 (All Cars/Trucks)¹

Car Maker	Year Established in China	Sales Volume (Unit cars)	Car Maker	Year Est. in China	Sales Volume (Unit cars)
Shanghai-GM-Wuling*	2002	650508	FAW-Toyota*	1998	370858
FAW-Volkswagen*	1991	498958	Chery	1997	356093
Shanghai-Volkswagen*	1985	490087	Dongfeng-Nissan*	2003	350520
Dongfeng Motor	1969	485983	Guangzhou-Honda*	1998	306230
Shanghai-GM*	1997	444756	Beijing-Hyundai*	2002	294506
Beijing-Foton	1996	409563	FAW	1953	270719
Chang'an Alto	1996	378866	Jinbei Auto	1958	250051

Note: “*” marked carmakers are international joint ventures. Others are indigenous makers.

¹ Including passenger cars and commercial cars. The source of sales data from: http://auto.sohu.com/20090123/n261879189_1.shtml The year of establishment came from each firm's official website.

Table 3. Major Variables and Measures

Variable	Name	Operationalization	Measurement	Source	Notes
Presence of foreign carmakers	PRESENCE	The technological activities of foreign invested carmakers	Accumulated number of units produced/100,000 in foreign invested passenger carmakers	CAIY	State level (aggregated)
Lobar Productivity	LABPROD		Value added divided by number of employees (year based and 1990 constant price adjusted) (in 1000 CNY)	CAIY	Firm level
Innovation	INNOVATION	The firm's share of "invention" type of patent in China patenting system	Patent share within same category for current and next two years	China Patent Data System	Firm level
Market Growth	MKTGROW	The growth of the firm's market (sales income)	The ratio of current sales to that of previous year minus one	CAIY	Firm level
Length of entry of FIE	FDIENTRY	The length of entry of pioneering foreign invested carmakers	1983 as the base year	CAIY	State level
IJV Partnership (dummy variable)	IJVPARTNER		Set to 1 if the indigenous carmaker is partner of an international joint ventured firm and 0 for else	CAIY	Firm level
Supply relationship with foreign invested carmakers	FDISUPPLIER		Set to 1 if the firm is in the supply network of FIEs and 0 for else.	CAIY	Firm level

Table 3. Major Variables and Measures (Cont'd)

Variable	Name	Operationalization	Measurement	Source	Notes
Local Content Ratio	LCR		The total types of parts and components produced by indigenous suppliers on the cars made in foreign invested carmakers divided by all types of parts and components defined in CAIY in the year	CAIY	State level (industry level)
Share of Suppliers	OVERLAP	The ratio of the indigenous carmaker's supplies that are/were made in IJV suppliers in engine and drivetrain categories.	The units of parts/components produced in IJV contracted (currently or formerly) suppliers divided by the total units of supplies of the indigenous carmaker	CAIY	Firm level
Ratio of suppliers from the same locations as the suppliers of foreign invested carmakers	COMMLOCAT	The ratio of the indigenous carmaker's supplies that are/were NOT made in IJV suppliers but in those suppliers within the same location as those IJV suppliers in engine and drivetrain categories.	The units of part/components that are produced in Non-IJV suppliers who are located in the same location (city level) as those suppliers who are a part of FIE supply network producing same products.	CAIY	Firm-level
Absorptive Capacity	ABCAP	Number of technology transfers through trade with foreign firms	Number of events of international transactions on equipment and technologies in previous ten years.		
Capability Accumulation	TECHACCUM	The productive activities before 1984	Total units of production of light Vehicles before 1984 (in 1000 units).	History of China Light Vehicle Industry	Firm-level

Table 3. Major Variables and Measures (Cont'd)

Variable	Name	Operationalization	Measurement	Source	Notes
Supplier FDI Capital Stock	SUPPFDI		Cumulated stock of FDI in supplier sectors (in million USD)	CAIY ; China Statistic Yearbook	State level
Number of FIEs in same supply category	SUPPFIENO		The number of foreign invested firms in the same supply category		
Ownership (Dummy variable)	OWNERSHIP		Set to 1 if state-owned or collective owned, 0 for else.		Firm level
Region dummies (5 variables)	REGION1, REGION2, REGION3, REGION4, REGION5		Traditional 6 regions of China (Dongbei, Huabei, Huadong, Huanan, Xinan, Xibei)		
Number of employees	EMPLOYEE		No. of employees at the year end	CAIY	Firm-level
Total assets	ASSETS		Total assets at the yearend (in 10000 CNY, 1990 constant price)	CAIY	Firm-level
Market size	MARKET	GDP per capita	[(GDP/population)*1000]/10000 (1990 constant price)	China Statistic Yearbook	State level
Policy dummies (2 variables)	POLICY_94 POLICY_00		Policy_94: set to 1 after year 1994, to 0 for else; Policy_00: set to 1 after year 2000, to 0 for else		

Table 4. Datasets and Variables Included in Hypothesis Testing

Hypothesis	Dataset	Dependent Variable	Independent variables
H1a, H1b	Firm level, all indigenous carmakers; ranging from 1985-1995	LABPROD; INNOVATION; MKTGROW	PRESENCE; LCR; IJVPARTNER; SUPPFDI; EMPLOYEE; ASSETS; MARKET; POLICY_94; POLICY_00; OWNERSHIP; REGIONAL DUMMIES
H2a, H2b	Firm level, indigenous supplier firms in engine and drivetrain related parts and components production	LABPROD; INNOVATION	PRESENCE; LCR; FDISUPPLIER; SUPPFINO; EMPLOYEE; ASSETS; MARKET; POLICY_94; POLICY_00; OWNERSHIP; REGIONAL DUMMIES; CATEGORY DUMMY
H3, H4a, H4b	Firm level, all indigenous carmakers	LABPROD; INNOVATION; MKTGROW	PRESENCE; OVERLAP; COMMLOCAT; IJVPARTNER; SUPPFDI; EMPLOYEE; ASSETS; MARKET; POLICY_94; POLICY_00; OWNERSHIP; REGIONAL DUMMIES
H5a, H5b	Firm level, all indigenous carmakers, ranging from 1992-2008	LABPROD; INNOVATION; MKTGROW	PRESENCE; TECHACCUM; ABCAP; IJVPARTNER; SUPPFDI; EMPLOYEE; ASSETS; MARKET; POLICY_94; POLICY_00; OWNERSHIP; REGIONAL DUMMIES
H6	Firm level, all indigenous carmakers	LABPROD; INNOVATION; MKTGROW	PRESENCE; FDIENTRY; IJVPARTNER; SUPPFDI; EMPLOYEE; ASSETS; MARKET; POLICY_94; POLICY_00; OWNERSHIP; REGIONAL DUMMIES

Table 5a. Descriptive Analysis: A List of Indigenous Carmakers

Firm Name	IJV partner (Yes or No)	Available # of Observations in Data Sources
FAW Hongta Yunnan Auto Manufacturing Co.	N	10
FAW Car Co.	Y	18
Shanghai Jiangling International Co.	N	2
Shanghai Auto Industrial Co. (Group) (SAIC)	Y	25
Dongfeng Liuzhou Auto Co.	N	18
Dongfeng Motor Co.	Y	24
Dongfeng Yu'an Vehicle Co.	N	12
China First Automobile Works Co. (FAW)	Y	25
Zhongshun Auto Holding (Shenyang) Co.	N	10
Dandong Huanghai Auto Co.	N	12
Beijing Auto Manufacturing Co. (BAIC)	Y	22
Beijing Yanjing Auto Works	N	15
Brilliance Auto Group Co. (Zhonghua Brand)	Y	18
Brilliance Jinbei Auto Co.	N	22
Nanjing Auto Industrial Group Co (NAIC)	Y	20
Jilin Tongtian Auto Co.	N	8
Hafei Auto Co.	N	23
Sichuan Auto Industrial Group Co.	Y	25
TAIC Meiya Auto Manufacturing Co.	N	16
TAIC-FAW Xiali Co.	Y	16
Tianjian Automobile Industrial Group Co. (TAIC)	Y	21
Chery Auto Co.	N	18

Table 5a. Descriptive Analysis: A List of Indigenous Carmakers (Cont'd)

Firm Name	IJV partner (Yes or No)	Available # of Observations in Data Sources
Anhui Jianhuai Auto Co.	N	15
Shandong Heibao Group Co.	N	16
Guangzhou Jing'an Yunbao Auto Co.	N	3
Guangzhou Longbao Auto Industrial Co.	N	4
Guangzhou Yangcheng Auto Co.	N	3
Guangzhou Cars Co.	Y	23
Qingling Auto Group Co.	N	19
Chengdu Xindadi Auto Co.	N	9
Changhe Aircraft Industrial Group Co.	N	22
Songliao Auto Co.	N	12
Liuzhou Wuling Auto Co.	Y	24
BYD Auto Co.	N	25
Jiangsu Yaxing Bus Group Co.	Y	6
Jiangxi Huaxiang Fuqi Auto Co.	N	8
Jiangxi Changhe Auto Co.	N	13
Jiangxi Jiangling Auto Holding Co.	Y	20
FAW Huali (Tianjin) Auto Co.	N	11
Shenyang Aircraft Industrial Group Co.	N	22
Hebei Zhongxing Auto Manufacturing Co.	N	12
Hebei Tianye Auto Group Co.	N	8
Hebei Hongxing Auto Manufacturing Co.	N	6
Hebei Chang'an Auto Co.	N	7

Table 5a. Descriptive Analysis: A List of Indigenous Carmakers (Cont'd)

Firm Name	IJV partner (Yes or No)	Available # of Observations in Data Sources
Zhejiang Geely Holding Group Co.	N	15
Zhejiang Ji'ao Auto Co.	N	8
Zhejiang Feidie Bus Manufacturing Co.	N	5
Hunan Jiangnan Auto Manufacturing Co.	N	21
Hunan Auto Manufacturing Co.	N	8
Hunan Auto Chassis Factory	N	7
Hunan Sanxiang Bus Group Co.	N	5
Fujian Bamin Auto Factory	N	5
Wuhu FAW Yangtze Auto Manufacturing Co.	N	13
Hawtai Motor Group Co.	N	12
Guizhou Youth Skylark Auto Co.	N	15
Zhengzhou Yutong Group Co.	N	10
Chongqing Lifan Cars Co.	N	12
Chongqing Chang'an Auto Co.	Y	20
Changfeng (Group) Co.	Y	21
Greatwall Auto Co.	N	15
Beijing Foton Auto Co.	N	8

Table 5b: Descriptive Analysis: A List of Foreign Carmakers (IJVs)

Name of FDI company	Foreign Parent (s)	Indigenous Partner(s)	Year Established
Tianjin Faw Toyota Motor Co.	Toyota	FAW, TAIC Xiali,	2000
FAW-Toyota Motor Co.	Toyota	FAW	1998
FAW-Volkswagen Auto Co.	Volkswagen	FAW	1991
SAIC-GM-Wuling Auto Co.	General Motor	SAIC, Liuzhou Wuling	2002
Shanghai-Volkswagen Auto Co.	Volkswagen	SAIC	1985
Shanghai-GM Auto Co.	General Motor	SAIC	1997
Southeast (Fujian) Auto Industrial Co.	Yulong (Taiwan), Mitsubishi	Fujian Southeast Auto Group	1995
Dongfeng Yueda Kia Auto Co.	KIA	Dongfeng Auto, Jiangsu Yueda	2002
Dongfeng Toyota Motor Co.	Honda	Dongfeng Motor	2003
Beijing Jeep Auto Co.	Jeep (Chrysler)	BAIC	1983
Beijing Benz-Daimler-Chrysler Auto Co.	Daimler, Chrysler, Mercedes Benz	BAIC	2005
Beijing-Hyundai Auto Co.	Hyundai	BAIC	2002
Brilliance BMW Auto Co.	BMW	Brilliance Auto	2003
Guangzhou Honda Motor Co.	Honda	Guangzhou Auto (GAIG)	1998

Table 5b: Descriptive Analysis: A List of Foreign Carmakers (IJVs) (Cont'd)

Name of FDI company	Foreign Parent (s)	Indigenous Partner(s)	Year Established
Guangzhou Peugeot Auto Co.	Peugeot	Guangzhou Auto (GAIG)	1985
Guangzhou Fengshen Auto Co.	Yulong (Taiwan, owned by Nissan)	Dongfeng Auto	2000
Guangqi-Toyota Motor Co.	Toyota	GAIG	2004
Jiangling Auto Co.	Ford	Jiangling Holding (by Jiangling & Chang'an)	1995
Shenglong Auto Co.	PSV (France)	Dongfeng Motor	1992
Zhengzhou Nissan Motor Co.	Nissan	Dongfeng Motor	1993
Chang'an Ford Mazda Motor Co.	Ford, Mazda	Chang'an Auto	2001
Chongqing Chang'an Suzuki Motor Co.	Suzuki	Chang'an Auto	1993
Guangqi-Changfeng Auto Manufacturing Co.	Mitsubishi	GAIG, Changfeng Auto	1996
Honda Motor (China) Co.	Honda	Dongfeng Motor	2003

Table 6. Correlation Matrix for Major Variables

	LABPROD	INNOVATIO N	MKTGRO W	LCR	OVERLAP	COMMLOCAT	ABCAP
INNOVATION	.529**						
MKTGROW	.478**	.526**					
LCR	.065	.056	.057				
OVERLAP	.257**	.277**	.177**	.389**			
COMMLOCAT	.185**	.255**	.077*	-.059	.599**		
ABCAP	.136**	.192**	.052	-.063	.637**	.153*	
TECHACCUM	.129**	.193**	.042	-.037	.406**	.043	.427**

Notes: **: Correlation is significant at the 0.01 level (2-tailed); *: Correlation is significant at the 0.05 level (2-tailed)

Table 7. Results

	H1a; H1b: Indigenous Carmaker (firm-level) (1 year lag) (1985-1995)			H2a; H2b: Indigenous Supplier Firm (1 year lag)	
Dependent Variables	LABPROD	INNOVATIO N	MKTGROW	LABPROD	INNOVATION
Independent Variables					
PRESENCE	-.084*	-.0031*	-.023*	.106**	.003
LABPROD(t-1)	.590***			.405***	
LCR	-1.602*	-.105	-.168	.089*	.002
LCR*PRESENCE	-.243*	-.001	-.146**		
FDISUPPLIER				3.197***	.026*
FDISUPPLIER*PRESENCE				.091**	.004
IJVPARTNER	-1.408	-.051**	-.015		
SUPPFDI	0.236	-.001	-.003		
SUPPFIENO				.0002*	-.001
EMPLOYEE	.0003	.001**	-.006**	.012***	.002**
ASSETS	.0004**	-.002	-.001*	.021**	.001*
MARKET	.022*	.074*	.009**	.027**	.025**
POLICY_94	.021	.007	.003	.005*	.010*
POLICY_00				1.49*	.022*
OWNERSHIP	.024	-.006	.003	-.105	-.092*
Total observations*	221	221	204	4543	4461
Adjusted R Square	.640***	.526***	.607***	.679***	.498***

Note: 1) †: $P < .1$, *: $P < .05$, **: $P < .01$, ***: $P < .001$. 2) Control variables not reported: Dummy variables for parts and component categories and dummy variables for geographic regions; 3) Total observations refer to the total number of observations used in the model. It is equal to number of years multiplied by number of subjects (firms). As the dataset contains unbalanced data, not all firms' data are available for all years.

Table 7. Results (Cont'd)

	H3; H4a; H4b Indigenous Carmaker (firm-level) (1 year lag)			H5a; H5b Indigenous Carmaker (firm-level) (1 year lag)		
Dependent Variables	LABPROD	INNOVATION	MKTGROW	LABPROD	INNOVATION	MKTGROW
Independent Variables						
PRESENCE	-.148*	.006	.002*	-.124	.003	-.001
TECHACCUM				.093*	.0034**	.0027*
PRESENCE*TECHACCUM				.0023*	.0004*	.0002†
LABPROD(t-1)	.524**			.367**		
ABCAP				.532*	.013**	.029**
PRESENCE*ABCAP				.013	.0023*	.001
OVERLAP	3.793***	.375**	.025**			
COMMLOCAT	0.798	0.294*	.010*			
IJVPARTNER	.021	-.001	-.005	.102	-.009	-.019*
SUPPFDI	.237*	-.030*	.006*	.176*	.003	.004*
EMPLOYEE	.004*	.0002*	.003*	.002**	.001	.001
ASSETS	.0002*	.0001*	.023**	.001*	.0001*	.000*
MARKET	.042**	.004*	.001	.016*	.002*	.003**
POLICY_94	.674*	.036*	-.002	.277*	.022*	.024*
POLICY_00	1.430*	.002	.014*	2.011**	.030**	.028**
OWNERSHIP	.103*	.004	.002	.492**	.002	-.001
Total observations*	464	353	390	206	201	190
Adjusted R Square	.732***	.544***	.529***	.719***	.505***	.476**

Note: 1) †: $P < .1$, *: $P < .05$, **: $P < .01$, ***: $P < .001$. 2) Control variables not reported: Dummy variables for parts and component categories and dummy variables for geographic regions; 3) Total observations refer to the total number of observations used in the model. It is equal to number of years multiplied by number of subjects (firms). As the dataset contains unbalanced data, not all firms' data are available for all years.

Table 7. Results (Cont'd)

	H6: Indigenous Carmaker (firm-level) (1 year lag)						
Dependent Variables	LABPROD			INNOVATION			MKTGROW
Independent Variables	Model 1a	Model 1b	Model 2a	Model 2b	Model 3a	Model 3b	
PRESENCE	-.134**	-.161***	-.0018	-.0015**	-.098*	-.105*	
FDIENTRY	.272***	.162**	.0005*	.0001	.036**	.021*	
PRESENCE*FDIENTRY_sq		.00067		.00017†		.0040**	
LABPROD(t-1)	.644**	.723**					
IIVPARTNER	1.02	2.120*	-.001	.001	-.030	-.027	
SUPPFDI	.478	0.423	.000	-.0002	.004	.003	
EMPLOYEE	.0040**	.0032**	.002**	.000*	.000*	.000*	
ASSETS	.0004*	.0004*	.001*	-.000	.000	.000	
MARKET	.046*	.048*	.0001*	.0001*	.021**	.011*	
POLICY_94	.350*	.375*	.003*	.004*	.045*	.078*	
POLICY_00	.470*	.430*	.003*	.002*	.050**	.044**	
OWNERSHIP	-.003	-.004	-.000	-.000	-.005	-.006	
Total observations*	424	424	308	308	416	416	
Adjusted R Square	.659***	.654***	.585***	.597***	.554***	.603***	
Sig. R-Square Change	n.s.		p<0.1		p<0.01		

Note: 1) †: P<= .1, *: P<= .05, **: P<= .01, ***: P<= .001. 2) Control variables not reported: Dummy variables for parts and component categories and dummy variables for geographic regions; 3) Total observations refer to the total number of observations used in the model. It is equal to number of years multiplied by number of subjects (firms). As the dataset contains unbalanced data, not all firms' data are available for all years.

Table 8: Robustness Check Using Different Measure for FDI Presence

Model A: Unit of production as measure Model B: Number of new models as measure	H1a; H1b:		H2a; H2b		H3; H4a; H4b		H5a; H5b		H6	
	A	B	A	B	A	B	A	B	A	B
Dependent Variables: INNOVATION										
Independent Variables										
PRESENCE	-.0031*	-.145	.003	.207*	.006	.106	.003	.302	-.0015**	-.018
LCR	-.105	.203	.002	.016						
LCR*PRESENCE	-.001	-.451								
FDISUPPLIER			.026*	.030*						
FDISUPPLIER*PRESENCE			.004	.109						
IJVPARTNER					-.001	-.031				
TECHACCUM							.0034**	.002*		
PRESENCE*TECHACCUM							.0004*	.130		
ABCAP							.013**	.022*		
PRESENCE*ABCAP							.0023*	.042		
OVERLAP					.375**	.249*				
COMMLOCAT					0.294*	.187				
FDIENTRY									.0001	.0001
PRESENCE*FDIENTRY_sq									.00017†	.137

Figure 1a. Illustration on Net Effect (Strong-Strong Interaction)

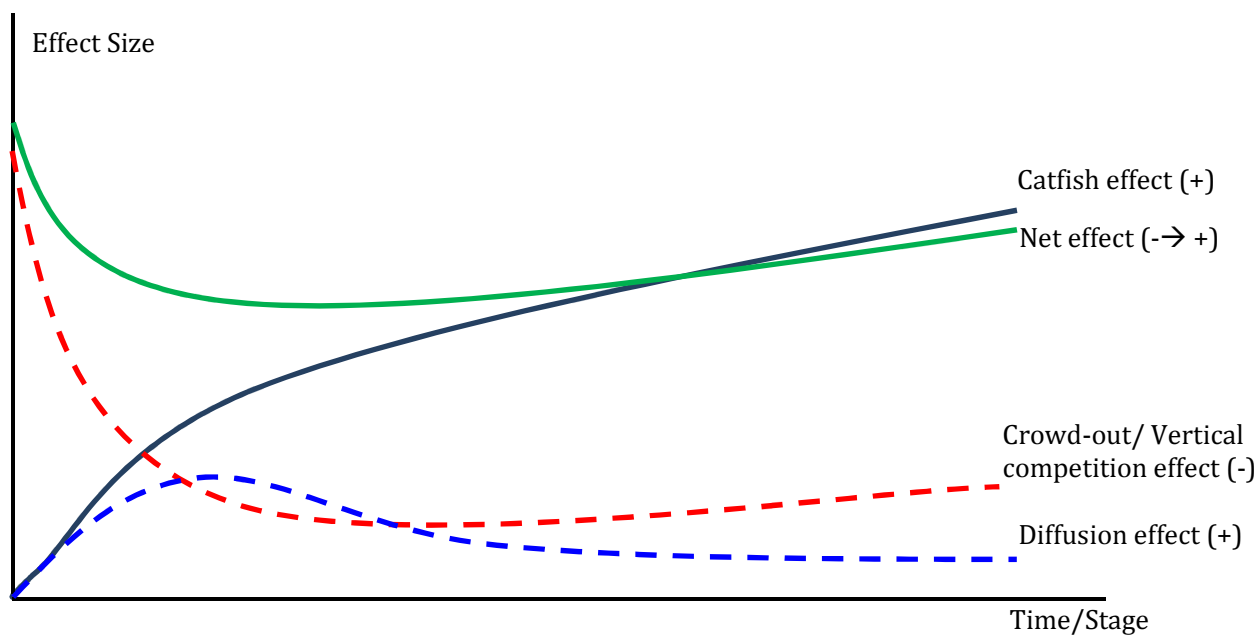


Figure 1b. Illustration on Net Effect (Strong-Weak Interaction with Catching-up)

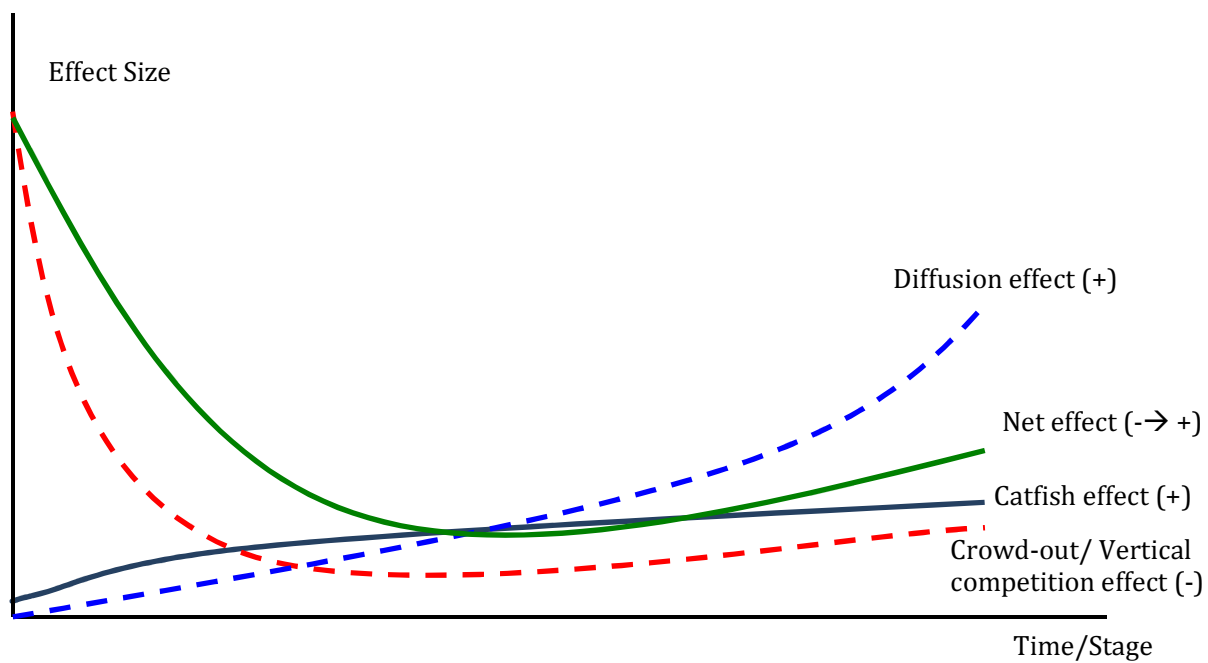


Figure 1c. Illustration on Net Effect (Strong-Weak Interaction with Driving-out)

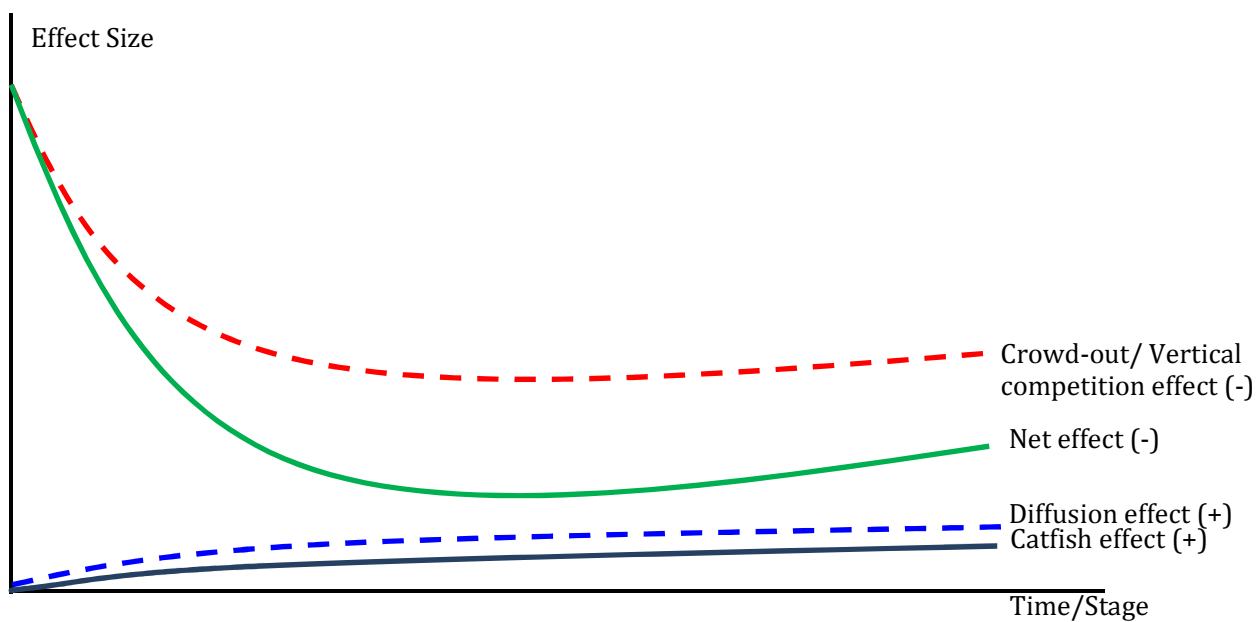
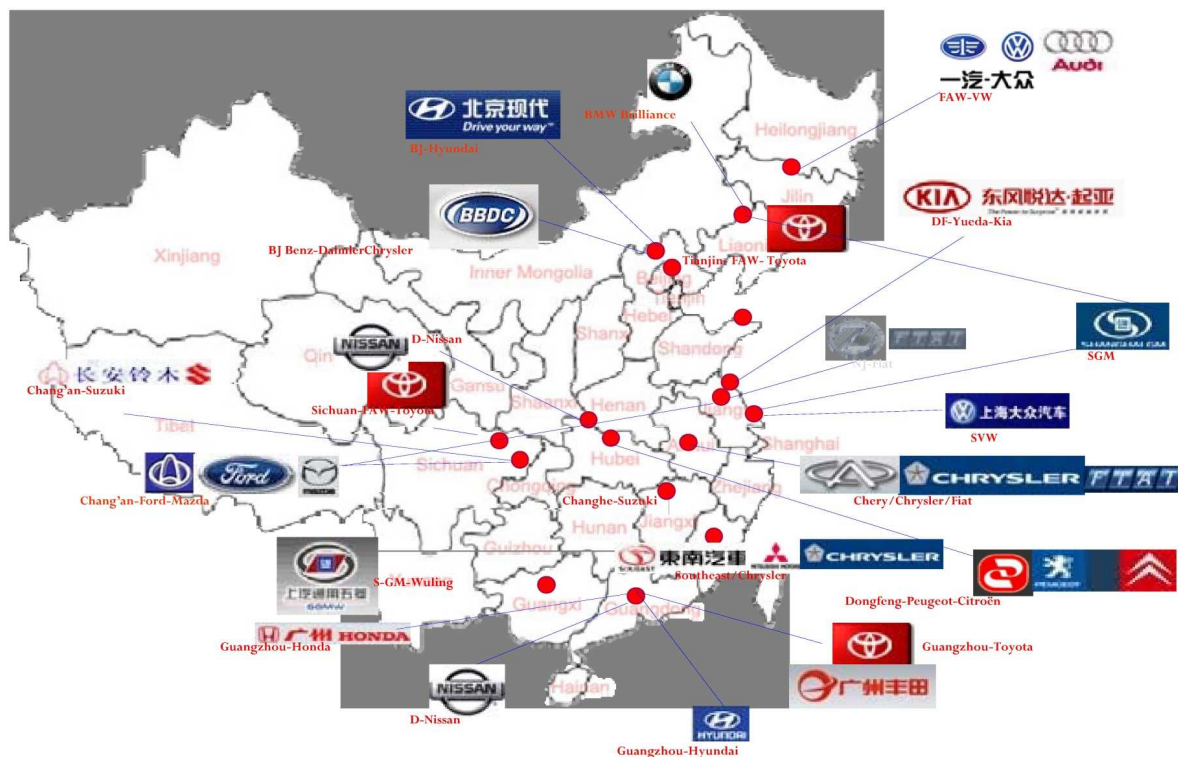
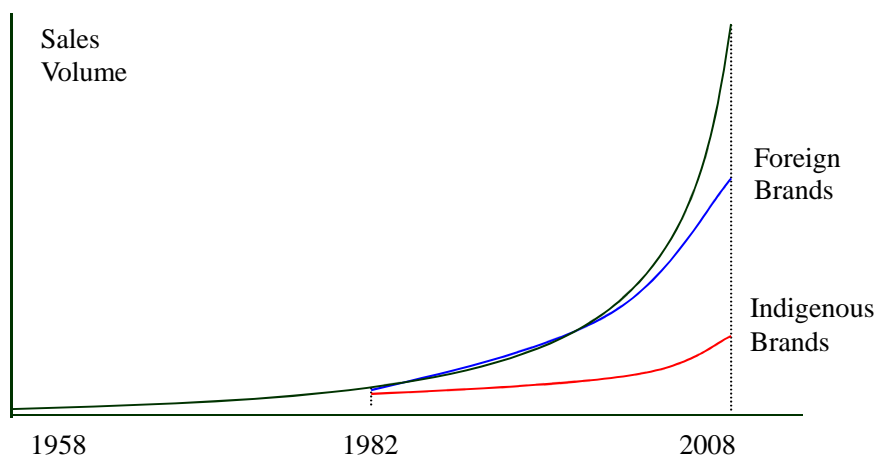


Figure 2a. Foreign Passenger Carmakers in China



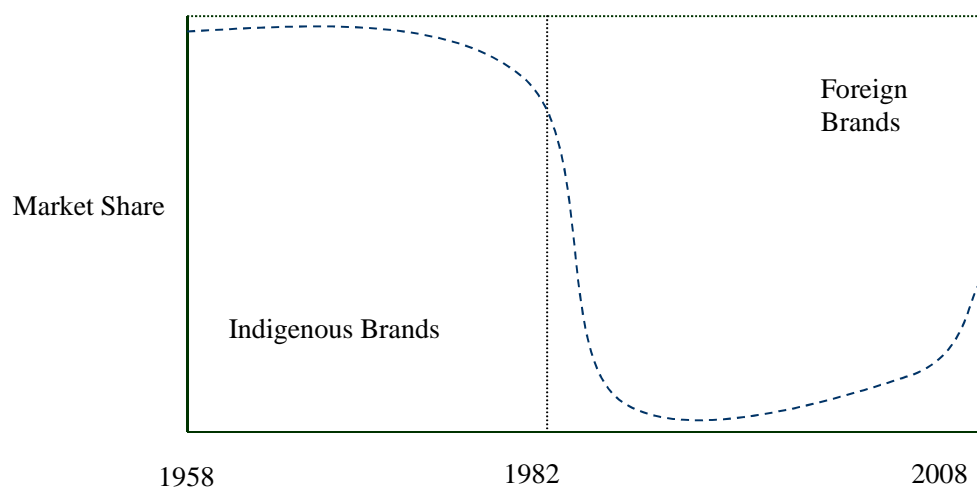
Source: China's Emerging Auto Market. 2008. China Business Update.

Figure 3a. The growth of the global and indigenous carmakers



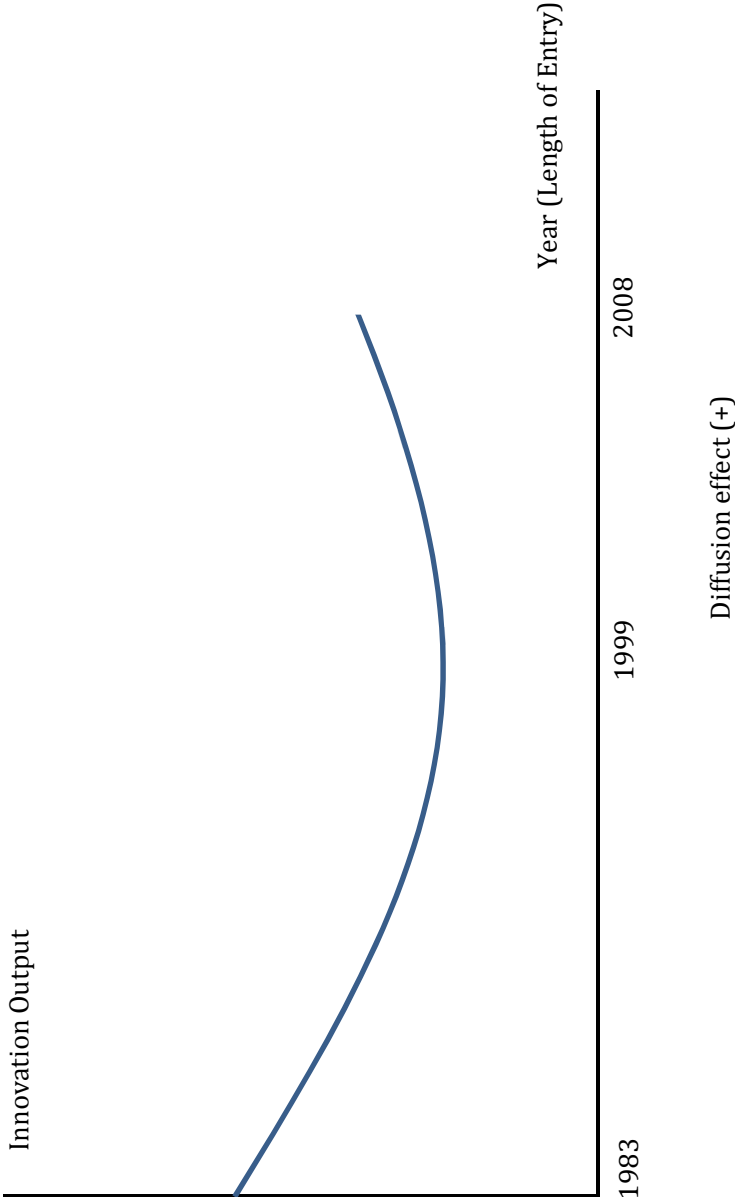
Note: This figure only illustrates the trend and was not drawn from actual data.

Figure 3b. The market shares of the global and indigenous carmakers



Note: This figure only illustrates the trend and was not drawn from actual data.

Figure 5: An Illustration of Net Effect of FDI in China Passenger Car Industry



Appendix: Company Name Abbreviations

Abbreviation	Name	Abbreviation	Name
FAW	First Auto Works Group	GM	General Motor
GAIG	Guangzhou Auto Industrial Group	TFTM	Tianjin FAW Toyota Motor
SAIC	Shanghai Auto Industrial Company	CAIY	China Automobile Industry Yearbook
NAIC	Nanjing Auto Industrial Company	FAW-VW	FAW-Volkswagen
SHVW	Shanghai-Volkswagen		

Curriculum Vitae

Name:

Shengsheng Huang, “Charlie”

Date of Birth:

October, 26, 1974

Place of Birth:

Tongcheng, Anhui, China

Education:

1988-1991 Tongcheng High School, Anhui, China

1991-1995 BA in Economics, School of Business, Nanjing University, China

2003-2005 Mphil in Business, Lingnan University, Hong Kong SAR

Professional Experience:

1995-2003 Copywriter, Planning Director, and later Consultant for firms with different ownerships and industries