

**Subsidiary Innovation and Diffusion:
An Integrated Approach on
Learning of Subsidiaries from Diverse Local Environments**

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(ABSTRACT)

This dissertation investigates the factors that influence the learning of subsidiaries from their local environment and the sequential knowledge outflow from the subsidiaries. Scholars have recognized the ability to learn from diverse local environments as a critical source of competitive advantage for multinational corporations (MNCs). However, the factors influencing the extent to which MNCs learn from local environments in order to develop innovative capabilities have not been well understood.

Considering the complexity of institutional environments faced by subsidiaries, this dissertation explores cross-level factors that influence subsidiary learning from diverse local environments. At interface levels, a subsidiary's local embeddedness and its learning strategy influence the awareness of local strategic knowledge by the subsidiary. At context levels, local market competition and corporate entrepreneurial culture affect the motivation of a subsidiary to learn from diverse local environments. Finally at subsidiary level, top management team heterogeneity impacts the capability of a subsidiary to learn.

This dissertation applies both qualitative and quantitative research methods. Multiple-case studies provide rich details, while survey research tests the generalizability of the proposed conceptual model. Overall, the empirical evidence supports the impact of local embeddedness, learning strategy and corporate entrepreneurial culture on subsidiary learning, and in turn, on knowledge outflow. The impact of top management team heterogeneity turns insignificant upon the simultaneous inclusion of all other factors. The influence of local competition is absent. The control variables include size, technology resources, and internationalization.

This dissertation contributes to both MNC and organizational learning literature. The major contribution to MNC literature is the advancement of the understanding of knowledge acquisition and creation of MNCs by learning from the local environment. The cross-level approach with subsidiary as the unit of analysis provides a unique perspective. The major contribution of this dissertation to organizational learning literature lies in the development of a learning framework, and its application to MNC context with empirical tests. This dissertation presents potentials to advance the local responsiveness-global integration framework with a knowledge-based view.

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To God,
who gives me life and gracious love
and to my parents,
who care so much about
my well-being and education.

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TABLE OF CONTENTS

| | |
|--|-----|
| CHAPTER 1 INTRODUCTION AND OVERVIEW OF RESEARCH | 1 |
| 1.1 MOTIVATION FOR THE RESEARCH..... | 1 |
| 1.2 RESEARCH QUESTIONS | 2 |
| 1.3 SUMMARY OF CONCEPTUAL MODEL | 2 |
| 1.4 SUMMARY OF EMPIRICAL RESULTS..... | 5 |
| 1.5 MAJOR CONTRIBUTIONS AND IMPLICATIONS | 5 |
| 1.6 STRUCTURE OF THE DISSERTATION..... | 8 |
| CHAPTER 2 LITERATURE REVIEW | 10 |
| 2.1 RESEARCH ON MULTINATIONAL CORPORATIONS (MNCs) | 10 |
| 2.1.1 <i>Evolution of the unit of analysis</i> | 10 |
| 2.1.2 <i>Subsidiary research review</i> | 16 |
| 2.1.3 <i>The gap in subsidiary innovation research</i> | 20 |
| 2.2 RESEARCH ON ORGANIZATIONAL LEARNING AND KNOWLEDGE-BASED VIEW | 22 |
| 2.3 RESEARCH ON ORGANIZATIONAL INNOVATIONS..... | 34 |
| 2.4 SUMMARY AND CONCLUSIONS | 43 |
| CHAPTER 3 A CONCEPTUAL FRAMEWORK AND HYPOTHESES..... | 45 |
| 3.1 LOCALIZED SUBSIDIARY INNOVATION..... | 46 |
| 3.2 LOCAL MARKET-SUBSIDIARY INTERFACE: LOCAL EMBEDDEDNESS..... | 48 |
| 3.3 MNC CORPORATE-SUBSIDIARY INTERFACE: LEARNING STRATEGY..... | 52 |
| 3.4 LOCAL CONTEXT: COMPETITION INTENSITY | 54 |
| 3.5 MNC CONTEXT: CORPORATE ENTREPRENEURIAL CULTURE..... | 56 |
| 3.6 SUBSIDIARY LEVEL: TOP MANAGEMENT TEAM HETEROGENEITY..... | 57 |
| 3.7 KNOWLEDGE OUTFLOW..... | 60 |
| 3.8 SUMMARY AND CONCLUSIONS | 63 |
| CHAPTER 4 MULTIPLE-CASE STUDIES | 66 |
| 4.1 INTRODUCTION..... | 66 |
| 4.2 LOCALIZED SUBSIDIARY INNOVATION: A PREVALENT PHENOMENON..... | 69 |
| 4.3 PHILIPS U.K. AND ITS TELETXT..... | 75 |
| 4.4 ACER AMERICA AND ASPIRE..... | 77 |
| 4.5 MOTOROLA IN CHINA..... | 80 |
| 4.5.1 <i>The mobile phone market in China</i> | 82 |
| 4.5.2 <i>Motorola in China</i> | 89 |
| 4.6 NOVOZYMES NORTH AMERICA, INC. | 99 |
| 4.6.1 <i>Global industrial enzyme market</i> | 101 |
| 4.6.2 <i>Innovations in Novozymes A/S</i> | 105 |
| 4.6.3 <i>Novozymes North America Inc. (Franklinton)</i> | 110 |

| | |
|--|-----|
| 4.7 CASE DISCUSSION AND CONCLUSIONS | 115 |
| 4.7.1 <i>Cross-case analysis</i> | 115 |
| 4.7.2 <i>Validation from foreign firms in the U.S. pharmaceutical industry</i> | 122 |
| 4.7.3 <i>Conclusions</i> | 128 |
| CHAPTER 5 SURVEY DESIGN AND METHODOLOGY | 131 |
| 5.1 INTRODUCTION..... | 131 |
| 5.2 SAMPLE SELECTION..... | 135 |
| 5.3 SURVEY DESIGN | 137 |
| 5.3.1 <i>Questionnaire construction and pretest</i> | 138 |
| 5.3.2 <i>Definition and operationalization of key constructs</i> | 141 |
| 5.3.3 <i>Self-administered questionnaires via mail</i> | 146 |
| 5.3.4 <i>Structural equation modeling</i> | 148 |
| 5.4 SURVEY IMPLEMENTATION | 148 |
| 5.5 SUMMARY AND CONCLUSIONS | 153 |
| CHAPTER 6 EMPIRICAL RESULTS | 154 |
| 6.1 SAMPLE ONE | 154 |
| 6.2 SAMPLE TWO..... | 159 |
| 6.2.1 <i>Descriptive sample statistics and exploratory factor analysis</i> | 162 |
| 6.2.2 <i>Measurement model</i> | 163 |
| 6.2.3 <i>Structure models</i> | 170 |
| 6.3 SUMMARY AND CONCLUSIONS | 176 |
| CHAPTER 7 DISCUSSION, IMPLICATIONS AND CONCLUSIONS..... | 178 |
| 7.1 INTRODUCTION..... | 178 |
| 7.2 SUMMARY AND DISCUSSION OF FINDINGS | 178 |
| 7.3 THEORETICAL CONTRIBUTIONS | 181 |
| 7.3.1 <i>Contribution to MNC literature</i> | 181 |
| 7.3.2 <i>Contribution to organizational learning and innovation literature</i> | 183 |
| 7.4 LIMITATIONS OF CURRENT RESEARCH | 186 |
| 7.5 IMPLICATIONS FOR FUTURE RESEARCH..... | 188 |
| 7.6 MANAGERIAL IMPLICATIONS..... | 190 |
| BIBLIOGRAPHY..... | 192 |
| APPENDIX..... | 207 |
| VITA..... | 216 |

LIST OF TABLES

| | |
|--|-----|
| TABLE 2-1 LITERATURE SUMMARY ON MNCs RESEARCH..... | 12 |
| TABLE 2-2 CLASSIFICATION OF MNC SUBSIDIARY RESEARCH | 18 |
| TABLE 2-3 LITERATURE SUMMARY ON ORGANIZATIONAL LEARNING AND KNOWLEDGE | 25 |
| TABLE 2-4 CLASSIFICATION OF RESEARCH ON ORGANIZATIONAL LEARNING AND KNOWLEDGE | 29 |
| TABLE 2-5 LITERATURE SUMMARY ON ORGANIZATIONAL INNOVATION | 37 |
| TABLE 2-6 CLASSIFICATION OF RESEARCH ON ORGANIZATIONAL INNOVATION..... | 41 |
| TABLE 3-1 SUMMARY TABLE OF HYPOTHESES | 65 |
| TABLE 4-1 ILLUSTRATIONS OF LOCALIZED SUBSIDIARY INNOVATION | 70 |
| TABLE 4-2 WITHIN-CASE SUMMARY – PHILIPS U.K..... | 78 |
| TABLE 4-3 WITHIN-CASE SUMMARY – ACER AMERICA | 81 |
| TABLE 4-4 WITHIN-CASE SUMMARY – MOTOROLA IN CHINA..... | 100 |
| TABLE 4-5 WITHIN-CASE SUMMARY – NOVOZYME NORTH AMERICA, INC. (NZNA)..... | 116 |
| TABLE 4-6 CROSS-CASE PATTERN SEARCHES | 118 |
| TABLE 4-7 SUMMARY OF THE MULTIPLE-CASE RESEARCH..... | 121 |
| TABLE 4-8 CONTENT ANALYSIS (HOFFMANN-LA ROCHE INC., 2000-2002)..... | 125 |
| TABLE 5-1 METHODOLOGY COMPARISON OF EMPIRICAL STUDIES RELATED TO THIS STUDY | 134 |
| TABLE 6-1 DESCRIPTIVE STATISTICS IN SAMPLE ONE | 155 |
| TABLE 6-2 CORRELATION TABLE OF SAMPLE ONE (SINGLE INDICATOR)..... | 156 |
| TABLE 6-3 CORRELATION TABLE OF SAMPLE ONE (MULTIPLE INDICATORS) | 160 |
| TABLE 6-4 DESCRIPTIVE STATISTICS AND EXPLORATORY FACTOR ANALYSIS IN SAMPLE TWO | 164 |
| TABLE 6-5 CORRELATION TABLE IN SAMPLE TWO..... | 165 |
| TABLE 6-6 INTERNAL CONSISTENCY AND DISCRIMINANT VALIDITY OF CONSTRUCTS | 168 |
| TABLE 6-7 PARAMETER ESTIMATES FOR THE MODERATOR | 169 |
| TABLE 6-8 SUMMARY TABLE OF RESULTS: THE PROPOSED MODEL | 171 |
| TABLE 6-9 CORRELATION OF SUMMATED VARIABLES IN SAMPLE TWO | 173 |
| TABLE 6-10 SUMMARY TABLE OF RESULTS: THE PARSIMONIOUS MODELS | 175 |
| TABLE 6-11 GRAND SUMMARY OF SUPPORT FOR HYPOTHESES..... | 177 |

LIST OF FIGURES

| | |
|---|-----|
| FIGURE 1-1 A CROSS-LEVEL INVESTIGATION ON SUBSIDIARY LEARNING | 3 |
| FIGURE 1-2 AN INTEGRATED MODEL OF SUBSIDIARY LEARNING FROM LOCAL ENVIRONMENTS ... | 4 |
| FIGURE 1-3 A PARSIMONIOUS MODEL OF SUBSIDIARY LEARNING FROM LOCAL ENVIRONMENTS . | 6 |
| FIGURE 1-4 THE RESEARCH PROCESS OF THIS DISSERTATION | 9 |
| FIGURE 3-1 MODERATION EFFECT OF INTER-SUBSIDIARY COMMUNICATION | 64 |
| FIGURE 4-1 THE RESEARCH PROCESS OF MULTIPLE-CASE STUDIES | 67 |
| FIGURE 4-2 MOBILE PHONE USERS IN CHINA, 1999-2002 | 83 |
| FIGURE 4-3 MARKET SHARE OF MOBILE PHONE MANUFACTURERS IN CHINA, 1999-2002..... | 84 |
| FIGURE 4-4 PRODUCTION AND EXPORT SHARE OF MOBILE PHONE MANUFACTURERS IN CHINA, 2002..... | 88 |
| FIGURE 4-5 LOCAL CONTENT OF PRODUCTS PRODUCED BY MOTOROLA CHINA | 98 |
| FIGURE 4-6 ROYALTIES AND LICENSE FEES RECEIPTS OF FOREIGN AFFILIATES..... | 123 |
| FIGURE 4-7 ASSETS OF FOREIGN AFFILIATES IN THE U.S. MANUFACTURING INDUSTRIES | 124 |
| FIGURE 4-8 FOREIGN R&D FACILITIES IN THE DRUG AND BIOTECHNOLOGY INDUSTRY | 127 |
| FIGURE 6-1 MODERATION EFFECT OF INTRA-UNIT COMMUNICATION | 158 |

Chapter 1 Introduction and Overview of Research

This dissertation studies the contextual factors that influence subsidiary learning from local environments and the sequential knowledge outflow from the subsidiaries. A subsidiary refers to “any operational unit controlled by multinational corporations (MNCs) and situated outside the home country” (Birkinshaw, Hood, and Jonsson, 1998: 224). The increasing importance of tapping into worldwide knowledge motivates this dissertation research. In this chapter, I will start to explain the motivation of this research in section one and explain the research questions in section two. Section three and four summarize the conceptual model proposed in this research and correspondent results. Section five highlights the major contributions and implications. The structure of this dissertation is explained at the end of this chapter.

1.1 Motivation for the research

The survival and success of multinational corporations (MNCs) increasingly depends on their ability to innovate and to exploit those innovations globally (Ghoshal and Bartlett, 1988; Cheng and Bolon, 1993; Subramaniam and Venkatraman, 2001; Zander, 1999; Pearce, 1999). Ghoshal (1987) highlighted the diversity of environments in which a MNC operates as a key asset for MNC to innovate and to learn. As knowledge is increasingly scattered around the globe, learning from local environments becomes strategically important for MNCs (Doz, Santos, and Williamson, 2001). In spite of this importance, there have been few studies that investigate the factors influencing the extent to which MNCs learn from local environments in order to develop innovative capabilities.

A key objective of MNCs is to develop shared learning (Ghoshal, 1987). The learning of subsidiaries from local environments has potentials to contribute both to subsidiary performance in the local market, and to the knowledge stock of the MNC corporate. Corresponding to the “global integration-local responsiveness” framework (Bartlett and Ghoshal, 1998), subsidiary

learning has potentials to increase local responsiveness by improving the understanding of local market. It has also potentials to contribute to global integration when other units of MNC can use the acquired knowledge. Thus the impact on knowledge outflow of subsidiary learning becomes particularly importance in strategic management of MNCs.

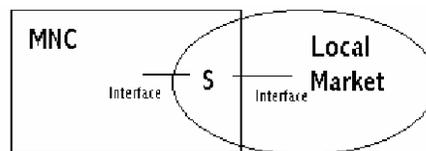
Thus, investigating the factors that influence the learning of a subsidiary from a local environments and subsequently transferring knowledge to the rest of the MNCs would have both research and managerial salience.

1.2 Research questions

This dissertation focuses on the following research questions: What factors influence the learning of MNCs' foreign subsidiaries from diverse local environments? To what extent can a subsidiary's learning from local environments impact its knowledge outflow to the rest of the MNCs? To investigate the research questions, this dissertation draws on perspectives from various research streams that relate to organizational learning and innovation in current literature: a knowledge-based view and organizational learning (Grant, 1996; Kogut and Zander, 1992; Huber, 1991; March, 1991), social network (Granovetter, 1973; Gulati, Nohria, and Zaheer, 2000), competition (Porter, 1980; Chen, 1996), top management team (Hambrick and Mason, 1984), and innovation and entrepreneurship (Cohen and Levinthal, 1990; Dougherty and Heller, 1994). The investigation from diverse theoretical perspectives can not only allow for an integrated inquiry into the research questions, but also present potentials to achieve a parsimonious understanding by empirical tests. The second research question involves the relationship between subsidiary learning and knowledge outflow. Knowledge outflow of subsidiary learning influences the extent to which the rest of the MNC can benefit from a subsidiary's learning from diverse local environments. It directly influences the ability of MNCs to gain leverage from their experience of market diversification (Ghoshal, 1987; Zander, 1998).

1.3 Summary of conceptual model

To address the first research question, this dissertation adopts the awareness-motivation-capability framework of organizational action (Chen, 1996; Lant, Milliken and Batra, 1992; Allison, 1971). It proposes that the awareness of local strategic knowledge, motivation to learn, and capability to learn determine a subsidiary's learning from diverse local environments. This dissertation investigates factors at three levels (or five sublevels) as antecedents for subsidiary learning. Those levels are: 1) subsidiary; 2) context, including both context of local market and MNC corporate; and finally, 3) interface levels, including both the interface between subsidiaries and local markets, and the interface between subsidiaries and the corporate MNC (Figure 1-1). Figure 1-2 depicts the conceptual model proposed in this dissertation. At the interface levels, a subsidiary's local inter-organization networks and its learning strategy influence the awareness of local strategic knowledge by the subsidiary. At the context levels, local market competition and corporate entrepreneurial culture affect the motivation of a subsidiary to learn from diverse local environments. Finally, at the level of a subsidiary, top management team diversity impacts the capability of a subsidiary to learn. Recognizing that subsidiaries are under the influence of both their parent MNCs and local environments (Rosenzweig and Singh, 1991), the proposed model reflects the complexity of environments faced by subsidiaries. The cross-level approach (Birkinshaw, Hood, and Jonsson, 1998) allows for a more integrated inquiry into the examination of the research question, but also prompts an investigation of the factors defined at different levels. Regarding knowledge outflow, I argue that subsidiary learning would increase its knowledge outflow to the rest of MNCs. Moreover, inter-subsidary communication would moderate the relationship between subsidiary learning and knowledge outflow.



Legend: "S" - Subsidiary

Figure 1-1 A Cross-Level Investigation On Subsidiary Learning

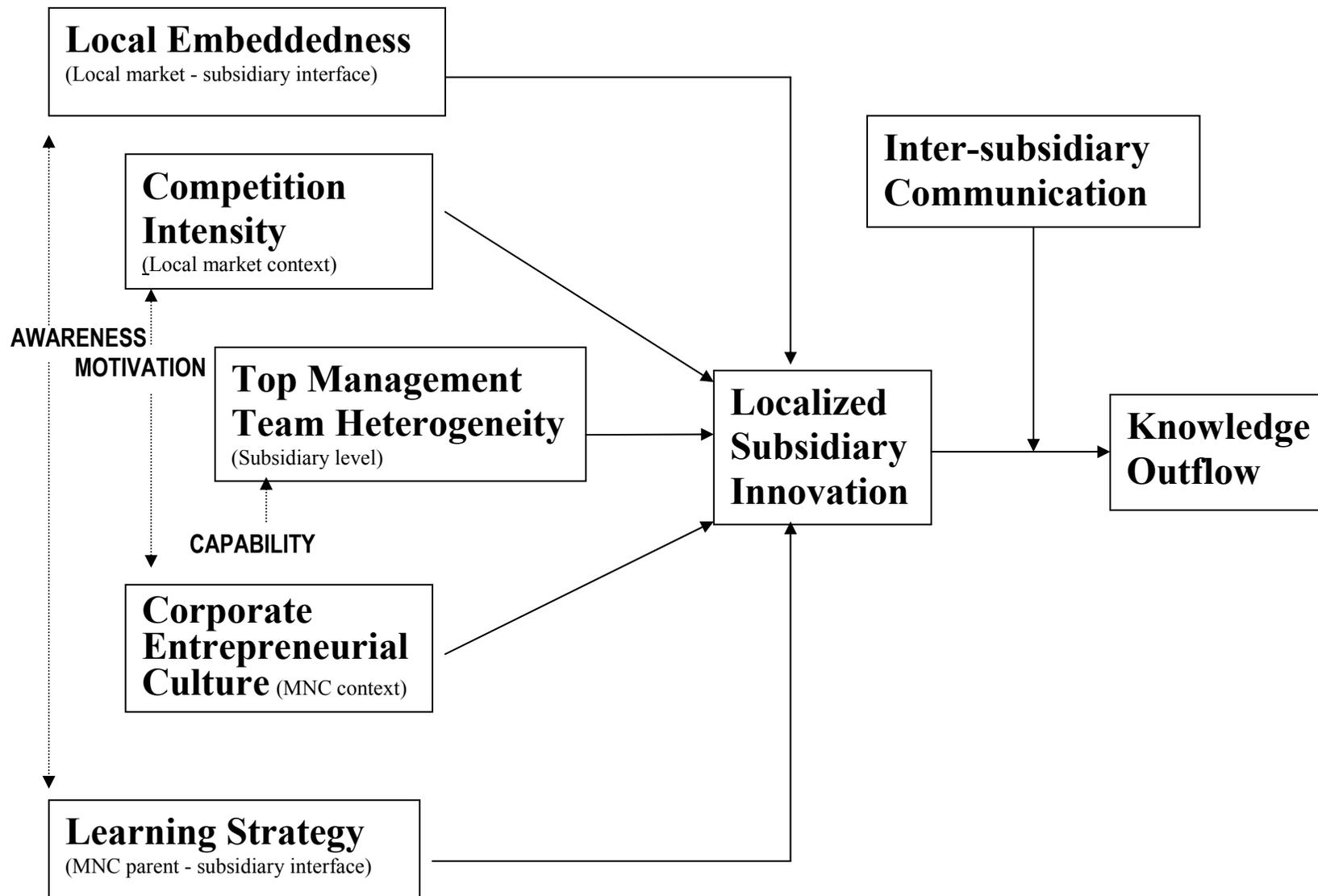


Figure 1-2 An Integrated Model Of Subsidiary Learning From Local Environments

1.4 Summary of empirical results

This dissertation applies both qualitative and quantitative research methods. Multiple-case studies provide rich details on the related issues. Survey research, within two special populations, provides empirical tests for the hypotheses. One special population is the foreign subsidiaries in U.S. pharmaceutical industry. The other includes foreign subsidiaries in U.S. from the top five home countries. The consistency of results from the two special populations suggests that the empirical results may be generalizable to a broader population, i.e., all foreign subsidiaries in the United States. The combination of the two research strategies (i.e., multiple-case studies and survey research) can reduce common method bias and thus increase the confidence of the findings in this dissertation.

The empirical tests indicate that corporate entrepreneurial culture, local embeddedness, and knowledge exploration as a learning strategy, exert significant influence on localized subsidiary innovation. Top management team heterogeneity has significant impact on localized subsidiary innovation only in correlation tests. Its influence becomes less significant in the models including other factors simultaneously. Local competition does not impact localized subsidiary innovation significantly in all the tests. The control variables include knowledge resources, size, and internationalization of MNCs. The results do not find them significant. Size and internationalization are insignificant even in correlation tests. Knowledge resources become insignificant after the simultaneous inclusion of other factors. Localized subsidiary innovation influences knowledge outflow significantly. The significance scales down after including the moderation effect of inter-subsidary communication. Figure 1-3 depicts the resulted parsimonious model.

1.5 Major contributions and implications

This dissertation contributes to both MNC and organizational learning literature. The contribution to MNC literature mainly lies in its holistic view of subsidiary learning. It addresses multiple topics in international management with a multiple-level focus. Werner (2002) has

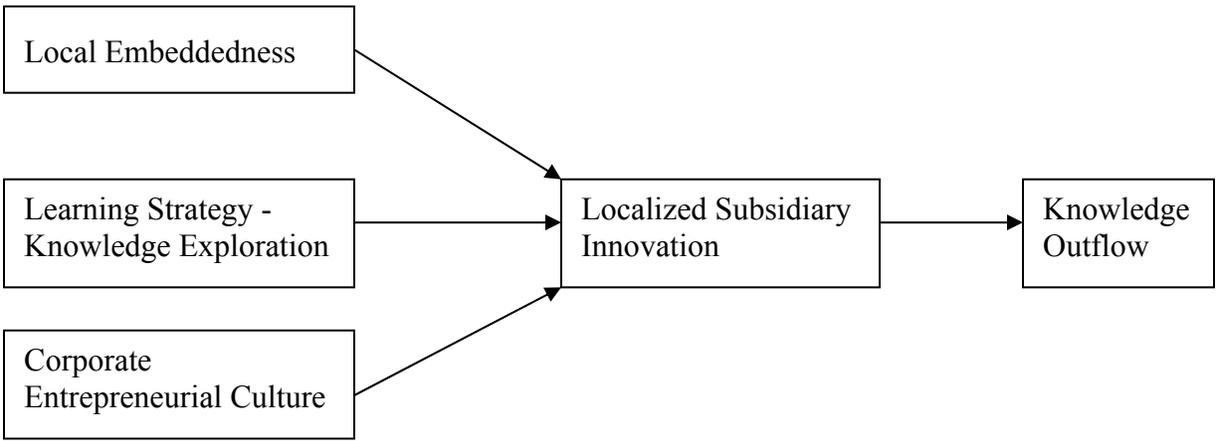


Figure 1-3 A Parsimonious Model Of Subsidiary Learning From Local Environments

classified twelve topic areas in international management research. This dissertation touches upon eight out of the twelve topic areas, including global business environments, internationalization, motivation of foreign direct investment and location, antecedent of knowledge transfer, consequence of international alliances, description of MNCs, subsidiary control and performance, and multinational team management. The holistic view in this dissertation suggests subsidiary learning bears the potential to advance MNC literature by testing the linkage among these topic areas of international management. The empirical test highlights the institutional influence on subsidiary learning, which has been neglected in both MNC and organizational literature.

The dissertation particularly contributes to the recently growing MNC literature with subsidiary as unit of analysis (e.g., Birkinshaw, 1997; Gupta and Govindarajan, 2000). This research takes subsidiaries as a unit of analysis to reflect the organizational learning of MNCs because of the increased importance of subsidiaries in tapping into worldwide knowledge (Doz et al., 2003) and of the subsidiary heterogeneity suggested by Ghoshal and Nohria (1989). Moreover, Ghoshal and Bartlett (1988) discuss how subsidiaries create innovations but focus on only the factors within MNCs. Influence of local environments on subsidiaries is still under question. The cross-level approach in this research can well fit the complexity of organizational environments of subsidiaries. A subsidiary is both a node of the internal MNC network, which

includes the headquarters of the MNC and all the subsidiaries, and a node of the external MNC network, which includes the subsidiary and the institutions in local environments that the subsidiary has connections (Ghoshal and Barlett, 1990). The complexity of institutional environments calls for a more sophisticated approach to address the research questions in this research. Furthermore, recent research on MNCs strategic management with knowledge-based view focuses on the knowledge transfer process within MNCs (e.g., Gupta and Govindarajan, 1991; 2000; Kostova, 1999). However, the previous research assumes a given knowledge within a close system of MNCs. This research discards the assumption and explores knowledge-related factors both inside and outside MNCs. Thus, this dissertation advances research on the strategic management of MNCs with a knowledge-based view, and develops connections between three streams of research on MNCs: knowledge acquisition from local environments, knowledge creation within MNCs, and knowledge diffusion within MNCs.

The major contribution of this dissertation to organizational learning and innovation literature lies in the development of a learning framework, and its application to MNC context with empirical tests. Moreover, it highlights the mode of institutional learning as Miller (1996) suggests. Comparing with the routines and processes of organizational learning, institutional learning has not obtained much attention in organizational learning literature. Furthermore, this research adopts a “dual” approach, which simultaneously considers learning enablers from both the external (or local) and internal (or organizational) environments. The findings from both qualitative and quantitative methods in this research support the dual approach. The major contribution to innovation literature is the empirical demonstration of factors that influence innovations in a multinational context.

This dissertation presents potentials to advance the local responsiveness-global integration framework with a knowledge-based view. The apparent conflicts between global integration and local responsiveness impart tension for MNCs (Bartlett and Ghoshal, 1998). Few MNCs have successfully developed a transnational strategy by simultaneously pursuing both global integration and local responsiveness. Ever-intensifying competition, however, continually adds pressure on MNCs to improve their performance on both dimensions. The knowledge-based view may present a potential solution to overcome the apparent conflicts between global

integration and a local responsiveness framework. By learning from local environments, subsidiaries can develop knowledge with a high level of local responsiveness. By sharing knowledge with the rest of MNCs, the potential increases for global integration of knowledge gainers. Thus, investigating the relationship between subsidiaries learning from the local environments and knowledge outflow would likely advance the understanding of the “global integration-local responsiveness” framework.

1.6 Structure of the dissertation

Figure 1-4 depicts the overall research process of this dissertation. Chapter 2 reports a comprehensive review of the literature in related areas, including MNC, organizational learning and knowledge-based view, and innovation literature. This review classifies the representative research focus in those areas, and gives particular attention to the literature that relates to this dissertation. The research gap identified in Chapter 2 points the direction of hypothesis development. Chapter 3 develops a conceptual framework and seven corresponding hypotheses. Chapter 4 presents a qualitative investigation in relating to the research questions and the proposed hypotheses. The multiple case studies focus on subsidiary innovations with sequential knowledge outflow to the rest of the MNC. The cross-case pattern search provides some evidence to the proposed model. Chapter 5 describes the survey design and implementation. Chapter 6 presents the results of hypothesis testing in two samples. Chapter 7 ends this dissertation, with the discussion of the findings. Although not all the hypotheses are significant, the findings highlight the importance of institutional learning in MNCs in order to increasingly innovate worldwide and to overcome the dilemma between global integration and local responsiveness. The discussion of the contributions of this dissertation follows the discussion of the limitations and implications for future research. Managerial implications of this dissertation conclude the endeavors of this research.

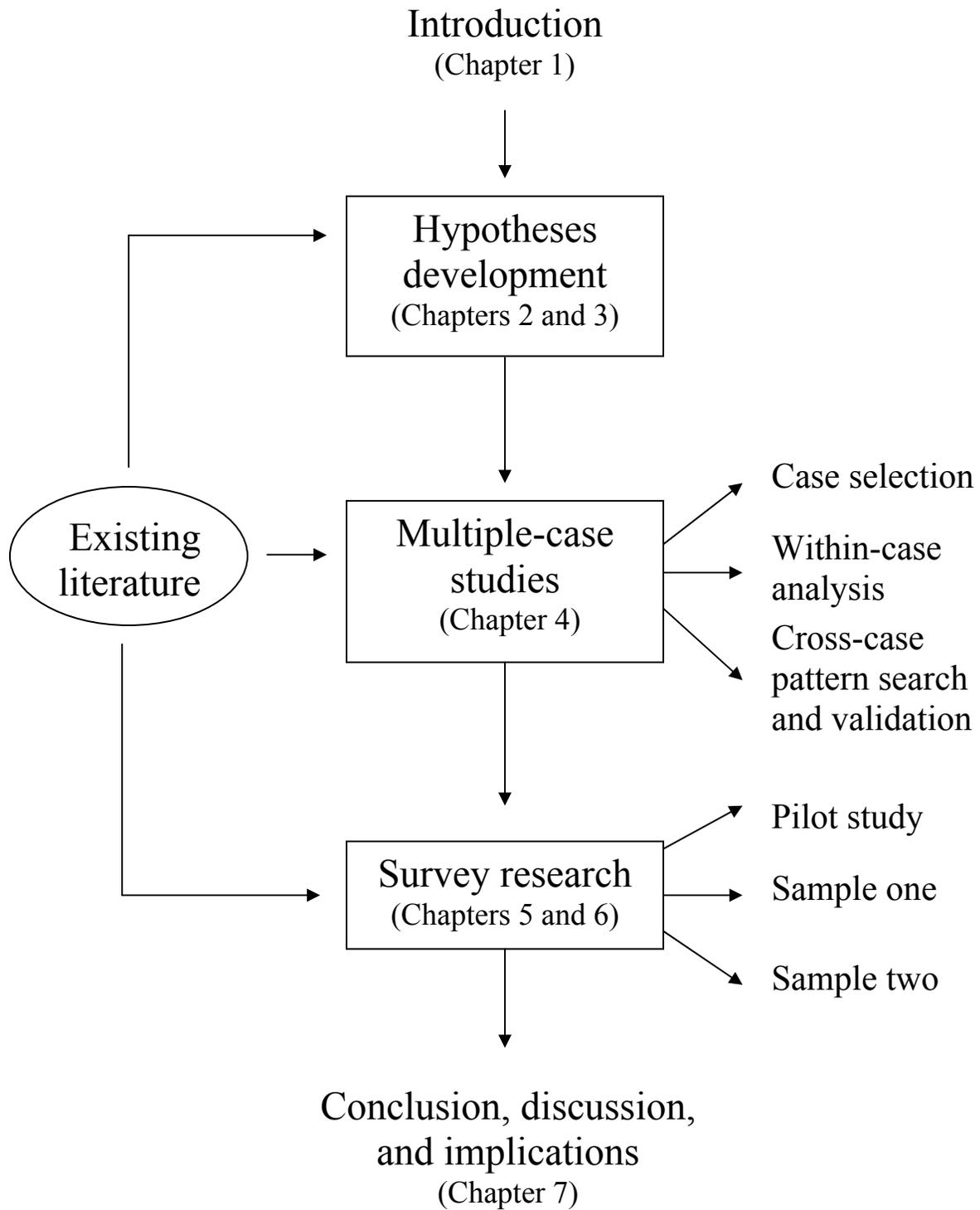


Figure 1-4 The Research Process Of This Dissertation

Chapter 2 Literature Review

To understand the phenomenon of localized subsidiary innovation, I review three research streams: 1) current research on multinational corporations (MNCs), 2) organizational learning and knowledge-based view, and 3) organizational innovations consequently. Each research stream has a unique history and focus. I highlight the contributions of each stream as a whole as it relates to the purpose of this study. The literature review is not particularly extensive, but rather representative. I will summarize key themes of each literature stream in a series of tables.

This literature review has two goals. First, the review of three research streams can reveal the current understanding pertaining to this research. Secondly, the literature review can help identify an original perspective of investigation in relating to the research questions, by facilitating the conversation across the research areas.

2.1 Research on Multinational Corporations (MNCs)

Research on MNCs has developed from the disciplines of international business and economics. Concerning with subsidiary learning from local environments of MNC to gain competitive advantages, I focus on recent research on MNCs in the paradigm of strategic management. I start with reviewing the development of MNC research in terms of the evolution of the unit of analysis. Then I focus on subsidiary research, which relates to the purpose of this study. Based on the resulting findings, I proceed to look for unique perspectives to address my research questions so as to contribute to the field. Table 2.1 summarizes the major findings of research on MNCs, in chronological order.

2.1.1 Evolution of the unit of analysis

The unit of analysis in the research on the global strategic management has evolved downward from country, to industry, and to corporate level (Bartlett & Ghoshal, 1991; also

Hymer, 1960; Vernon, 1966; Buckley & Casson, 1976; Dunning, 1977; Stopford & Wells, 1972; Prahalad, 1975).

The early research on MNCs explains the reason for existence of MNCs by using comparative advantage theory in international business. Hymer (1960) shifts the unit of analysis from country to industry. He uses I/O school to explain competitive advantages gained through monopolistic market position. Buckley and Casson (1976) uses internalization to justify the existence of MNCs. Combining both I/O school and TCT, Dunning (1978) adds the location advantage to his eclectic paradigm in order to explain the competitive advantages of MNCs. Current research on MNC focuses on corporate level, moving down from country and industry levels. The main stream of research focuses on either the strategy-structure configuration (e.g. Egelhoff, 1982, 1988; Stopford & Wells, 1972) or global integration/local responsiveness framework (e.g. Doz & Prahalad, 1984; Prahalad, 1975). This dominant view of taking MNCs as the unit of analysis has assumed the homogeneity of subsidiaries.

Ghoshal and Bartlett (1990) are among the first to consider MNCs as a differentiated network. Following their lead, recent research has seen the rise of subsidiary as the unit of analysis (Birkinshaw and Hood, 1998; Birkinshaw, Hood, and Jonsson, 1998; Nobel and Birkinshaw, 1998; Gupta and Govindarajan, 1991; 2000). Ghoshal (1987) suggests that taking advantage of national differences can bring competitive advantages to MNCs. The difference among subsidiaries within a MNC becomes significant and catches academic attention. Ghoshal and Nohria (1989) provide empirical evidence to support the heterogeneity of subsidiaries. They concluded that the environmental diversity and resource contingencies are required for systematic heterogeneity across subsidiaries.

Doz, Santos, and Williamson (2001) further advocate the role that subsidiaries can play in contributing the competitive advantages of MNCs. They suggest new assumptions and challenges in the global market place. The new assumptions are 1) global presence is no longer a distinctive competitive advantage; 2) a single national market no longer leads in most industries; 3) valuable knowledge is increasingly scattered; and 4) valuable knowledge is sophisticated and

| Author(s) | Year | Key term(s) | Unit of analysis | Type | Major contributions |
|------------------------|-------------|--|-------------------------|-------------|--|
| Egelhoff | 1982 | Strategy; structure | MNC corporate | Empirical | An empirical test of the fit between structure and strategy in MNCs by an information-processing approach. |
| Ghoshal | 1987 | Global strategy | MNC corporate | Conceptual | The strategic task of managing globally is to use all three sources of competitive advantage to optimize efficiency, risk and learning simultaneously in a world-wide business |
| Egelhoff | 1988 | Strategy; structure | MNC corporate | Empirical | An empirical test of Stopford & Wells (1972) model. Strategy measured by percentage of foreign sales and foreign product diversity can predict structure, but not by relative size of foreign manufacturing. |
| Ghoshal and Bartlett | 1988 | Subsidiary innovation | Subsidiary | Empirical | Organizational socialization, and dense intra-and inter-unit communication contribute to the creation, adoption and diffusion of subsidiary innovations. |
| Ghoshal and Nohria | 1989 | Structure, Internal differentiation | Subsidiary | Empirical | The internal structure in MNCs is systematically differentiated so as to fit the different environmental and resource contingencies faced by the different national subsidiaries. |
| Ghoshal and Bartlett | 1990 | Network density | Subsidiary | Conceptual | The structural properties of external network of a subsidiary can predict its resource allocation. |
| Gupta and Govindarajan | 1991 | Knowledge flows, control | Subsidiary | Conceptual | The outflow and inflow of knowledge can predict the lateral interdependence, corporate socialization, global responsibility, and the need for autonomous initiative of subsidiaries. |
| Rosenzweig and Singh | 1991 | Local isomorphism, internal consistency | Subsidiary | Conceptual | Organizational environments of subsidiaries of MNEs exert dual pressures for the subsidiaries: local isomorphism vs. internal consistency. |

Table 2-1 Literature Summary On MNCs Research

| Author(s) | Year | Key term(s) | Unit of analysis | Type | Major contributions |
|-------------------------|-------------|------------------------------|-------------------------|-------------|--|
| Melin | 1992 | International-ization | MNC corporate | Review | Major themes of international business research: stage models; strategy-structure linkage; process school |
| Kogut and Zander | 1993 | Internalization of knowledge | MNC corporate | Empirical | The codifiability and teachability of the technology are related to transfer mode of knowledge, either to wholly owned subsidiaries or to other parties. |
| Cheng and Bolon | 1993 | Multinational R&D management | MNC corporate | Conceptual | To initiate the process of developing multinational R&D management as an area of study rather than to advance specific theories about multinational R&D behavior |
| Birkinshaw and Morrison | 1995 | Strategy, structure | Subsidiary | Empirical | A configurational approach is used to develop a typology of subsidiary roles, with empirical confirmation. |
| Robinson | 1995 | Structural interdependence | Subsidiary | Empirical | The structural interdependence of subsidiary can predict the conformity of parent and subsidiary practices. |
| Almeida | 1996 | Knowledge Sourcing | MNC corporate | Empirical | Foreign subsidiaries in U.S. regions cited significantly more local (i.e., at the regional and country level) patents than similar domestic firms. |
| Florida | 1997 | Globalization of R&D | MNC corporate | Empirical | A major objective of foreign R&D investment in the United States is to secure access to scientific and technical human capital. |
| Birkinshaw and Hood | 1998 | subsidiary charter change | Subsidiary | Conceptual | The subsidiary evolution processes are classified though the drivers of parent company factors, subsidiary factors, and host country factors. |

Table 2-1, Continued

| Author(s) | Year | Key term(s) | Unit of analysis | Type | Major contributions |
|-------------------------------|-------------|---|-------------------------|-------------|--|
| Birkinshaw, Hood, and Jonsson | 1998 | Contribution role, subsidiary initiatives | Subsidiary | Empirical | The contribution role of subsidiary can be predicted by subsidiary initiative, and specialized subsidiary resources. |
| Kuemmerle | 1998 | Scale of foreign R&D | Subsidiary | Conceptual | The paper proposes a concave relationship between laboratory size and performance, as well as a linear relationship between firm learning and laboratory performance |
| Nobel and Birkinshaw | 1998 | Control, communication | Subsidiary | Empirical | The innovation role of R&D units impacts their control and communication patterns. |
| Kostova | 1999 | Organizational practices transfer | Subsidiary | Conceptual | The internalization of transferred practice are influenced by institutional distance of countries, organizational culture of subsidiary, and attitudes of transfer coalition and dependence on parent company. |
| Kuemmerle | 1999 | Exploration, exploitation | Subsidiary | Empirical | Relative market size, and relative strength of a country's science base can predict the drivers of foreign direct investment into R&D, either exploration or exploitation. |
| Patel and Vega | 1999 | Foreign R&D location | MNC corporate | Empirical | Firms tend to locate their technology abroad in their core areas where they are strong at home. |
| Zander | 1999 | Innovation networks | MNC corporate | Empirical | A taxonomy of international innovation networks in MNCs is developed based on two dimensions: international duplication, and international diversification of technological capabilities. |

Table 2-1, Continued

| Author(s) | Year | Key term(s) | Unit of analysis | Type | Major contributions |
|------------------------------|-------------|-------------------------------|-------------------------|-------------|--|
| Birkinshaw and Hood | 2000 | Local network embeddedness | Subsidiary | Empirical | Subsidiaries in leading-edge clusters are more embedded in their local network, have greater decision-making autonomy, and are more internationally-oriented. |
| Gupta and Govindarajan | 2000 | Knowledge flows | Subsidiary | Empirical | Knowledge inflows and outflows of a subsidiary can be predicted by subsidiary's knowledge stock; motivational disposition to share/acquire knowledge, the reach of transmission channels, and the capacity to absorb the incoming knowledge. |
| Belderbos | 2001 | Overseas innovations | MNC corporate | Empirical | The overseas innovations of MNCs are influenced by their R&D intensity, export intensity, overseas manufacturing intensity, operating experience in greenfield manufacturing subsidiaries overseas, and entry mode. |
| Doz, Santos, and Williamson | 2001 | Metanational advantages | MNC corporate | Empirical | To innovate by learning from the world is critical for the metanational advantage. MNCs are competing on sensing, mobilizing, operationalizing the dispersed knowledge worldwide. |
| Schulz | 2001 | Knowledge outflows | Subsidiary | Empirical | The horizontal and vertical knowledge outflows of a subsidiary are determined by its exposure of a knowledge domain to new experiences, its uniqueness of experiences compared to its peers, the level of knowledge codification, and the inflow of knowledge. |
| Andersson, Forsgren and Holm | 2002 | External network embeddedness | Subsidiary | Empirical | Relational embeddedness (business embeddedness and technical embeddedness) in external networks as a strategic resource for performance and competence development in MNCs. |

Table 2-1, Continued

sticky. Thus the “metanational” advantage is called for. The new advantage requires MNCs to innovate by learning from the world, namely, connecting globally dispersed knowledge, and mobilizing the dispersed knowledge to create new products, services, processes, and business models. The contributing role of subsidiaries starts to be a new focus of research in MNCs (e.g., Gupta and Govindarajan, 1991; Birkinshaw, Hood, and Jonsson, 1998). Assuming voluntarism of subsidiaries and subsidiary heterogeneity, the new research focus challenges the main stream of research on MNCs.

2.1.2 Subsidiary research review

The literature with subsidiaries as the unit of analysis is developing rapidly. Rosenzweig and Singh (1991) have suggested that subsidiaries of MNCs face dual institutional pressures. One is from the organization of MNCs, and the other is from host country or local market. Based on the institutional focus, I develop a classification of the subsidiary research. I call the studies focusing on internal MNC organizations as “internal” research, and those focusing on external environments as “external” research. The last group is “dual”, combining the influence of both external and internal environments. I will review the key findings in each of the three groups. Table 2-2 lists the studies of each type.

The majority of current literature assuming heterogeneity of subsidiaries looks into the internal institutional environments of subsidiaries, namely, the MNC organization. These studies investigate knowledge flow (Gupta and Govindarajan, 1991, 2000; Schulz, 2001), and various configurations of strategy, control, and structure across subsidiaries within a MNC (Ghoshal and Nohria, 1989; Birkinshaw and Morrison, 1995; Nobel and Birkinshaw, 1998). By looking at the organizational characteristics, these studies suggest: 1) various roles subsidiaries can play (Birkinshaw and Morrison, 1995; Gupta and Govindarajan, 1991), 2) internal consistency among the parent company and subsidiaries (Robinson, 1995; Gupta and Govindarajan, 2000; Kostova, 1999), and 3) subsidiary performance (Ghoshal and Bartlett, 1988; Nobel and Birkinshaw, 1998). Innovation is an important performance of subsidiaries in these studies. Cheng and Bolon (1993) have pointed out the importance of research on the multinational R&D management. The advocacy is echoed on special issues on *IEEE Transactions on Engineering Management* in 1996, and on *Research Policy* in 1999. However, the studies seem lack of theoretical rigor. It

may be because multinational R&D management should be an area of its own instead of advancing specific theories about the phenomenon, as suggested by Cheng and Bolon (1993). Or the theoretical rigor should be advanced, as suggested by Melin (1992).

Nevertheless, the unique and complex institutional environments of subsidiaries make them good candidates of testing organizational theories. Empirical studies in “internal” subsidiary research far outnumber conceptual papers. The theoretical foundation mainly include the configuration school (Ghoshal and Nohria, 1989; Birkinshaw and Morrison, 1995; Nobel and Birkinshaw, 1998), transaction cost theory (Kogut and Zander, 1993), network view (Robinson, 1995; Birkinshaw and Hood, 2000), and knowledge-based view (Gupta and Govindarajan, 2000; Schulz, 2001).

Other research looks outside the MNC organization and brings in variables from external institutional environments. Testing with patent citations, Almeida (1996) focuses on external environments of subsidiaries exclusively, and finds that foreign subsidiaries in the United States tend to utilize more local knowledge than do domestic firms. Birkinshaw and Hood (2000) compare the location of subsidiaries and find that subsidiaries in leading-edge clusters are more embedded in their local network. Andersson, Forsgren and Holm (2002) further suggest the positive implications on performance of embedding business and technical aspects in external (or local) networks. Kuemmerle (1999) suggests that the relative market size and relative strength of a country's science base determine the learning strategy of R&D foreign investment in terms of exploration or exploitation.

In comparison of the dominance of empirical investigation in the “external” subsidiary research, the “dual” research appears more theoretically oriented. Ghoshal and Bartlett (1990) pioneer the view of a MNC as an inter-organizational network. They suggest that the structural properties of the external and internal networks of subsidiaries influence the power of subsidiary in the internal MNC network, and thus its resource allocation. Birkinshaw and Hood (1998) use an integrative approach and develop a model of subsidiary evolution regarding the capabilities and charter of subsidiaries. They suggest that head-office assignment, subsidiary choice, and local environment determinism all affect subsidiaries’ roles. More specifically, they specify that

| Research Focus | | | |
|-----------------------|--|---|--|
| | Internal | External | Dual |
| Conceptual | Gupta and Govindarajan (1991) | | Ghoshal and Bartlett (1990) Rosenzweig and Singh (1991) Birkinshaw and Hood (1998) Kostova (1999) |
| Empirical | Ghoshal and Bartlett (1988) Ghoshal and Nohria (1989) Kogut and Zander (1993) Birkinshaw and Morrison (1995) Robinson (1995) Kuemmerle (1998) Nobel and Birkinshaw (1998) Zander (1999) Gupta and Govindarajan (2000) Belderbos (2001) Schulz (2001) | Almeida (1996) Kuemmerle (1999) Birkinshaw and Hood (2000) Andersson, Forsgren and Holm (2002) | Birkinshaw, Hood and Jonsson (1998) Doz, Santos and Williamson (2001) |

Table 2-2 Classification Of MNC Subsidiary Research

a competitive internal resource allocation mechanism, decentralization of decision making, and an ethnocentric attitude among parent company managers are the factors in the parent company that influence subsidiaries' roles. The subsidiary factors include a strong track record, credibility of subsidiary management, and the entrepreneurial orientation of subsidiary employees. They suggest that the external drivers in the host country include the strategic importance of the host country, the support of the host government, the dynamism of the local business environment, and relative cost of factor inputs in the host country.

Rosenzweig and Singh (1991) apply institutional theory to explore the dual pressures on subsidiaries of local isomorphism and internal consistency. They propose that legal imperatives in the host country can force a subsidiary to become similar to local companies. Subsidiaries with multidomestic strategy can be expected to appear with more local isomorphism than those with global strategy. Entry mode can influence the local isomorphism too. An acquired subsidiary should bear more similarity to local companies than a greenfield subsidiary. By contrast, the prominence of expatriates can increase internal consistency. The culture distance should influence the formal mechanisms of control on the subsidiary. The complex environments faced by MNCs make them excellent candidates to “serve as catalysts for reconceptualizing organization-environment relations” (Rosenzweig and Singh, 1991). Based on the institutional theory, Kostova (1999) investigates the transnational transfer of organizational practices. She proposes that the institutional distance between home country and host country of a subsidiary influences the transfer. The organizational culture of a MNC, the subsidiary's attitudes and its dependence on parent company affect the transfer as well.

The empirical “dual” studies run relatively short. Birkinshaw, Hood and Jonsson (1998) have investigated the contributing role of subsidiaries by looking at variables of both external and internal environments. They find that in the external environments, local competition can decrease the contributing role of subsidiaries. However, the globalization of its industry can positively influence the contributing role of subsidiaries. They also find that in the MNC organizational environments, subsidiary autonomy, and parent-subsidiary communication can positively influence the contributing role of subsidiaries. If a subsidiary has non-location-bound resources that are superior to the rest of MNC, it will more likely contribute more to the firm-

specific advantage of MNC. Subsidiary leadership and its entrepreneurial culture have positive influence on its contributing role as well.

Camping in the process school pioneered by Prahalad (1975), Doz, Santos, and Williamson (2001) have identified three distinctive competences for MNCs to achieve the metanational advantage. Their field study illustrates that MNCs need to develop the distinctive competences of sensing, mobilizing, and applying the dispersed knowledge gained worldwide in order to be able to innovate successfully. In other words, MNCs need to sense new knowledge faster and more effectively than their competitors. They need to figure out what knowledge they should focus on, for example, technology knowledge, or market knowledge, or others. Choosing where to identify the knowledge is critical too. Lead markets and clusters have been argued with rich embedded knowledge. The last aspect for sensing new knowledge is to decide who might provide a fertile source of knowledge, customers, or partners, or others. Prospecting capabilities and accessing capabilities are both the keys for developing a distinctive competence in sensing.

The second distinctive competence required for metanational advantage is to mobilize dispersed knowledge to innovate more creatively than competitors. MNCs need to be capable of moving globally dispersed knowledge and of integrating the knowledge to pioneer new products and services. An international repertoire network can contribute to the capabilities. The third competence is to implement innovations more effectively than competitors. MNCs need to optimize the size and configuration of operations for efficiency and flexibility. A MNC can improve its efficiency by scaling up the supply chain, and it can become more locally responsive by making incremental improvements, and engineering local adaptations. In this way, a MNC can leverage its innovation worldwide.

2.1.3 The gap in subsidiary innovation research

My review of the MNC literature shows that the MNC research evolves to explain the complexity of multinational management and to catch up with new challenges in the real world with both theoretical and empirical endeavors. The growing number of subsidiary studies signals

the increasingly significant role that a subsidiary plays in the global market. The emergence of “external” subsidiary research highlights the importance of external environments for subsidiaries to fulfill its increasingly significant roles. The “dual” research reflects that the complexity of institutional environments faced by subsidiaries provides opportunities to test and further develop existing theories. Moreover, the discrepancy between the theoretical appeal and the lack of empirical findings in the “dual” research seems to imply a promising path to advance subsidiary research.

Going back to my research question: what contextual factors influence subsidiaries to innovate by learning from local environment, I still have not found the answer for it in the literature. The literature, however, confirms the importance of the issue. For an instance, Ghoshal (1987) claims that a key asset of the multinational is the diversity of environments in which it operates. Learning from the diverse environments is one of the goals of MNCs. Doz, Santos, and Williamson (2001) further articulate the importance of learning. The research on global R&D dispersion is another evidence of the prevalence and importance of the phenomenon. Belderbos (2001) uses patent grants as a measure of overseas innovations by Japanese MNCs. He confirms that R&D foreign investment has technology sourcing motivation.

The current few research endeavors to understand the phenomenon have been mainly focused on “internal” organizational characteristics. Ghoshal and Bartlett (1988) have investigated organizational characteristics that influence the creation, adoption, and diffusion of innovations by subsidiaries. They find that organizational socialization and dense intra-and inter-unit communication can increase the innovation creations by subsidiaries. The slack resources and autonomy of subsidiaries can increase their innovations as well. Belderbos (2001) finds that MNCs’ internationalization characteristics and R&D intensity can affect the overseas innovations of MNCs. The internationalization characteristics include export intensity, overseas manufacturing intensity, operating experience in greenfield manufacturing subsidiaries overseas, and entry mode. Schulz (2001) suggests different processes of learning by mainly focusing internal institutional environments with a slight touch on external institutional environments. Schulz (2001) empirically tests how organizational learning in subsidiaries affects outflows of knowledge to the rest of MNCs. He suggests three learning processes, including collecting new

knowledge, codifying knowledge, and combining old knowledge. He investigates both vertical flow to supervising units and horizontal flow to peer units, and finds that collecting new knowledge increases vertical flow of knowledge, codifying knowledge enhances both vertical and horizontal flows, and combining old knowledge mainly affects horizontal flow. Investigating the impact of collecting new knowledge, Schulz examines both the exposure of a knowledge domain to internal sources of new experiences, and the exposure to external sources of new experiences. The latter brings in an element of external institutional dimension. The major focus of this study, however, is still "internal."

The "dual" research on subsidiary learning and innovation is absent except for Doz, Santos, and Williamson (2001). Based on field studies, they provide the basis for advancing the research in this area. The processes of innovating by learning from the world are the focus in their study. In this study, I will explore contextual factors in both external and internal institutional environments that increase subsidiaries' learning from local environments. In addition to building on current studies on subsidiary learning and innovation, I can draw insights from other studies with less relevance. Birkinshaw, Hood and Jonsson (1998) focus on the contributing role of subsidiaries to MNC's firm-specific advantage. Thus their focus is relevant but different from the purpose of this study. The variables that they have tested are local competition, industry globalization, subsidiary autonomy, and parent-subsidiary communication.

Based on the review of current literature, I realize the significance of and need for advancing the understanding of subsidiary learning and innovation through studies of both theoretical coherence and empirical confirmation in the realm of "dual" research. I start a journey searching for theoretical foundations in organizational learning and innovation, before I build a theoretical framework in next chapter.

2.2 Research on organizational learning and knowledge-based view

I review the literature of organizational learning and knowledge-based view together because the two fields share the same theme of knowledge augmentation. Instead of viewing

organizational learning as history-dependent and routine-based (Levitt and March, 1988), I assume a broad view. Cyert and March (1963) use organizational learning to indicate the adaptive behaviors of organizations over time. Huber (1991: 89) assumes that "an organization learns if any of its units acquires knowledge that it recognizes as potentially useful to the organization." Powell, Koput, and Smith-Doerr (1996) hold that "organizational learning is both a function of access to knowledge and the capabilities for utilizing and building on such knowledge." Literature of knowledge-based view also assumes the importance of knowledge, and investigates ways of integrating, transforming, and transferring knowledge in organizations (Grant, 1996; Nonaka, 1994; Szulanski, 1996; Hansen, 1999). The merging interests on augmenting knowledge for competitive advantage of both research streams provide abundant opportunities to converse, although each has its own focus.

For instance, Huber (1991) explicitly identifies that in the domain of organizational learning, knowledge acquisition includes learning from their own experience, others' experience, searching for information, and "grafting on new members who possess knowledge not previously available within the organization." Grant (1996), and Nonaka (1994) in the knowledge-based view camp suggest the importance and mechanisms of transforming individual knowledge to organizational knowledge. Thus, in this review, I use the locus of learning as an ontological dimension to classify the literature. If a study focuses on knowledge augmentation from inside the unit of analysis, it is an "internal" study. The opposite is then an "external study." Among the numerous "internal" studies, I classify a study focusing on learning from its past experience as "history/routines" research. I categorize a study focusing on the processes of knowledge augmentation within an organization as the "process/knowledge" literature. Although the classification is not completely exclusive to each other, it can serve the purpose of literature review, enabling me to highlight the difference and similarity among the literature. Table 2-3 summarizes, in chronological order, the major findings in the literature pertaining to the purpose of this study. The classification appears in Table 2-4.

Although it may seem quite unusual to use organizational learning as an umbrella to house some major studies in knowledge-based view, it is not arbitrary. Spender and Grant (1996) in their introduction to the special issue of *Strategic Management Journal: Knowledge and the*

Firm, suggest that knowledge-based view literature has its root in organizational learning, innovation literature, and evolutionary economists (notably Nelson and Winter) which organizational learning has built upon as well. Huber (1991) has suggested that knowledge acquisition is an important construct of organizational learning. This literature review only constitutes a primary endeavor to remap the fields of organizational learning and knowledge-based view in order to reach a more consistent and parsimonious view of the two related research streams.

“Internal” history-oriented view of organizational learning Organizational learning literature has its root in psychology, mainly stimulus-response theory. A person learns from experience, and similarly an organization learns from history (Cyert and March, 1963). Cyert and March (1963) use learning and adaptation exchangeably. They suggest that it is a function of their experience that organizations change their goals, shift their attention, and revise their procedures for search. Nelson and Winter (1982) confirm that firms grow the understanding of the causal structure of their own capabilities by repetition and practice. The learning-by-doing approach means that the current capability of the firm is a function of history.

The early work in organizational learning emphasizes the experience, and organizational memory to store and retrieve information, and routines to record organizational memory (Levitt and March, 1988). Tracing back to the stimulus-response theory in psychology, Weick (1991) discusses the applicability of the theory to organizational behaviors, and suggests applying the theory with different configuration of stimulus-response. Although individual learning happens when one improves his response to the same stimulus, organization learns when it develops the same response to different stimulus. This insightful comparison highlights the importance of routines and memories in organizational learning. Nevertheless, Weick (1991) still belongs to the traditional organizational learning literature that focuses on action, as Fiol and Lyles (1985) has emphasized the difference between organizational learning and adaptation. The dominance of action is diluted as the area develops. Instead of emphasizing actions, Huber (1991: 89) focuses on knowledge “as potentially useful to the organization.”

| Author(s) | Year | Key term(s) | Type | Major findings |
|---------------------|-------------|-------------------------------------|-------------|---|
| Cyert and March | 1963 | A Behavioral Theory of the Firm | Empirical | Organizations learn as they exhibit adaptive behavior over time. It is a function of the experience. |
| Argyris | 1976 | Single-Loop, Double-Loop learning | Conceptual | Single-loop learning is found to be the most general model of action. A double-loop model is proposed as providing feedback and more effective decision making. |
| Hedberg | 1981 | Organizational learning, unlearning | Conceptual | Unlearning is a process through which learners discard obsolete and misleading knowledge. |
| Nelson and Winter | 1982 | Routines | Empirical | Firms grow the understanding of the causal structure of their own capabilities by repetition and practice. The learning-by-doing approach means that the current capability of the firm is a function of history. |
| Fiol and Lyles | 1985 | Organizational Learning, adaptation | Conceptual | The difference between learning and adaptation is elaborated. Learning focuses on action whereas adaptation focuses on change. Content of learning, and level of learning are suggested as two dimensions of organizational learning. |
| Levitt and March | 1988 | Routines, organizational memory | Conceptual | Organizational learning is routine-based, history-dependent, and target-oriented. Organizations memory is developed by encoding, storing, and retrieving the lessons of history. |
| Cohen and Levinthal | 1990 | Absorptive capacity | Empirical | The ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to the firm's innovative capabilities. |
| Brown and Duguid | 1991 | Communities-of-practice | Conceptual | Significant learning and innovation are generated in the informal communities-of-practice in which people work. |

Table 2-3 Literature Summary On Organizational Learning And Knowledge

| Author(s) | Year | Key term(s) | Type | Major findings |
|---------------------------|-------------|--|-------------|---|
| Huber | 1991 | Organizational learning | Review | Four constructs related to organizational learning: knowledge acquisition, information distribution, information interpretation, and organizational memory. |
| Hamel | 1991 | Inter-Partner Learning | Empirical | Learning is an important goal and outcome for alliances. Partners are racing on internalizing the skills of their counterparts. |
| March | 1991 | Exploration, exploitation | Conceptual | It is hard to achieve the balance between exploitation and exploration because of two social contexts of organization learning - mutual learning between organizations and individuals, and competition for primacy. |
| Weick | 1991 | Simulation-action paradigm | Conceptual | An alternative definition of organizational learning is suggested and compared with the traditional one in the simulation-action paradigm. |
| Lant, Milliken, and Batra | 1992 | Managerial Learning, strategic reorientation | Empirical | Poor past performance, environmental awareness, top management team heterogeneity, and CEO turnover increased the likelihood of reorientation. The stability of environment moderates the influence of poor past performance. |
| Kogut and Zander | 1992 | Combinative capabilities | Conceptual | What firms do better than markets is the sharing and transfer of the knowledge of individuals and groups within an organization. Firms learn new skills by recombining their current capabilities. |
| Levinthal and March | 1993 | Learning myopia | Conceptual | The two major mechanisms to facilitate learning from experience (simplification and specialization) contribute to three forms of learning myopia - temporal, spatial, and failure myopia. |
| Nonaka | 1994 | Knowledge creation | Conceptual | Organizational knowledge is created through a continuous dialogue between tacit and explicit knowledge |
| Miller | 1996 | Organizational learning typology | Review | A typology of organizational learning by voluntarism vs. determinism and methodical vs. emergent: analytic, experimental, structural, synthetic, interactive, and institutional learning. |

Table 2-3, continued

| Author(s) | Year | Key term(s) | Type | Major findings |
|--------------------------------|-------------|-----------------------------------|-------------|--|
| Powell, Koput, and Smith-Doerr | 1996 | Networks of learning | Empirical | A network approach to organizational learning is developed. Longitudinal hypotheses linking R&D alliances, experience with managing interfirm relationships, network position, rates of growth and portfolios of collaborative activities are supported. |
| Szulanski | 1996 | Knowledge stickiness | Empirical | The major barriers to internal knowledge transfer are mainly knowledge-related factors instead of motivational factors. The knowledge-related factors include the recipient's lack of absorptive capacity, causal ambiguity, and an arduous relationship between the source and the recipient. |
| Grant | 1996 | Knowledge-based view | Conceptual | The firm is conceptualized as an institution for integrating knowledge. Coordination mechanisms through which firms integrate the specialist knowledge of their members are explored. |
| Spender | 1996 | Actor networks | Conceptual | Knowledge is viewed as a process, dynamic and contained within actor networks. Systemic and component attributes of the actor network differ in their implications for a dynamic knowledge-based activity system. |
| Liebeskind | 1996 | A theory of the Firm | Conceptual | Firms have particular institutional capabilities that allow them to protect knowledge from expropriation and imitation more effectively than market contracting. |
| Lane and Lubatkin | 1998 | Relative absorptive capacity | Empirical | The ability of a firm to learn from other organizations depends on the similarity of the partners' basic knowledge, lower management formalization, research centralization, compensation practices, and research communities. |
| Crossan, Lane, and White | 1999 | Organizational learning processes | Conceptual | Organizational learning is suggested as four processes: intuiting, interpreting, integrating, and institutionalizing across the individual, group, and organizational levels. |

Table 2-3, continued

| Author(s) | Year | Key term(s) | Type | Major findings |
|--------------------------------|-------------|--|-------------|--|
| Gulati | 1999 | Network resources, alliance formation | Empirical | Network resources, and alliance formation capabilities influence the likelihood of entering a new alliance in the subsequent year. |
| Hansen | 1999 | Tie strength, knowledge search, knowledge transfer | Empirical | Weak inter-unit ties can contribute knowledge search, whereas strong ties contribute to the transfer of complex knowledge. |
| Inkpen | 2000 | Knowledge acquisition | Conceptual | The acquisition of learning in alliance is determined by alliance knowledge accessibility, and knowledge acquisition effectiveness. |
| Dyer and Nobeoka | 2000 | Knowledge-sharing network | Empirical | Network-level intellectual property rights, and network-level knowledge-sharing processes are the keys to develop dynamic learning capacity. |
| Rothaermel | 2001 | Exploration, exploitation | Empirical | Incumbents with alliances for exploiting complementary assets outperform those with alliances for exploring the new technology, when they adapt to radical technological changes. |
| Yli-Renko, Autio, and Sapienza | 2001 | Social capital, knowledge acquisition | Empirical | Knowledge acquisition is positively related to social interaction customer network ties, and negatively to relationship quality. |
| McEvily and Chakravarthy | 2002 | Knowledge complexity, tacitness, specificity | Empirical | The complexity and tacitness of technological knowledge are useful for defending a firm's major product improvements from imitation, but not for protecting its minor improvements. The design specificity of technological knowledge delayed imitation of minor improvements. |
| Almeida, Dokko, and Rosenkopf | 2003 | External learning | Empirical | External learning increases with startup size. The mechanisms of external learning moderate the relationship between startup size and external learning. |

Table 2-3, continued

| | Locus of learning | | |
|-------------------|--|--|--|
| | Internal | | External |
| | History/Routines | Process/Knowledge | Routines/Process |
| Conceptual | Cyert and March (1963) Nelson and Winter (1982) Fiol and Lyles (1985) Levitt and March (1988) Weick (1991) Levinthal and March (1993) | Argyris (1976) Hedberg (1981) March (1991) Kogut and Zander (1992) Nonaka (1994) Grant (1996) Spender (1996) Liebeskind (1996) Crossan, Lane, and White (1999) | Brown and Duguid (1991) Inkpen (2000) Gnyawali and Stewart (2003) |
| Empirical | Cohen and Levinthal (1990) Lant, Milliken and Batra (1992) Gulati (1999) | Szulanski (1996) Hansen (1999) | Hamel (1991) Powell, Koput, and Smith-Doerr (1996) Lane and Lubatkin (1998) Dyer and Nobeoka (2000) Rothaermel (2001) Yli-Renko, Autio, Sapienza (2001) Almeida, Dokko, and Rosenkopf (2003) |

Table 2-4 Classification Of Research On Organizational Learning And Knowledge

The “history” focus has gained empirical support. Cohen and Levinthal (1990) empirically test that a firm's absorptive capacity is largely a function of the firm's level of prior related knowledge. The absorptive capacity indicates the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends. The identification of new knowledge involves a process of scanning and acquiring new knowledge, which is part of knowledge acquisition and learning (Huber, 1991). Gulati (1999) provides empirical evidence that firms with experience of alliances more likely set up new alliances next year. Lant, Milliken, and Batra (1992) suggest a managerial learning and reorientation with empirical evidence. They find that poor past performance, environmental awareness, top management team heterogeneity, and CEO turnover all increase the likelihood of organizational reorientation. This history-based view of learning has been applied to the MNC literature. Kuemmerle (1998) uses learning to indicate experience of setting up new laboratory sites, when he investigates the relationship between overseas laboratory size and performance.

Levinthal and March (1993), however, challenge the history-based view of learning. They uncover that simplification and specialization are the two major mechanisms to facilitate learning from experience of organizational learning. Unfortunately, the two mechanisms contribute to three forms of learning myopia - temporal, spatial, and failure myopia. Nevertheless, the “external” learning literature discussed later (e.g., Powell, Koput, and Smith-Doerr, 1996; Dyer and Nobeoka, 2000) has well adopted the history-based view of organizational learning, particularly the ideas of “routines.”

“Internal” process-oriented view of organizational learning Instead of focusing the history or experience aspect of organizational learning, other researchers have investigated the processes of organizational learning, and transformed organizational learning to be more knowledge-focused. Argyris (1976) differentiates single-loop and double-loop learning as different decision-making processes. As Huber (1991) argues that the distinction hardly exists in practice, the influence of this distinction, however, rather goes to innovation literature in terms of routine and radical learning or innovation (Easterby-Smith, Crossan, and Nicolini, 2000). Hedberg (1981) suggests a process of unlearning in organizational learning. The unlearning of obsolete and misleading knowledge is functional and even intentional. Along with the

development of the field by identifying the processes of learning, knowledge starts being focused as the content of learning. March (1991) classifies two learning processes – exploitation and exploration by looking into the knowledge exchange at difference levels. He suggests that the mutual learning between organizations and individuals results in the tendency of overemphasizing knowledge exploitation in organizations. Control for organizational learning is, therefore, a recommendation. Nonaka (1994) further investigates the mutual learning processes between organizations and individuals. He suggests that organizational knowledge is created through a continuous dialogue between tacit and explicit knowledge across individual and organizations. Grant (1996) theorizes firms as institutions for integrating individual knowledge. Nonaka (1994) and Grant (1996), among few others, signal the debut of knowledge-based view. They suggest that knowledge is a resource, a notion from the resource-based view in strategic management. However, Spender (1996) suggests knowledge as a process instead of a resource. Still in the camp of internal process-oriented view of organizational learning, Crossan, Lane, and White (1999) divide organizational learning into four processes: intuiting, interpreting, integrating, and institutionalizing across the individual, group, and organizational levels. The institutionalizing process is echoed by the knowledge-based view literature on knowledge transfer. Szulanski (1996) finds with empirical evidence that the major barriers to internal knowledge transfer are mainly knowledge-related factors, including the recipient's lack of absorptive capacity, causal ambiguity, and an arduous relationship between the source and the recipient. Hansen (1999) introduces network theory and finds that inter-unit ties influence the search and transfer of knowledge within an organization with a moderation effect of knowledge complexity.

Assuming knowledge as the content of learning, I include another stream of knowledge-based view work in the internal process-oriented organizational learning literature. This group of work investigates the nature and advantage of knowledge. Rooted in Transaction Cost Theory, Kogut and Zander (1992) suggest that knowledge can be a reason explaining for the existence of firm, a fundamental question for strategic management (Rumelt, Schendel, and Teece, 1994). They argue that firms do better than markets in sharing and transferring the knowledge of individuals and groups within an organization. Liebeskind (1996) further supports that firms have particular institutional capabilities that allow them to protect knowledge from expropriation

and imitation more effectively than market contracting. Regarding the nature of knowledge, epistemologist Polanyi (1967) articulates the distinction between tacit and explicit knowledge in his seminal work, which has inspired and enriched many studies in knowledge-based view (e.g., Nonaka, 1994; Hansen, 1999). McEvily and Chakravarthy (2002) have designed an empirical study to test the advantage or performance implication of knowledge. They find that the complexity and tacitness of technological knowledge are useful for defending a firm's major product improvements from imitation, but not for protecting its minor improvements. The design specificity of technological knowledge delayed imitation of minor improvements.

“External” organizational learning Strategic management paradigm has the tradition of emphasizing the importance of organizational alignment to external environments (Barnard, 1938; Lawrence and Lorsch, 1967). The attention to external environments appears in organizational learning as well. Fiol and Lyles (1985: 804) suggest four contextual factors that affect the probability of the occurrence of organizational learning. They are corporate culture conducive to learning, strategy that allows flexibility, an organizational structure that allows both innovativeness and new insights, and the environment. Gnyawali and Stewart (2003) suggest that the perception of the environment influences the use of learning processes in organizations, which in turn influences their learning types.

The external organizational learning literature is mainly a convergence of organizational learning and knowledge-based view. The definition of learning in this group of research is represented in Powell, Koput, and Smith-Doerr (1996), who suggest that organizational learning is both a function of access to knowledge and the capabilities for utilizing and building on such knowledge. The notion of communities-of-practice initiated by Brown and Duguid (1991) emphasizes the importance of external network to learning by an individual or an organization.

Inter-organizational learning constitutes the focus in the realm of external organizational learning. Hamel (1991) pioneers the view of alliances as a learning race. He challenges the traditional view of considering termination and economic returns as alliance performance. Instead, he suggests that learning is an important goal and outcome for alliances, based on his case studies. Lane and Lubatkin (1998) further argue with empirical evidence that the ability of a

firm to learn from other organizations depends on the similarity of the partners' basic knowledge, management formalization, research centralization, compensation practices, and research communities. In the tradition of Huber (1991), Inkpen (2000) suggests that alliance knowledge accessibility, and knowledge acquisition effectiveness determines the learning or knowledge acquisition in alliances. Comparing the performance implication of exploitation and exploration (March, 1991), Rothaermel (2001) finds that when adapting to radical technological change the biopharmaceutical industry, incumbents with alliances for exploiting complementary assets outperform those with alliances for exploring the new technology. Examining a cross-section of semiconductor startups, Almeida, Dokko, and Rosenkopf (2003) find that external learning increases with startup size. Moreover, the mechanisms of external learning moderate the relationship between startup size and external learning. For alliances, firms learn regardless of their size. For mobility and geographic co-location, the informal mechanisms of external learning, learning decreases with firm size.

Along with the rise of network theory in strategic management, network and communities-of-practice become the prevalent notions for inter-organizational learning. Applying network theory to biotechnology industry in a longitudinal study, Powell, Koput, and Smith-Doerr (1996) find empirical support to link network position, R&D alliances, experience with managing inter-firm relationships, rates of growth, and portfolios of collaborative activities. Based on an in-depth case study of Toyota and its suppliers, Dyer and Nobeoka (2000) suggest the importance of developing network-level intellectual property rights, and network-level knowledge-sharing processes in order to create and manage a high-performance knowledge-sharing network. The knowledge-sharing processes include supplier association, consulting teams, learning teams, and employee transfers. Yli-Renko, Autio, Sapienza (2001) find that social interaction, relationship quality, and customer network ties can increase knowledge acquisition, which in turn influence knowledge exploitation in young technology-based firms.

Overall, routines and processes have constituted the focus in the organizational learning literature. Comparing with MNC literature which highlights the complex institutional environments, the institutional influence has not been explicitly incorporated in organizational learning literature except in Miller (1996). Miller (1996) suggests a typology of learning by two

dimensions, namely, voluntarism/determinism and methodical/emergent dimensions. Institutional learning is a learning characterized with both determinism and emergent. Institutional learning highlights the importance to managerial thinking of institutional indoctrination, either subtle or direct (Miller, 1996; Selznick, 1957; Scott, 1995; DiMaggio and Powell, 1983). Miller (1996) suggests that institutional learning takes place at lower level than upper echelons, and middle managers. Structural learning typically happens at the same level with the nature of determinism, but it suggests the importance of methodical analysis to organizational learning. Routine-based learning belongs to this camp, because routines standardize the learning process. Research on routines has become a tradition in organizational learning literature (e.g., Nelson and Winter, 1982; Levitt and March, 1988; Powell, Koput, and Smith-Doerr, 1996; Dyer and Nobeoka, 2000). The research on institutional learning falls short, though. As foreign subsidiaries are at lower level than headquarters or parent companies, and the diverse institutional environments present challenges for MNCs to implant routines worldwide, institutional learning seems promising in MNC learning through subsidiaries. Thus, an investigation of organizational learning in the context of MNCs can advance the understanding of institutional learning, which is under investigation in the current organizational learning literature. Moreover, the dual institutional focus that emerges in the MNCs literature can contribute to the organizational learning literature with a balanced view of both internal and external learning. The current literature with a single focus in organizational learning does need justifications. An empirical test with a dual focus can timely meet the need.

2.3 Research on organizational innovations

Table 2-5 summarizes the major findings in innovation literature in the area of Strategic Management. Instead of being exclusive, this list is rather representative. The list is in chronological order. Again, I classify them with their research focus. If a study focuses on the internal institutional environments of an organization, I name it as “internal.” If a study investigates the relationship between innovations with factors outside an organization, I name it as “external.” The classification appears in Table 2-6.

“Internal” organizational innovation research Innovations have been considered as a key indicator of organizational adaptability (e.g., Eisenhardt and Tabrizi, 1995). Equipped with organizational theory, studies in the field of strategic management have long focused on organizational characteristics that facilitate innovations. Burns and Stalker (1961) have used a configuration approach and found that organic systems of management are better associated with successful innovations than mechanic systems of management. Integrating the abundant but fragmented previous literature, Damanpour (1991) conducts a meta-analysis to determine the relationships between organizational innovation and thirteen potential determinants. He finds nice significant predictors of innovations, including specialization, functional differentiation, professionalism, centralization, managerial attitude toward change, technical knowledge resources, administrative intensity, slack resources, and external and internal communication. His moderator analyses indicated that the type of organization adopting innovations and their scope are more effective moderators of the predicting relationships than the type of innovation and the stage of adoption. With all the organizational determinants of innovations suggested in previous literature, Brown and Eisenhardt (1995) highlight the distinction between process performance and product effectiveness and the importance of agents, including team members, project leaders, senior management, customers, and suppliers. They categorize product development research into three streams – product development as rational plan, communication web, and disciplined problem solving. Based on resource- or competence-based view, Henderson and Cockburn (1994) distinguish between "component" and "architectural" competence, and suggest their implications to research productivity in pharmaceutical industry. Similarly, Kusunoki, Nonaka, and Nagata (1998) classify organizational capabilities into "local," "architectural," and "process" capabilities along the two dimensions of modularity and designability. They discuss the various product development performances of these organizational capabilities in Japanese firms.

Instead of investigating organizational innovation as a whole, some studies take a more focused approach. For examples, Eisenhardt and Tabrizi (1995) examine the speed of product innovation, and Klein and Sorra (1996) focus on innovation implementation. Comparing two theoretical models on the speed of product innovation, Eisenhardt and Tabrizi (1995) find in their field study that hypotheses based on experiential theory of uncertainty are better supported

than compression theory of certainty in the global computer industry. Faster product development is associated with more testing, more frequent milestones, more iteration, and multifunctional teams. Planning and CAD usage are surprisingly associated with slower product development. Project leader power, supplier involvement, project overlap, and reward for schedule attainment do not bear significant influence on the speed of product development in the study. Klein and Sorra (1996) find that successful innovation implementation requires a favorable climate and the fit of that innovation to the values of targeted users.

Other researchers, on the other hand, look into factors that inhibit organizational innovations. Leonard-Barton (1992) suggests that traditional core capabilities can inhibit innovation. Dougherty and Heller (1994) have further explored the paradox. They argue that product innovation is illegitimate in large, mature firms, because it either violates established practice or falls into a vacuum where no shared understandings exist to make them meaningful. Dougherty and Hardy (1996) add that the key to overcome the illegitimacy is to connect new products with organizational resources, processes, and strategy. Unfortunately, innovators lack the power to make the connections. Building upon the distinction of sustaining and disruptive technology, Christensen (1997) argues that large firms willingly develop sustaining technology but resist disruptive technology, which fail them. Henderson and Clark (1990), however, argue that the distinction between incremental or radical innovation does not account for all the disastrous effects on industry incumbents. They distinguish architectural innovation from component innovation. If a seemingly minor improvement in technological products carries the nature of architectural innovation, it can become fatal because architectural innovation destroys the usefulness of the architectural knowledge embedded in the structure and information-processing procedures of established organizations. Moreover, the destruction is difficult for firms to recognize and hard to correct.

Remedies to the organizational myopia to innovations are suggested in some studies. Day (1994) have found three processes for successfully championing radical product innovations, including top management champions, dual-role champion of both product champion and organizational sponsor), and bottom-up champion. Galunic and Eisenhardt (2001) suggest that firms can use modular corporate forms to take advantage of architectural innovation and thus

| Author(s) | Year | Key term(s) | Type | Major findings |
|---------------------|-------------|------------------------------------|-------------|--|
| Schumpeter | 1934 | Entrepreneurship | Conceptual | Innovation and entrepreneurship drives economic development. |
| Burns and Stalker | 1961 | Organic, mechanic organizations | Empirical | Organic systems of management fit in changing environments, whereas mechanic systems of management fit in stable environments. |
| Kamien and Schwartz | 1975 | Market structure, innovation | Review | For inventions of small value, monopoly leads to most rapid development, whereas rivalry does for more valuable inventions. Monopoly retards innovation of a superceding product. |
| Drucker | 1985 | Innovation, entrepreneurship | Applied | Innovation and entrepreneurship are purposeful tasks that require the attention of executives. Successful practices and policies are introduced. |
| Von Hippel | 1988 | Innovation source | Empirical | Product manufacturers is not the only source of new product innovations. Customers, suppliers, and other companies or institutions are the typical sources of innovation in some industries. |
| Henderson and Clark | 1990 | Architectural innovation | Empirical | Architectural innovations destroy the usefulness of the architectural knowledge embedded in the structure and information-processing procedures of established organizations. The destruction is difficult for firms to recognize and hard to correct. |
| Saxenian | 1990 | Local network, knowledge diffusion | Empirical | Local network facilitates the transmission of knowledge through communication between individuals across agents, firms, and even industries is conducive to innovative activity. |
| Damanpour | 1991 | Innovation determinants | Empirical | A meta-analysis confirms 9 determinants of organizational innovation. The type of organization and their scope are more effective moderators than the type of innovation and the stage of adoption |
| Leonard-Barton | 1992 | Core capabilities, core rigidities | Field study | Traditional core capabilities have a downside that inhibits innovation, called core rigidities. |

Table 2-5 Literature Summary On Organizational Innovation

| Author(s) | Year | Key term(s) | Type | Major findings |
|------------------------|-------------|--|-------------|--|
| Day | 1994 | Championing processes, new internal ventures | Empirical | Top-down championing processes are relatively unexplored comparing with bottom-up championing. Top-down champions are classified into top management champions, and dual-role champions (product champion and organizational sponsor). They emerge according to the nature of the innovative ventures. |
| Dougherty and Heller | 1994 | Product innovation, illegitimacy | Empirical | Product innovation is illegitimate, because it either violates established practice or falls into a vacuum where no shared understandings exist to make them meaningful. |
| Henderson and Cockburn | 1994 | Component, architectural competence | Empirical | The analysis distinguishes between "component" and "architectural" competence. The two forms of competence are important for research productivity. |
| Lipparini and Sobrero | 1994 | Entrepreneurship, networks | Empirical | When the entrepreneur is leading and managing the business, more suppliers are involved in the development of new products. The type of contribution given by suppliers differs by management typology. |
| Brown and Eisenhardt | 1995 | Product development | Review | Three streams of research in NPD: product development as rational plan, communication web, and disciplined problem solving. |
| Eisenhardt and Tabrizi | 1995 | Product innovation speed | Empirical | Two theoretical models for firms' achieving fast adaptation through product innovation are contrasted. Hypotheses based on experiential theory of uncertainty are better supported than compression theory of certainty. |
| Dougherty and Hardy | 1996 | Innovation, legitimacy | Empirical | The inability to connect new products with organizational resources, processes, and strategy impedes innovation in large, mature organizations. Innovators lack the power to make these connections. |

Table 2-5, continued

| Author(s) | Year | Key term(s) | Type | Major findings |
|------------------------------|-------------|---|-------------|---|
| Klein and Sorra | 1996 | Innovation implementation | Conceptual | The implementation effectiveness of innovations refers to the consistency and quality of targeted organizational members' use of an innovation. It is determined by the organization's climate for the implementation of that innovation, and the fit of that innovation to targeted users' values. |
| Pouder and St.John | 1996 | Geographical clusters, innovation | Conceptual | Industry innovation changes over a cluster life cycle, increasing in the origination phase, and decreasing in the convergence phase. |
| Christensen | 1997 | Disruptive technology | Empirical | Disruptive technology makes large firms vulnerable. Strategies to manage disruptive technology change is discussed. |
| Kusunoki, Nonaka, and Nagata | 1998 | Organizational capabilities, innovation | Empirical | Organizational capabilities are classified into "local," "architectural," and "process" capabilities along two dimensions: modularity and designability. The effects of these organizational capabilities varies in product development performance. |
| Tsai and Ghoshal | 1998 | Social capital, intrafirm networks | Empirical | Social interaction and trust are related to interunit resource exchange, and sequentially to product innovation. |
| Ahuja | 2000 | Inter-firm network, and innovation | Empirical | In the inter-firm collaboration network, direct and indirect ties are positive related to innovation, and structural holes are negatively related to innovation. |
| Fritsch and Lukas | 2001 | R&D cooperation | Empirical | Having a gatekeeper, company size and R&D expenses, industry, and regions can all account for R&D cooperation with customers, suppliers, competitors and public research institutions |
| Galunic and Eisenhardt | 2001 | modular corporate forms | Field study | Dynamic capabilities can be achieved through charter change or architectural innovation within firms with modular corporate forms. |

Table 2-5, Continued

| Author(s) | Year | Key term(s) | Type | Major findings |
|---------------------|-------------|---|-------------|---|
| Rao and Drazin | 2002 | Recruiting talent from rivals, product innovation | Empirical | Young and poorly-connected firms use recruitment of talents from rivals as a practical strategy to overcome constraints on product innovation. However, the practice has stronger effects on product innovation only in poorly connected organizations. |
| Hill and Rothaermel | 2003 | Firm survival, radical innovation | Conceptual | Incumbents can survive through radical technological innovations by investments in basic research so as to accumulate the necessary absorptive capacity. |

Table 2-5, continued

| | Research Focus | |
|-------------------|---|---|
| | Internal | External |
| Conceptual | Brown and Eisenhardt (1995) Klein and Sorra (1996) | Kamien and Schwartz (1975) Pouder and St.John (1996) |
| Empirical | Burns and Stalker (1961) Henderson and Clark (1990) Damanpour (1991) Leonard-Barton (1992) Day (1994) Dougherty and Heller (1994) Henderson and Cockburn (1994) Eisenhardt and Tabrizi (1995) Dougherty and Hardy (1996) Christensen (1997) Kusunoki, Nonaka, and Nagata (1998) Tsai and Ghoshal (1998) Galunic and Eisenhardt (2001) Hill and Rothaermel (2003) | Von Hippel (1988) Saxenian (1990) Lipparini and Sobrero (1994) Ahuja (2000) Fritsch and Lukas (2000) Rao and Drazin (2002) |

Table 2-6 Classification Of Research On Organizational Innovation

achieve dynamic capabilities. Hill and Rothaermel (2003) argue that incumbents can survive through radical technological innovations by investing in basic research. Social network of innovators within a firm can also contribute to successful championing (Floyd and Woolridge, 1999). Tsai and Ghoshal (1998) confirm the positive relationship between social capital in intrafirm networks and product innovation. They use social capital to indicate trusting relationship, trustworthiness, and social interaction ties among units.

External organizational innovation research Innovation is a traditional discipline in economics research. Economics studies tend to investigate the relationship between innovation and factors of larger domain than firms, like economic development and market structure. Schumpeter (1934) calls attention to innovation by arguing that innovation is the key driver for economic development. Kamien and Schwartz (1975) have reviewed existing literature that discusses the relationship between market structure and innovation. They conclude that monopoly or lack of rivalry leads to most rapid development of inventions of small value, whereas rivalry leads to more valuable inventions. Monopoly retards innovation of a superceding product or a disruptive technology.

In spite of the traditional attention to internal organizational characteristics and capabilities in the area of strategic management, recent studies start looking outside firms and find sources of innovations. Drucker (1985) has offered practical suggestions on monitoring seven sources, mainly external, for innovative opportunity. Von Hippel (1988) further challenges the traditional introspective assumption. Collecting data from various industries, he finds that product manufacturers are not the only source of new product innovations. Customers, suppliers, and other companies or institutions are the typical sources of innovation in some industries. Saxenian (1990) further explores the close relationship between these firms and institutions and the performance implications by investigating regional clusters. Applying a knowledge perspective, she finds that the local network in the clusters facilitates the transmission of knowledge through communication between individuals across agents, firms, and even industries. The knowledge transmission is conducive to innovative activity. However, Poudel and St. John (1996) suggest a twist to this finding. They argue that clusters have a life cycle too. Industry innovation increases in the origination phase, and decreases in the convergence phase. Going beyond special clusters, Ahuja (2000) applies a network approach and finds that firms can generate more innovations by developing collaboration networks with more direct ties. Increasing structural holes in the collaboration networks, however, may reduce innovation generations. Poorly connected firms can recruit talents from rivals in order to increase product innovation. The practice, however, does not work for young firms (Rao and Drazin, 2002).

The studies on the external network and innovations have gone beyond the performance implication. With a “who” question in their mind, Lipparini and Sobrero (1994) explore the role of entrepreneurs in promoting external and innovative ties. Particularly in their study of Italian industrial networks, they find that when entrepreneurs are leading a business, more suppliers are involved in the development of new products. Based on a sample of German manufacturing enterprises, Fritsch and Lukas (2001) find that firms engaging in R&D cooperation with customers, suppliers, competitors and public research institutions tend to be relatively large and have a high share of R&D. They are more likely to have a Gatekeeper who is screening the environment for the innovation activity. They also find industry effect and interregional differences on the tendency of developing R&D cooperation.

Learning and innovation The two areas of organizational learning and innovations are quite related. Cohen and Levinthal (1990), and Brown and Duguid (1991) have advocated a unified view between learning and innovation. Powell, Koput, and Smith-Doerr (1996) find that the locus of innovation in biotechnology industry is the networks of learning. Yli-Renko, Autio, Sapienza (2001) find that learning or knowledge acquisition is the mediator between social networks and new product development. The underlying theme of both learning and innovation literature is the adaptability or dynamic capabilities.

2.4 Summary and conclusions

This chapter has reviewed the theoretical and empirical literature on MNCs, organizational learning, and innovation. Each research stream bears its own research interests, focus, and theories. Knowledge-based view and network theory are rising in MNC literature recently. The “dual” research on MNCs is particularly promising due to the nature of MNCs. With a broad and inclusive perspective of organizational learning, I have reviewed the traditional domain of organizational learning, and its current emerging themes. Organizational learning originates with a focus on history and routine. Recently, it has been enriched with studies building on knowledge-based view and network perspective. Innovation literature has also seen a rise of network perspective, in addition to the traditional focus on organizational characteristics

and capabilities. The “dual” focus that emerges in the MNCs literature has been basically absent in both the organizational learning and innovation literature.

Thus, the abundant literature in these three areas can surely equip me with current understanding in relation to the purpose of this research. The conversation across the three areas builds the foundation of this research. Moreover, it helps me identify a unique perspective to address the research questions of this study. In next chapter, I will develop a conceptual framework using a “dual” approach. I will also develop a set of hypotheses regarding the contextual factors that influence subsidiaries learning from local environments.

Chapter 3 A Conceptual Framework And Hypotheses

With the identified gap and current understanding of the issue in question from last chapter in my mind, I am building a conceptual framework in this chapter. I adopt a “dual” perspective on the organizational environments of a subsidiary (Figure 1-1). A good theory requires parsimony, testability, and logical coherency (Pfeffer, 1982). The abundant literature on organizational learning, knowledge-based view, and innovation particularly presents challenges to build a parsimonious model. I apply a behavior framework (i.e., motivation-awareness-capability) of organizational action (Chen, 1996; Lant, Milliken and Batra, 1992; Allison, 1971), in order to achieve theoretical parsimony and coherence. Given the promising contribution of “dual” studies in learning and innovation literature, I adopt a cross-level approach, investigating contextual factors in not only external and internal environments, but also the interaction between subsidiaries and their environments. I develop a set of testable hypotheses to address the two research questions – What factors influence the learning of MNCs’ foreign subsidiaries from local environments? To what extent can a subsidiary’s learning from local environments impact its knowledge outflow to the rest of the MNC?

Given the research context and research gaps, I focus on institutional learning instead of routines and processes when I identify the predictors of localized subsidiary innovation. Institutional learning roots in institutional theory. Both internal and external environments can serve as the source of learning (Scott, 1995). Different from learning through programmed routines, institutional learning suggests an emergent and inductive process (Miller, 1996). The institutional theory suggests a unique unit of analysis, neither a single organization nor a population of firms as suggested in population ecology literature (DiMaggio and Powell, 1983). The network view of MNCs suggests a similar level of unit of analysis, i.e., organization set (Ghoshal and Bartlett, 1990). I limit the organizational learning of subsidiaries from local environments to the MNC organizational set and local organizational set. A MNC organizational set involves parent company and sister subsidiaries that a focal subsidiary has contacts with. A local organization set involves local competitors, customers, suppliers and research institutions. I am interested in how the two organizational sets influence the learning of subsidiaries from local environments. Parent companies can serve as the influential members suggested in Meyer and

Rowan (1977), which “teach” subsidiaries to learn from local environments through indoctrination. Institutional learning emphasizes values and beliefs (Miller, 1996). In addition to the institutional learning approach, I integrate subsidiary factors simultaneously into the proposed model.

Figure 1-2 presents the conceptual framework developed in this research of subsidiary learning from diverse local environments. As the figure illustrates, I argue that localized subsidiary innovation is influenced by local embeddedness, learning strategy, competition intensity, corporate entrepreneurial culture, and top management team heterogeneity. In turn, localized subsidiary innovation impacts knowledge outflow from the subsidiary to the rest of the MNC. Inter-subsidiary communication of the subsidiary moderates the relationship between localized subsidiary innovation and knowledge outflow. I will develop arguments relating to each element of the conceptual model below. My discussion begins with localized subsidiary innovation and its antecedents, followed by a discussion of knowledge outflow.

3.1 Localized subsidiary innovation

Localized subsidiary innovation indicates the extent to which subsidiaries “develop and adopt new product, processes, or administrative systems locally” (Ghoshal and Bartlett, 1988: 365). A localized subsidiary innovation can either be developed internally within a subsidiary or acquired from local environments (Nelson and Winter, 1982). For example, Philips of Canada created the company’s first color TV, Philips of Australia created the first stereo TV, and Philips of the United Kingdom created the first TVs with teletext. An innovation is a “new combination of means of production” (Schumpeter, 1961/1934: 47). It can take shape in many forms, such as a new product, a new process, or a new organizational structure (Schumpeter, 1934). It may be a recombination of old ideas, a formula, a unique approach, or a scheme that challenges the present order. As long as the people involved perceive the idea as new, it is an “innovation,” even though it may appear to others to be an “imitation” of something that exists elsewhere (Van de Ven, 1986: 591). Bearing all the natures of an innovation, a localized subsidiary innovation is unique

in that the new idea or innovation is not only perceived by a focal subsidiary, but also by the MNC of the subsidiary.

Localized subsidiary innovation can result from subsidiaries learning from valuable local knowledge. A number of investigators have acknowledged the close relationship between learning and innovation (e.g., Cohen and Levinthal, 1990; Brown and Duguid, 1991; Powell et al., 1996; Yli-Renko et al., 2001). Learning and innovation have been identified as important strategic objectives of MNCs (Ghoshal, 1987). As valuable knowledge has been increasingly dispersed worldwide, the ability to learn from diverse international environments is a critical source of competitive advantage for MNCs (Doz et al., 2001). Gaining access to knowledge in these diverse environments often requires a physical presence because local knowledge is typically “sticky” and tacit to the local markets (Szulanski, 1996; Doz et al., 2001). By taking advantage of valuable local knowledge, subsidiaries can provide MNCs diverse capabilities that increase the adaptation of MNCs and enhance the probability of their survival (Ghoshal, 1987).

The case of Proctor and Gamble illustrates the preceding point. As early as 1955, the overseas vice president of Proctor and Gamble established principles for foreign subsidiary development. Recognizing the unique preference of foreign consumers, the overseas vice president emphasized the importance of acquiring the same intensive level of knowledge regarding local consumers as was those regarding domestic customers acquired in the United States (Bartlett, 1983). In the 1970s and 1980s, many MNCs set up “scanning units” to tap into ideas coming out of key foreign markets. For example, European MNCs such as Volkswagen, Volvo, and Ericsson established development centers in California. Philips set up a lab in Aachen (Germany) for fiber optics technology, a lab in Paris (France) for chip materials and design, and a research lab in Hamburg (Germany) for medical imaging technology (Business Week, 1988). Investigating the process of subsidiary learning and innovation would therefore have both research and managerial significance. In this study, I use localized subsidiary innovation to focus on the innovation output of a subsidiary. Thus, localized subsidiary innovation is different from innovation efforts. Innovation output is a question of research productivity (Kamien and Schwartz, 1975; Ahuja, 2000).

The seminal research, which explored how subsidiaries create new knowledge through learning from local environments, has left many questions as yet unanswered. Ghoshal and Bartlett (1988) discussed how subsidiaries created innovations but focused only on the factors within MNCs. Recent research on internationalization of R & D has emphasized the importance of local resources for MNC innovations (Meyer-Krahmer and Reger, 1999; Pearce, 1999; Kuemmerle, 1999; Zander, 1997), but has failed to explore the factors that facilitate innovations by learning from these local resources. Birkinshaw et al. (1998: 226) briefly discussed the influence of local competition on subsidiary initiatives of MNCs. However, their research focused on the contributing role of subsidiaries and did not discuss the influence of the interface between subsidiaries and local environments.

Adopting the behavioral framework of organizational action (Chen, 1996; Lant, Milliken and Batra, 1992; Allison, 1971), this research considers three essential enablers for a subsidiary to learn from local environments: (1) the awareness of local knowledge, (2) the motivation to learn from local environments, and (3) the capability to learn from local environments. Based on a wide range of theories, this research proposes that at the interface level, a subsidiary's local inter-organization networks and its learning strategy influence the awareness of local strategic knowledge by the subsidiary, thereby affecting localized subsidiary innovation. At the context level, local market competition and corporate entrepreneurial culture influence the motivation of a subsidiary to learn from diverse local environments, therefore influencing localized subsidiary innovation. Finally, at the subsidiary level, diversity of the top management team influences the capability of a subsidiary to learn from local environments, thus impacting localized subsidiary innovation. The subsequent discussion of antecedents follows this order.

3.2 Local market-subsidiary interface: Local embeddedness

Local embeddedness can impact localized subsidiary innovation by influencing subsidiaries' awareness of valuable local knowledge. I define "local embeddedness" as the extent to which a subsidiary is connected with local institutions. Local institutions include suppliers, customers, and research institutions. Local embeddedness involves two aspects: 1) connectedness to local institutions; and 2) tie strength with local institutions. Connectedness is

the number of local institutions that a subsidiary has connections with. Tie strength is “the frequency of interaction between partners and their level of resource commitment to the relationship” (Rowley, Behrens, and Krackhardt, 2000). The interaction between subsidiaries and local institutions varies from an arm’s-length transaction to ownership exchange. Ownership exchange typically results in a stronger tie than the arm’s-length transaction between subsidiaries and local institutions. Local embeddedness is one type of network resources that subsidiaries have within the context of a local market. Interfirm network resources are also sources of firm heterogeneity and can be developed as sources of competitive advantage (Gulati, 1999; McEvily and Zaheer, 1999; Dyer and Singh, 1998). The content of network resources can be the exchange of asset, information, or social status (Gnyawali and Madhavan, 2001). This research will focus on knowledge-related strategic assets or information.

Connections with customers, suppliers, and research institutions can be important network resources for localized subsidiary innovation. These network resources increase the awareness and accessibility of local strategic knowledge by subsidiaries. Signals from multiple sources facilitate awareness of the signals (Ansoff, 1975). Source accessibility influences the choice of information sources greatly (O’Reilly, 1982). The ties between subsidiaries and multiple local institutions such as customers, suppliers, and research institutions can therefore increase both the awareness and availability of local knowledge embedded in these local information sources.

In certain industries such as scientific instruments, more than two-thirds of the innovations could be traced back to a customer's initial suggestions or ideas (Von Hippel, 1988). A good understanding of new markets (Cooper, 1983) and the availability of market and customer information (Moorman, 1995) determine the possibility of innovation. Customers can provide user know-how regarding product improvement possibilities, new functional requirements, the value of prototypes, and the like (Yli-Renko, Autio, and Sapienza., 2001). Connections with customers can assist in avoiding the misalignment between market and innovation, and this misalignment hinders the success of innovation (Dougherty and Heller, 1994). Involving customers can also improve the effectiveness of new product development (Brown and Eisenhardt, 1995). Connections with suppliers facilitate innovation as well. In

industries such as wire termination equipment, the majority of innovations could be traced back to suppliers (Von Hippel, 1988). Hewlett Packard and other Silicon Valley firms have greatly decreased total value chain costs, increased product differentiation, and shortened product development cycles by developing long-term partnerships with physically proximate suppliers (Saxenian, 1994). Involving suppliers can improve the effectiveness of new product development (Brown and Eisenhardt, 1995). Connections with local research institutions assist subsidiaries in accessing information about new research or new products and also in accessing local researchers. Kuemmerle (1999) observes that firms in the pharmaceutical and electronics industries often locate their R&D sites close to universities. In the biotechnology industry, patents are typically filed by a large number of individuals working for different organizations, including biotech firms, pharmaceutical companies, and universities (Powell, Koput, and Smith-Doerr, 1996).

Moreover, the exposure to many different external contacts is essential to learning (McEvily and Zaheer, 1999). Connections with customers, suppliers, and research institutions provide knowledge diversity to subsidiaries. Knowledge diversity can increase the depth, breadth, and speed of subsidiary learning, leading to a greater number of product introductions (Yli-Renko et al., 2001). In fact, overseas subsidiaries have become increasingly engaged in the local integration of several related technologies (Zander, 1997). The R&D units that provide more R&D inputs to MNCs typically have more communication with external institutions such as local universities, customers, and suppliers (Nobel and Birkinshaw, 1998). Toshihiko Yamashita, the president of Matsushita launched an Operation Location program in 1982 in order to help Matsushita's overseas subsidiaries develop innovative capability. The Operation Location program included technology and material localization. To carry on this program, the company developed its national subsidiaries' expertise to source equipment locally, modify designs to meet local requirements, incorporate local components and adapt corporate processes and technologies to accommodate these changes. Therefore, when subsidiaries develop connections to local institutions, the probability of localized subsidiary innovation becomes higher.

Tie strength, as another aspect of local embeddedness, influences localized subsidiary innovation as well. First, strong ties enhance relation-specific investments and develop

knowledge-transfer routines between subsidiaries and local institutions. Firms engaging in frequent and recurring transactions can afford to adopt more specialized and complex governance structures (Williamson, 1985). Thus, subsidiaries and local institutions can invest on physical asset specificity such as customized machinery and tools that are tailored to each other. Human asset specificity increases as the transaction-specific know-how accumulates through longstanding relationships (Williamson, 1985; Dyer and Singh, 1998). For example, Toyota set up strong ties with its suppliers through consulting teams, learning teams, and employee transfers. Knowledge-transfer mechanisms (Von Hippel, 1988) or knowledge-transfer routines (Dyer and Singh, 1998; Grant, 1996), as a regular pattern of interfirm interactions that permits the transfer of specialized knowledge, are more likely to emerge. Both the physical and human asset specificities facilitate effective communication of knowledge (Dyer, 1996). Since firms create innovations through knowledge communication and combination (Schumpeter, 1934; Kogut and Zander, 1992), strong ties facilitate localized subsidiary innovation through increased physical and human asset specificities. The strong ties with suppliers resulted in the dynamic learning capacity of Toyota (Dyer and Nobeoka, 2000).

Secondly, strong ties enhance the ability of subsidiaries to identify and combine the complementary resources or capabilities within local institutions. Resources are important for innovations (Dougherty, and Hardy, 1996). For example, complementarities can be composed of linkages between the strong basic research capabilities of US firms and the unique local knowledge and distribution capabilities of their partners in overseas markets (Shan and Hamilton, 1991). Rothaermel (2001) suggested that established firms adapt to radical technological change through exploitation of complementary assets within new entrants. Firms such as Hewlett Packard, Xerox, and Microsoft even appointed a Director of Strategic Alliances in order to screen potential partners and ensure the accumulation of knowledge on successful partner combinations. Although complementary resources facilitate innovation, firms vary in the ability to identify potential partners and their complementary resources. The ability to exploit outside sources of knowledge is largely a function of prior related knowledge or the "absorptive capacity" of the recipient of knowledge (Cohen and Levinthal, 1990). Strong ties increase the depth, breadth, and efficiency of mutual knowledge exchanges (Lane and Lubatkin, 1998) between subsidiaries and local institutions. The exposure to new knowledge will develop the

absorptive capacity of subsidiaries. Moreover, strong ties facilitate the discovery of effective means for communication with local institutions. In fact, through frequent communication with external institutions, new product development teams are “likely to develop an absorptive capacity such that they become more efficient in gaining and using the information being conveyed (Brown and Eisenhardt, 1995: 368). Therefore, strong ties facilitate localized subsidiary innovation by developing the ability of subsidiaries to identify and combine potential complementary resources.

Third, strong ties facilitate learning from local know-how and in turn, develop localized subsidiary innovation. Many scholars divide knowledge into two types: information and know-how (Grant, 1996; Kogut and Zander, 1992). Information is easily codifiable such as facts and symbols, whereas know-how involves knowledge that is tacit, "sticky", and complex (Kogut and Zander, 1992; Nelson and Winter, 1982; Szulanski, 1996). Deeply rooted in action, and involvement in a specific context, tacit know-how represents the basis of knowledge creation (Nonaka, 1994; Polanyi, 1996). Since strong ties facilitate the exchange of tacit knowledge (Hansen, 1999), localized subsidiary innovation requires strong ties between subsidiaries and local institutions. Thus,

Hypothesis 1: Subsidiaries with higher local embeddedness would develop more localized subsidiary innovations than subsidiaries with lower local embeddedness.

3.3 MNC corporate-subsidiary interface: Learning strategy

Another factor to increase the awareness of local strategic knowledge by subsidiaries is the learning strategy of subsidiaries. The mere existence of diverse local environments of MNCs would not enhance learning, but only create a potential for learning (Ghoshal, 1987). Without explicit intention and appropriate mechanisms, the learning potential can be lost because subsidiaries may pay little attention to the existence of local knowledge. Subsidiaries implementing learning strategies would more likely take advantage of local knowledge. Learning strategy is defined as the extent to which the goal of a subsidiary is to augment the knowledge base of its MNC or exploit the knowledge base (Kuemmerle, 1999; March, 1991). Knowledge

exploration and exploitation are the two types of learning strategies. Knowledge exploration is to discover new possibilities and new technology, and knowledge exploitation is to refine an existing technology and extension of old certainties (March, 1991). Since knowledge exploitation and knowledge exploration compete for scarce resources, organizations have to make explicit or implicit choices between the two types of learning strategies (March, 1991). Explicit choices are made by calculated decisions about alternative strategies, and implicit choices are “buried in many features of organizational forms and customs” (March, 1991: 71). Research on typologies of subsidiaries has implied heterogeneity in learning strategies of subsidiaries. For instance, subsidiaries that implement knowledge exploration are “global innovators” (Gupta and Govindarajan, 1991) or “global creators” (Nobel and Birkinshaw, 1998). Subsidiaries that implement knowledge exploitation are “implementers” (Gupta and Govindarajan, 1991) or “local adapters” (Nobel and Birkinshaw 1998).

Although both can result in innovation by learning from valuable local knowledge, this research suggests that subsidiaries with knowledge exploration as the learning strategy will result in more localized subsidiary innovation than subsidiaries with knowledge exploitation as the learning strategy. First, subsidiaries with knowledge exploration as the learning strategy tend to search for local strategic knowledge. With the objective of augmenting the knowledge base of MNCs, these subsidiaries increasingly engage in small-scale activities to monitor and scan new technological developments (Patel and Vega, 1999). By contrast, subsidiaries with knowledge exploitation as the learning strategy focus on making the best use of existing knowledge. This focus makes resource allocation in these subsidiaries favorable to learning from within MNCs instead of learning from local knowledge. Second, subsidiaries with knowledge exploration as the learning strategy develop the ability to identify local strategic knowledge through experiences. Since the goal of these subsidiaries is to augment the knowledge base of MNCs, the relevance of local knowledge is less of a concern. By experimenting with diverse local knowledge, subsidiaries with knowledge exploration as learning strategy develop absorptive capacity to identify local strategic knowledge. With identified valuable local knowledge, subsidiaries are more likely to create localized subsidiary innovation. By contrast, knowledge exploitation requires the organization to focus on incremental innovation based on the existing technology. The learning objective of subsidiaries is only to adapt products, processes, or

materials to suit local markets. Only the valuable local knowledge that is relevant to the existing technology could be picked up to develop a localized subsidiary innovation. In fact, “Global innovators”, namely those with knowledge exploration as the learning strategy innovate more and contribute more knowledge to the MNC (Gupta and Govindarajan, 1991). Based on this discussion, I propose the following:

Hypothesis 2: The learning strategy of a subsidiary would influence its localized subsidiary innovation.

Hypothesis 2a: Subsidiaries with higher emphasis on knowledge exploration would develop significantly more localized subsidiary innovations than subsidiaries with lower emphasis on knowledge exploration.

Hypothesis 2b: Subsidiaries with higher emphasis on knowledge exploitation would not develop significantly more localized subsidiary innovations than with lower emphasis on knowledge exploitation.

3.4 Local context: competition intensity

Competition intensity can impact localized subsidiary innovation by influencing subsidiaries’ motivation to learn from valuable local knowledge. Competition intensity is defined as the level of competitive actions initiated by subsidiaries’ local competitors. Competitive actions can involve pricing, advertising, new product or service introductions, or change in market scope (Miller and Chen, 1994). Competition intensity has two aspects: 1) the number of competitors; and 2) the frequency of competitive initiatives. When the number of competitors is high, competition intensity will be likely high (Porter, 1980). When competitors aggressively compete for competitive advantages, the competition intensity is high. High competition intensity can stimulate the motivation of subsidiaries to learn from diverse local environments.

High competition intensity, due to high number of competitors, motivates localized subsidiary innovation. Institutional theory suggests that mimetic isomorphism resembles companies (DiMaggio and Powell, 1983). The mimetic outcome depends on the number of

competitors and the extent to which they learn from the experience of others (Levitt and March, 1988). Geographic proximity facilitates mimetic isomorphism due to the increased possibilities of knowledge spillover to competitors. Information flows locally more easily than over greater distances (Marshall, 1920). Geographical proximity provides informal channels that allow codified knowledge to be disseminated faster and also to enable the dissemination of tacit knowledge (Maskell, 1999). Informal channels include the exchange of employees, related industries, industry "spin-off", personal networks of employees, apparent design elements that are easily captured by eyes and ears (Tallman, Jenkins, Henry, and Pinch, 1999). Other scanning mechanisms of competition intelligence such as trade shows, publications, and professional meetings also present threats to knowledge advantages of subsidiaries. For example, patent citations tend to occur more frequently within the state in which they were patented than outside of that state (Jaffe, Trajtenberg and Henderson, 1993). Learning that the team-selling techniques of its British competitor succeeded, an international pharmaceutical firm asked its British subsidiary to learn from it (Cerny, 1996). Knowledge spillover presents continuous pressures on subsidiaries to innovate in order to sustain competitive advantages over their imitators.

High competition intensity, due to frequent competitive initiatives, facilitates localized subsidiary innovation as well. Intense competition results in sustainable competitive advantages (Porter, 1990). Frequent competitive initiatives constitute continuous pressure on subsidiaries through their actions on each other. The pressure will reduce the potential inertia of firms with good performance (Hambrick, Geletkanycz, and Fredrickson, 1993). Reduced inertia, namely, willing to change, makes innovation possible. The perceived threat due to high competition would increase information-seeking of firms (Lang, Calantone, and Gudmundson, 1997). The dynamic of competition in the semiconductor industry has encouraged firms to diversify across technological sub-fields to maintain their competitive advantages (Kim and Kogut, 1996). Moreover, as units of MNCs, subsidiaries are more likely to surpass local competition and to learn from competitive experience. Competitive experience and market diversity reduce competitive inertia (Miller and Chen, 1994). Having access to competitive experience and market diversity of MNCs, subsidiaries enjoy favorable asymmetries in market similarity and resource similarity with local competitors (Chen, 1996). Therefore, subsidiaries experience less mutual forbearance with local competitors than does a local competitor. While participating and

surpassing local competition, subsidiaries develop their understanding of the local market regarding both competitors and customers. The increased understanding can assist subsidiaries in easily identifying valuable local knowledge and combine it with their own knowledge. The combination of new knowledge could lead to innovation (Schumpeter, 1934; Kogut and Zander, 1992). In fact, one of the motives for MNCs to internationalize R & D is to learn from leading markets (Meyer-Krahmer and Reger, 1999). For example, the product development of Philips' subsidiaries often became a function of local market conditions. Therefore, subsidiaries facing high competition intensity more likely create localized subsidiary innovation. The preceding discussion leads to the following hypothesis:

Hypothesis 3: Subsidiaries that face higher local competition intensity would develop more localized subsidiary innovations than subsidiaries that face lower local competition intensity.

3.5 MNC context: Corporate entrepreneurial culture

Another factor that influences the motivation of subsidiaries to learn from local environments arises from corporate entrepreneurial culture, an internal factor of MNCs. Corporate entrepreneurial culture refers to the willingness to take risk, to learn and to change (Kostova, 1999).

A culture that is favorable to change and learning will also enhance localized subsidiary innovation. This culture will provide legitimacy to innovative efforts that by nature strive to change (Dougherty and Heller, 1994). First, the legitimacy may come from the climate fit between the innovative culture of the whole MNC and the innovative efforts of subsidiaries. Climate fit encourages subsidiaries to be more sensitive to valuable local knowledge. Subsidiaries become more willing to integrate valuable local knowledge for innovations, even when the short-term benefits of localized subsidiary innovation are not appealing. In practice, sustained innovations are hard to achieve in large and mature organizations. One of the primary reasons is that innovation was not valued and its constituent activities were perceived to be neither legitimate nor part of individual responsibilities (Dougherty and Hardy, 1996). When

subsidiaries do not take innovations as their responsibilities, localized subsidiary innovation would rarely occur due to lack of efforts.

Second, the legitimacy may come from strategic fit. Climate fit increases innovative efforts whereas strategic fit sustains innovative efforts. A corporation with a culture that is favorable to change and learning will not easily refuse to support innovative efforts for a lack of strategic fit. When innovation occurs by accident, innovators in large corporations may not gain the necessary support from senior management due to a lack of strategic fit with existing core technology (Dougherty and Heller, 1994). Corporations with a culture that explicitly values innovation, openly welcomes initiatives, and clearly rewards those who successfully resolve problems will make accident innovations a strategic fit (Kanter, 1988). Scotch Guard, a 3M product, is a well-known example of serendipitous innovation. It became one of 3M's most profitable products and took 3M into the fabric protection business, an area it had never planned to participate in. When MNCs develop a culture that values innovation, subsidiaries will be less concerned with the legitimacy of their innovative efforts.

Hypothesis 4: *Subsidiaries within MNCs having a strong corporate entrepreneurial culture would develop significantly more localized subsidiary innovations than subsidiaries within MNCs having a weak corporate entrepreneurial culture*

3.6 Subsidiary level: Top management team heterogeneity

Top management team heterogeneity can impact localized subsidiary innovation by influencing subsidiaries' capability to learn from valuable local knowledge. Top management team heterogeneity indicates the extent to which senior managers of subsidiaries have diverse backgrounds. This research focuses on the diversity in functional background and national background. Top managers in firms usually have experience in diverse functional areas such as marketing, production, process engineering, and so on. Meanwhile, top managers in subsidiaries typically have diverse national background such as local national managers, expatriates from MNC home countries, and even expatriates from a third country. While top management team

characteristics have significant strategic implications (Hambrick and Mason, 1984), this research argues that high top management team heterogeneity develops the capability of subsidiaries to learn from diverse local environments, therefore facilitating localized subsidiary innovation.

First, managers from different functional background have different perspectives on a task (Dearborn and Simon, 1958). Functional diversity increases the amount and variety of information available to design products (Brown and Eisenhardt, 1995). Communication among people from diverse functional areas brings up more alternatives to innovate and in turn makes innovative efforts more likely to succeed in subsidiaries (Eisenhardt, 1989; Ghoshal and Bartlett, 1988). Successful innovators need access to expertise from all functional areas to resolve design and manufacturing problems and to test ideas against market and operating constraints (Dougherty, 1992).

Second, high functional diversity increases the ability of subsidiaries to identify and integrate valuable local knowledge. At the early stage of subsidiaries learning from local environments, the relevance of local knowledge is often unknown to subsidiaries. Exposing the local knowledge to the prior knowledge of subsidiaries could help to discover the relevance (Schulz, 2001). Since high functional diversity increases the amount and variety of information available to a top management team, the increased prior knowledge of a diverse top management team will likely identify the potential relevance of new local knowledge. In the process of integrating new knowledge, absorptive capacity of subsidiaries determines their ability to integrate new knowledge. Since the absorptive capacity is a function of prior experience (Cohen and Levinthal, 1990), the functional diversity of a top management team increases the variety of prior knowledge, which in turn improves the ability of subsidiaries to integrate diverse new knowledge.

Third, top management teams having high functional diversity will provide support for diverse innovations and reduce departmental barriers. The support from the top management team to innovation is critical (Brown and Eisenhardt, 1995). Top managers with diverse background in marketing, sales, and product R & D will promote new product development and product differentiation. Top managers with a background of production and process engineering

emphasize the improvement on the efficiency (Hambrick and Mason, 1984). Having top managers of high diversity, diverse subsidiary innovative efforts are more likely to gain understanding and support. Moreover, one of the challenges for successful innovations is the lack of interdepartmental linkage (Dougherty and Hardy, 1996). A top management team with high functional diversity can help reduce departmental barriers and departmental clashes via institutional isomorphism (DiMaggio and Powell, 1983). For instance, cross-functional leadership that included a technical manager and a commercial manager was a typical practice in the subsidiaries of Philips, the innovative capacity of which has been long admired by its rival Matsushita.

National background of top management teams influence localized subsidiary innovation as well. Local nationals in subsidiaries have a better understanding of local environments. Prior knowledge of the local nationals will contribute to the ability of subsidiaries to collect and understand relevant valuable local knowledge. Whereas local nationals play a more important role in the process of collecting local knowledge that is new to MNCs, expatriates are important in building up the prior knowledge and in turn absorptive capacity of subsidiaries. The prior knowledge of subsidiaries mainly steps from knowledge transferred from parent companies and sister subsidiaries. Expatriate managers in subsidiaries are mechanisms to develop homophily between subsidiaries and the rest of the MNCs (Boyacigiller, 1990), which facilitates the knowledge flow within MNCs (Gupta and Govindarajan, 2000). With expatriates in its top management team, a subsidiary will gain a good understanding of the knowledge developed from the rest of MNC. The good understanding will improve the absorptive capacity of subsidiaries, which in turn improves the ability of subsidiaries to integrate local new knowledge to the prior knowledge of subsidiaries. With both local national and expatriates in their top management teams, subsidiaries will likely innovate by combing both local knowledge and MNC expertise. Therefore,

Hypothesis 5: Subsidiaries that have a higher level of diversity in their top management team would develop more localized subsidiary innovations than subsidiaries that have a lower level of diversity in their top management team.

3.7 Knowledge outflow

Shared learning from market diversification is a key objective of MNCs and it directly influences the ability of MNCs to gain leverage from its experience of multinationality (Ghoshal, 1987; Zander, 1998). Therefore, after investigating the factors that influence subsidiary learning from diverse local environments, another question come to my mind: To what extent do localized subsidiary innovations influence the knowledge contribution of the subsidiary which create the localized subsidiary innovations to the rest of MNCs? Moreover, the knowledge flow literature has been focusing on the linear relationship between the antecedents and knowledge flow, with the exception of Hansen (1999). In this section, I aim to contribute to the knowledge flow literature by investigating a moderation effect of intersubsidiary communication on the relationship between localized subsidiary innovation and knowledge flow.

Knowledge outflow Knowledge transfer within MNCs has been widely researched (Schulz, 2001; Gupta and Govindarajan, 2000; 1991; Kostova, 1999; Robinson, 1995; Ghoshal and Bartlett, 1988). Knowledge outflow indicates the extent to which a subsidiary transfers its innovations to the rest of MNCs. Current literature has well discussed the antecedents of knowledge outflow. The antecedents range from cross-country and MNC corporate characteristics, to subsidiary and inter-subsidiary attributes. The antecedents of MNC corporate characteristics include lateral interdependence, corporate socialization, and transmission channels (Gupta and Govindarajan, 1991, 2000). The cross-country and inter-subsidiary characteristics include institutional distance of countries (Kostova, 1999), and inter-unit tie strength (Hansen, 1999). Subsidiary characteristics of a wide range, however, constitute the major focus of knowledge outflow literature. They include subsidiary's knowledge stock, the exposure to a new knowledge domain, motivational disposition, absorptive capacity, subsidiary culture, attitudes of transfer coalition, and dependence on parent company (Gupta and Govindarajan, 2000; Schulz, 2001; Kostova, 1999). In relating to this study, I am particularly interested in the extent to which localized subsidiary innovation is associated with knowledge outflow.

I suggest a positive relationship between localized subsidiary innovations and the knowledge outflow from the knowledge-sharing subsidiary to the rest of MNCs. First, collecting new knowledge from local environments increases knowledge outflow from subsidiaries to the rest of their MNC (Schulz, 2001). Localized subsidiary innovation results from learning from local environments, which involves the collecting of new knowledge from local environments. Therefore, localized subsidiary innovation should increase the outflow of localized subsidiary innovation. Moreover, literature on the diffusion of innovations suggests that the adoption rate of an innovation is positively related to its relative advantage (Rogers, 1995). Localized subsidiary innovations combine both knowledge within the MNC and knowledge in diverse local environments. This combination is likely to produce relative advantages for these innovations to the previous knowledge of MNCs. Particularly, the more localized subsidiary innovations a subsidiary creates, the stronger signal of relative advantage the subsidiary sends to the rest of the MNC. The strong signals of relative advantage will also increase the possibility of knowledge outflow. Furthermore, Gupta and Govindarajan (2000) suggested that a subsidiary's knowledge stock positively influences knowledge outflow from the subsidiary to the rest of MNCs. As a result of learning from local environments, localized subsidiary innovations require high absorptive capacity, which results from rich prior knowledge of subsidiaries. Meanwhile, localized subsidiary innovations require collecting local knowledge as well. Thus, subsidiaries that create more localized subsidiary innovations are likely to have more knowledge stock than other subsidiaries. In turn, these subsidiaries would likely have more knowledge outflow to the rest of MNCs. Therefore, I propose the following:

Hypothesis 6: The more localized subsidiary innovations created by a subsidiary, the greater the knowledge outflows from the subsidiary to the rest of the MNC.

Intersubsidiary communication Refers to “the exchange of information through various media, including face-to-face contact, telephone, letter, and electronic mail” between a subsidiary and the rest of the MNC (Nobel and Birkinshaw, 1998: 483). Gupta and Govindarajan (1991) suggest that the intensity of organizational communication involve four dimensions: frequency, informality, openness, and density. High frequency of intersubsidiary communication facilitates the diffusion of innovation from subsidiaries (Ghoshal & Bartlett, 1988). In their case

study, they find that “in the few cases of adoption by one subsidiary of an innovation diffused by another, the two subsidiaries (such as Philips' subsidiaries in Germany and the UK) tended to be linked through fairly regular communication that was maintained either because of strong personal relationships or the dependence of one on the other for final or intermediate products” (Ghoshal & Bartlett, 1988: 372). Ghoshal, Korine, and Szulanski (1994) suggest that interpersonal networking influence the intersubsidiary communication, including both communication between subsidiaries, and between subsidiary and parent company.

In relating to this study, I am particularly interested in the moderation effect of intersubsidiary communication on the influence of localized subsidiary innovation on knowledge outflow. Knowledge-sharing routine can shed light on this issue. A knowledge-sharing routine refers to a repetitive pattern of “interactions that permits the transfer, recombination, or creation of specialized knowledge” (Dyer and Singh, 1998: 664). The development of these routines determines effective learning or knowledge transfer (Nelson and Winter, 1982; Levitt and March, 1988; Powell, Koput, and Smith-Doerr, 1998). The differentiation of subsidiaries in a MNC implies that the organizational routines vary across subsidiaries as well, according to Nelson and Winter (1982). When localized subsidiary innovation is high, the subsidiary and its counterpart can develop experience in knowledge exchange, and accumulate specialized information, language, and know-how through high intersubsidiary communication. The establishment of a common language of communication between a subsidiary and its counterpart can further facilitate knowledge sharing in a more extensive, efficiently, and effectively way. On the other hand, the knowledge sharing routine is absent in the case of low intersubsidiary communication. Thus, in the case of high localized subsidiary innovation, subsidiaries with high intersubsidiary communication can experience much higher knowledge outflow than subsidiaries with low intersubsidiary communication. When localized subsidiary innovation is low, the need for knowledge sharing is low. Subsidiaries do not have the stimuli to develop knowledge sharing experience and routines, in spite of the intensity of intersubsidiary communication. Thus, in the case of low localized subsidiary innovation, intersubsidiary communication may exert less influence on knowledge outflow than in the case of high localized subsidiary innovation. Figure 3-1 depicts the suggested moderation effect of intersubsidiary communication. Similarly, I propose the following:

Hypothesis 7: Intersubsidiary communication of a subsidiary would moderate the relationship between localized subsidiary innovation and knowledge outflows from the focal subsidiary to the rest of MNC. Specifically, when its localized subsidiary innovation is high, a subsidiary with high intersubsidiary communication would have significantly more knowledge outflow to the rest of MNC than a subsidiary with low intersubsidiary communication. When the localized subsidiary innovation of a subsidiary is low, the difference made by intersubsidiary communication is smaller.

3.8 Summary and conclusions

In this chapter, I explored contextual factors in three levels (or five sublevels) in relating to subsidiary learning from local environments. The five levels include local market level, local market-subsidiary interface level, the MNC organization level, MNC-subsidiary interface level, and finally subsidiary level. I applied a behavior framework (i.e., motivation-awareness-capability) in order to articulate the arguments and achieve theoretical parsimony and coherence. I summarize the testable hypotheses in Table 3-1.

In the next two chapters, I describe both qualitative and quantitative methods used to test the proposed hypotheses. While looking for evidence in the well-diverse contexts of multiple cases, I am looking for rival explanations for the research questions as well in the rich details. A survey study in the foreign subsidiaries located in the United States follows, which suggests higher generalibility of the research findings. The combination of both research strategies can make the research findings more robust than the use of either one of them.

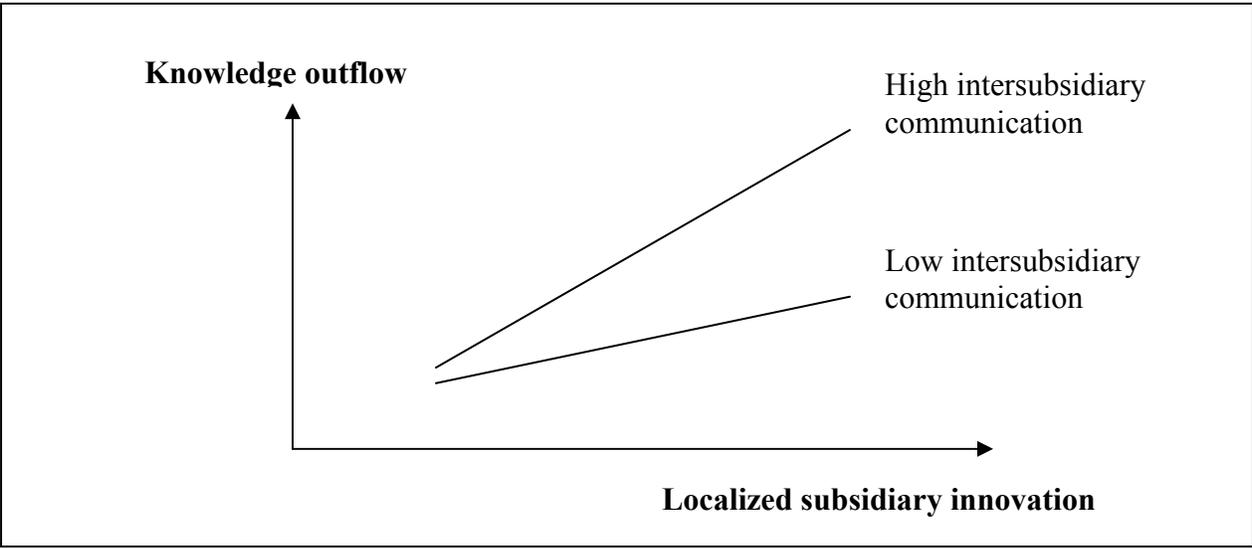


Figure 3-1 Moderation Effect Of Inter-Subsidiary Communication

Hypotheses

- H1** Subsidiaries with higher local embeddedness would develop more localized subsidiary innovations than subsidiaries with lower local embeddedness.
- H2** The learning strategy of a subsidiary would influence its localized subsidiary innovation. a) Subsidiaries with higher emphasis on knowledge exploration would develop significantly more localized subsidiary innovations than subsidiaries with lower emphasis on knowledge exploration. b) Subsidiaries with higher emphasis on knowledge exploitation would develop significantly more localized subsidiary innovations than subsidiaries with lower emphasis on knowledge exploitation.
- H3** Subsidiaries that face higher local competition intensity would develop more localized subsidiary innovations than subsidiaries that face lower local competition intensity.
- H4** Subsidiaries within MNCs having a strong corporate entrepreneurial culture would develop significantly more localized subsidiary innovations than subsidiaries within MNCs having a weak corporate entrepreneurial culture.
- H5** Subsidiaries that have a higher level of diversity in their top management team would develop more localized subsidiary innovations than subsidiaries that have a lower level of diversity in their top management team.
- H6** The more localized subsidiary innovations created by a subsidiary, the greater the knowledge outflows from the subsidiary to the rest of the MNC.
- H7** Intersubsidiary communication of a subsidiary would moderate the relationship between localized subsidiary innovation and knowledge outflows from the focal subsidiary to the rest of MNC. Specifically, when its localized subsidiary innovation is high, a subsidiary with high intersubsidiary communication would have significantly more knowledge outflow to the rest of MNC than a subsidiary with low intersubsidiary communication. When the localized subsidiary innovation of a subsidiary is low, the difference made by intersubsidiary communication is smaller.
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Table 3-1 Summary Table Of Hypotheses

Chapter 4 Multiple-Case Studies

4.1 Introduction

In the next chapters, I use multiple-case studies and survey research to test the hypotheses proposed in chapter three. Yin (1989: 13) suggests to choose case studies as a research strategy “when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context.” I use survey research to further test the generalizability of the proposed model.

This chapter starts from cases collected from existing literature, interviews, and archives on subsidiary learning and innovation. With evidence on the prevalence of subsidiary learning and innovation, I select four cases to further examine the details on the contextual factors relating to the phenomenon. The cases of Philips U.K. and Acer America are excerpted from existing cases studies. The cases of Motorola (China) Electronics Ltd., and Novozymes North America, Inc are based on my phone interviews, and extensive search for archival information. Cross-case pattern search follows with a cross-sector validation in pharmaceutical industry. Beside phone interviews and archival search, I conducted a content analysis on news report relating to pharmaceutical industry. This chapter ends with a summary of finding from the multiple-case studies. Figure 4-1 depicts the research process of my case studies.

Although corporation headquarters typically have a dominant position of transferring knowledge to subsidiaries, justified by the internalization theory of multinational corporations (MNCs) (Buckley and Casson, 1976), there are notable examples of localized subsidiary innovation. At this early stage of this research, I conduct case studies in order to observe emerging themes across specific contexts for localized subsidiary innovation. I will start with reviewing some examples of localized subsidiary innovation among MNCs that have knowledge outflow implications. The goal of my review is to illustrate that the phenomenon of localized subsidiary innovation is more prevalent than expected, and thus deserves more attention. I will

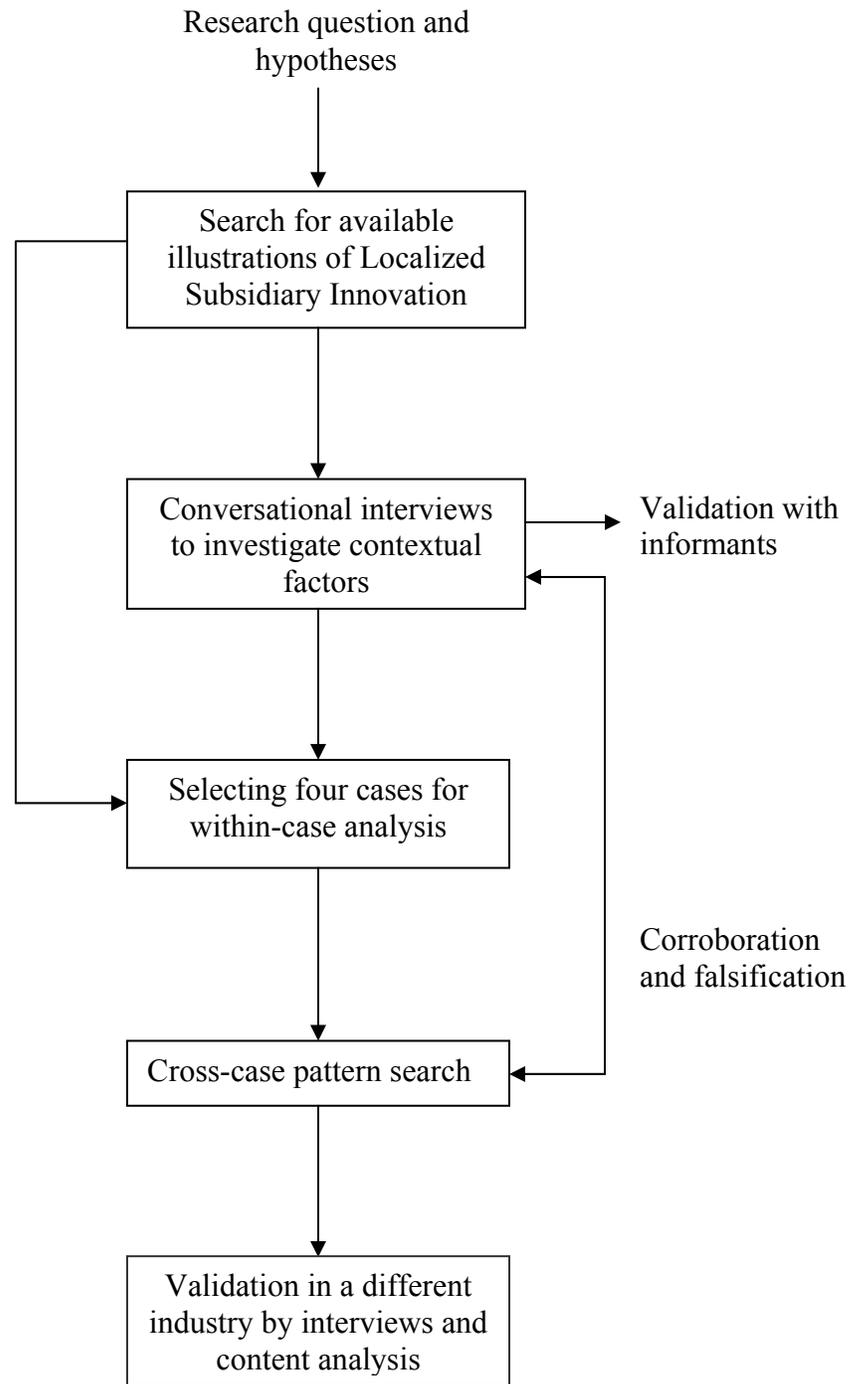


Figure 4-1 The Research Process Of Multiple-Case Studies

focus on the consequence that goes beyond local markets, since these consequences highlight the significance of localized subsidiary innovation.

I select four example cases and conduct a cross-case analysis. Yin (1989) suggests that the logic behind multiple case studies is the same as multiple experiments. The methodology for the selection of multiple cases, however, is theoretical instead of random sampling. When a proposed model can find its evidence in extreme or well-diverse cases, the confidence on the internal and external validity of the model increases correspondently. I deliberately choose the theoretically useful cases based on the variation maximization method. The number of cases is within the useful range suggested by Eisenhardt (1989), which is from four to ten. The mixed use of both existing case studies and my own case studies reduces the potential impartiality of any researchers involved (Eisenhardt, 1989; Yin, 1989). Moreover, the time horizon of the four cases goes across historical (Philips U.K.) to current (e.g., Novozymes North America, Inc). The home countries of the MNCs include both developed countries (e.g., USA) and newly industrialized economies (NIEs) (e.g., Taiwan). The host countries where the subsidiaries developed their localized innovation include both developed countries (e.g., USA) and developing countries (e.g., China). The case of Motorola (China) Electronics Ltd. Particularly presents a counter-intuitive case, where a MNC from a developed country can learn from its subsidiary in a developing country, producing innovations that have significant applications for other markets.

The multiple-case analysis in this research includes both within-case analysis and cross-case pattern search (Eisenhardt, 1989). The within-case analysis involves detailed case write-ups for each of the four selected cases. Following the suggestion of Yin (1989), I use multiple sources of evidence to increase the construct validity. The searching for causal explanations in the rich details of each case can increase the internal validity. The goal of searching for cross-case patterns is to look for similar themes among the four cases that go beyond their apparent difference in terms of their home and host counties. At the end, I conduct interviews and content analysis to validate the findings in the pharmaceutical industry. The replication logic behind these procedures can increase the external validity of the research findings.

Thus, this chapter has four goals: a) to explore the wide range of localized subsidiary innovation, b) to gain case-based understanding of localized subsidiary innovation, c) to look for emerging themes on the enabling characteristics of localized subsidiary innovation, and d) to validate the findings.

4.2 Localized subsidiary innovation: A prevalent phenomenon

This section reviews thirteen examples of localized subsidiary innovation, in an alphabetic order, in nine MNCs. Table 4-1 presents a summary and highlights the difference across these examples:

*Acer.*¹ Acer America (AAC) is the U.S. subsidiary of Acer, a Taiwan-based MNC. In 1993, AAC pioneered a revolutionary design of new computer model, *Aspire*. The new model challenged the standard putty-colored, boxy PCs that sat in offices throughout the world at the time. It attracted attention immediately from top managers and regional managers of Acer by its enhanced multimedia capabilities and a catching look: “a sleek low-profile shape with rounded edges presented in a choice of colors—charcoal grey or emerald green.” *Aspire* was rolled out in more than thirty countries with local adaptations in the following years. Acer ranks among the world’s top ten PC vendors. It started in 1976 to commercialize microprocessor technology in Taiwan. In the mid-1980s, Acer began its international operations. By 1998, Acer had grown to 17 manufacturing plants and 30 assembly facilities in 24 countries. Until now, Acer supports dealers and distributors in over 100 countries, with 60% of employees located outside of Taiwan.

*Ericsson.*² The Australian subsidiary of L.M. Ericsson, a Sweden-based MNC, played a crucial part in developing the successful AXE (Automatic Exchange Electric) digital telecommunications switch. The Australian subsidiary gave impetus to the conversion of the system from its initial analog design to the digital form. Later its engineers helped construct

¹ This example is based on Harvard Business School Case 399-011 (Bartlett, C. A. and A. S. George. 1998. “Acer America: Development of Aspire.”). Additional information is collected from <http://www.acer.com>. (All the information collected from the Internet in this dissertation is available as of June 5, 2003.)

² This example is drawn from Bartlett, C. A. and S. Ghoshal. (1986). “Tap your subsidiaries for global reach.” *Harvard Business Review*. Nov-Dec: 87-94. Additional information is collected from <http://www.ericsson.com>.

| Company | Home Economies | Host Economies | Localized Subsidiary Innovation | Knowledge Outflow |
|-----------------------------|-----------------------|-----------------------|--|--|
| Acer | Taiwan | USA | Aspire, a new computer design | More than thirty countries with local adaptations |
| Ericsson | Sweden | Australia | AXE digital telecommunications switch | Companywide |
| Jollibee | Philippines | USA | A cheesy bacon-mushroom sandwich | Jollibee stores in Philippines |
| McDonald | USA | Netherlands | A prefabricated modular store | Companywide |
| | | Singapore | Satellite stores, or low-overhead mini McDonald's | McDonald in the United States |
| | | Sweden | Enhanced meat freezer | Companywide |
| Motorola | USA | China | A6288, a new Mobile phone model | Some subsidiaries in East Asia and Europe |
| Novozymes | Denmark | USA | Best maintenance practices | Other innovations to subsidiary in China |
| Philips | Netherlands | Australia | Philips' first stereo color TV set | Companywide |
| | | Canada | Philips' first Color TV set | Companywide |
| | | UK | Teletext | Companywide |
| Procter & Gamble | USA | China | Fewer-layer organization; quicker decision-making | Potentially other subsidiaries |
| Unilever | UK/Netherlands | Germany | Krona: a "butter-beater" product | Austrian subsidiary |
| | | Germany | Brand and marketing strategy for a fabric softener product | Subsidiaries in France, Italy, Spain, Australia, and the United States |

Table 4-1 Illustrations Of Localized Subsidiary Innovation

several key components of the system. The world-leading AXE system became a core product of Ericsson.

Jollibee.³ The U.S. operations of Jollibee, a Philippines-based fast-food restaurant started at Daly City, California in 1998. Within a year, the U.S. operations have already located chicken and beef suppliers for its restaurants in Southeast Asia, and the Jollibee stores in Philippines have launched a cheesy bacon-mushroom sandwich originally developed for the U.S. market. Starting in 1975 as a two-branch ice cream parlor, Jollibee later expanded its menu to include hot sandwiches and other meals. As of 1998, Jollibee controlled 57 percent of the hamburger market in the Philippines compared with major rival McDonald's 36 percent. Jollibee started international operations in 1986. Comparing with the fast-food giants, such as McDonald's and Kentucky Fried Chicken, Jollibee has a humble but noteworthy number of overseas operations, twenty-eight restaurants operating in 7 countries. Currently, Jollibee has 7 stores in the USA, concentrating in California where there is a large Filipino population. The close cooperation between the parent company and its overseas operations establishes a dynamic of mutual learning in Jollibee.

McDonald's.⁴ Increasingly McDonald's learns that its foreign franchisees are a source of valuable new ideas. In Europe, its Dutch operation created a prefabricated modular store, which can be moved over a weekend. The prefabricated modular store is now widely used to set up temporary restaurants at big outdoor events. Its Swedish operation invented an enhanced meat freezer, which is now used companywide. In Asia, its Singapore operation invented satellite stores, or low-overhead mini McDonald's, which are now appearing in hospitals and sports arenas in the United States.

Motorola.⁵ In 2001, Motorola (China) Electronics Ltd. was celebrating the debut of Motorola A6288. The new model was the first mobile phone with email support on the GSM

³ This example is drawn from Bartlett, C. A. and S. Ghoshal. (2000). "Going global: Lessons from late movers." *Harvard Business Review*. March-April: 132-142. Page 140. Additional information is collected from <http://www.jollibee.com.ph> and www.conservativenews.org.

⁴ This example is drawn from Hill, C. W. and G. R. Jones (2001). *Strategic Management: An integrated approach*. Boston, MA, Houghton Mifflin Company. Page 271.

⁵ This example is based on conversational interview, and <http://www.motorola.com.cn>.

system across the globe. It can support GPRS, a more advanced system as well, being the first in China. Motorola A6288 became the pride of Motorola China since this model was invented solely by their local R&D talents. The major innovations of A6288 include GPRS system, email support, JAVA support, and beaming with other PDA supporting Vcard. During the conversational interview that I had in Beijing in June 2001, Ning of Motorola's Beijing office proudly claimed that Motorola A6288 has been transferred to Southeast Asia and Europe. Motorola established its first representative office in China in 1987.

*Novozymes.*⁶ Novozymes North America, Inc. at Franklinton, NC was the winner of the 2000 North American Maintenance Excellence (NAME) Award. The award is jointly sponsored by Plant Engineering Magazine, American Institute of Plant Engineers, and Reed Exhibition Companies. The award is an annual program conducted by the Foundation for Industrial Maintenance Excellence to recognize North American organizations that excel in performing the maintenance process to enable operational excellence. The award aims to “increase the awareness of maintenance as a competitive edge in cost, quality service and equipment performance.” Novozymes North America, Inc. is one of the three strategically globally strategic production sites of Novozymes, a Denmark-based MNC. They grow microorganisms in fermentation tanks to produce a variety of industrial enzymes. The goal of these production sites is to increase production efficiency. The NAME award confirmed that the Franklinton site has developed best maintenance practices, one aspect of production efficiency. According to a conversational interview with a R&D engineer at the Franklinton site in 2002, the site has transferred their process innovations on production efficiency to Novozymes' another strategic production site, Novozymes Biotechnology Co. Ltd. in Tianjin, China.

The Franklinton site has also made significant improvement over its environmental performance. In 1998, the Franklinton site received a notice of violation from the North Carolina Division of Water Quality for elevated levels of nitrates. In 2003, it receives the state's first environmental stewardship award. The Franklinton site used reduction in nitrogen loading as a strategy to manage nitrate excess. It has made efforts to reduce noise as well. Several initiatives

⁶ This example is based on www.NAMEaward.com, conversational interview, *The News & Observer* (February 28, 2003), and <http://www.novozymes.com>.

in the past have been very successful. In 2001, the Franklinton site was accepted into the US Environmental Protection Agency's "National Performance Track Program" and became a top environmental performer.

Philips.⁷ The subsidiaries of Royal Philips Electronics are well known to be innovative historically. The Canadian subsidiary of Philips produced and sold the first Philips color TV set. Although the K6 chassis used in those sets was designed in the central research laboratory in Holland, the Canadian subsidiary, being in a market that closely followed the U.S. lead in introducing color transmission, played a major role in the development process and had an even greater input in designing the production system. The Australian subsidiary of Philips developed the first stereo color TV set. The British subsidiary developed its first teletext TV sets. North American Philips invented the first programmed word processing typewriter. Philips. The Netherlands-based MNC is a global leader in color television sets, medical diagnostic imaging and patient monitoring, one-chip TV products, and many other areas. Its 166,000 employees are located in more than 60 countries.

Procter & Gamble.⁸ Considering the limited purchasing power in China, Procter & Gamble (P&G) did not sell all its products in China, and the quality of products sold was not as high as it is in Western countries. The Chinese P&G subsidiaries tried to offer a consistency of quality the Chinese consumers were willing to pay for. Counterfeits are the greatest competition for the company. Nevertheless, the economic and political environments made the Chinese market quite dynamic and changing. P&G evolved very quickly in China. Consequently, the Chinese P&G organization did not have the time to implement the same structure as P&G in other countries. It developed fewer layers. Its decision-making took a shorter time within the organization. The resulting organizational efficiency became valuable assets for Chinese P&G organization. P&G intended to implement some of its features in other countries.

⁷ This example is drawn from Bartlett, C. A. and S. Ghoshal. (1998). *Managing Across Borders: The transnational solution*. Boston, MA, Harvard Business School Press. Page 143.

⁸ This example is drawn from Hill, C. W. and G. R. Jones (2001). *Strategic Management: An integrated approach*. Boston, MA, Houghton Mifflin Company. Page C541.

Unilever. Unilever's ability to respond in innovative ways to local opportunities is quite noteworthy. One example was Krona, a "butter-beater" product, developed by its German subsidiary in Hamburg in 1989. German subsidiary spotted an opportunity for a new spread category other than butter and margarine. In Germany, customers perceived butter as a symbol of wealth, but with high fat that may threaten the health. On the contrary, Margarine with low fat had been perceived as an alternative for poor people. Moreover, since Margarine were artificially processed, and some experts claimed that vegetable fats were not as healthy as were animal fats. Thus a new spread category with low fat, good taste, and nature ingredients was called for. With those customer preferences in mind, the German subsidiary of Unilever created Krona. It is made from cream rather than a vegetable fat, and has only natural and healthful ingredients. It has a creamier mouth feel and tastes better than low-fat butter alternatives. Yet it contains only 26% fat (compared to 80% in butter). Krona has achieved huge success in Germany. It was launched in Austria and sales volumes surpassed expectations.⁹

The German subsidiary has turned Unilever's Comfort, a fabric softener product into a huge success with a new brand and marketing strategy. After Procter & Gamble created the fabric softener product category with a brand called Downy in the United States and Lenor in Europe, Unilever soon followed into this fast-growing segment with its own brand, Comfort. However, years of effort didn't make it a threat for P&G's dominant position. Then, Unilever's German subsidiary developed a new brand Kuschelweich ("cuddles" in German). Its teddy bear symbol won an enormous success in gaining share rapidly. Consumer research showed that the bear not only communicated the desired image of softness, but also evoked strong recognition and trusting associations among consumers. The German brand and its product market strategy were successfully transferred to other markets around the world, becoming Cajoline in France, Cocolino in Italy, Mimosin in Spain, and Huggy in Australia. When Unilever introduced it as Snuggle in the United States in the mid-1980s, the company tripled its market share in the softener category.¹⁰

⁹ This example is drawn from Harvard Business School Case 9-698-017. (Zobel, J. and C. Christensen. 1997. "Unilever's Butter-Beater: Innovation for Global Diversity").

¹⁰ This example is drawn from Bartlett, C. A. and S. Ghoshal. (1998). *Managing Across Borders: The transnational solution*. Boston, MA, Harvard Business School Press. Page 135-136.

The above examples of localized subsidiary innovations show that subsidiary innovation is a prevalent phenomenon in multinational corporations. The home countries of those corporations include both developed countries (e.g., USA) and developing countries (e.g., Philippines). Those corporations can learn not only from developed countries (e.g., Germany) but also from developing countries (e.g., China). The localized subsidiary innovation can be new products (e.g., a new computer design), new processes (e.g., maintenance practices, and a prefabricated modular store), or new practice (e.g., a new brand).

Based on the variation maximization method (Yin, 1989), I selected four cases from the above examples. Among them, there are both historical and current cases. There are a process innovation case and three product innovation cases. The cases involve MNCs from both developed countries and NIEs. The involved subsidiaries are located both in developed and developing countries. The cases for Acer America and Philips U.K. are drawn from Harvard Business School cases. I made the extracts based on the research questions in this research. Further details are available on the original sources. The detailed cases for Novozymes North America, Inc. and Motorola (China) Electronics Ltd. are based on conversational interview and archives. The combined use of existing case studies, conversational interviews, and archives increases the confidence on the finding of this multiple-case study by reducing potential impartiality of any one of the data sources.

4.3 Philips U.K. and its Teletext

Bartlett and Ghoshal (1986) have briefly explained the development history of Teletext in Philips U.K.

“In the early 1970s, the BBC and ITV (an independent British TV company) simultaneously launched projects to adapt existing transmission capacity to permit broadcast of text and simple diagrams. But teletext, as it was called, required a TV receiver that would accept and decode the modified transmissions. For TV set manufacturers, the market opportunity required a big investment in R&D and product facilities, but commercial possibilities of teletext were highly uncertain, and most producers decided against making the investment. They spurned teletext as a typical British toy - fancy and not very useful. Who would pay a heavy premium just to read text on a TV screen?

Philips' U.K. subsidiary, however, was convinced that the product had a future and decided to pursue its own plans. Its top officers persuaded Philips' component manufacturing unit to design and produce the integrated-circuit chip for receiving teletext and commissioned their Croydon plant to build the teletext decoder.

In the face of poor market acceptance (the company sold only 1,000 teletext sets in its first year), the U.K. subsidiary did not give up. It lent support to the British government's efforts to promote teletext and make it widely available. Meanwhile, management kept up pressure on the Croydon factory to find ways of reducing costs and improving reception quality - which it did.

In late 1979, teletext took off, and by 1982 half a million sets were being sold annually in the United Kingdom. Today almost three million teletext sets are in use in Britain, and the concept is spreading abroad. Philips has built up a dominant position in markets that have accepted the service. Corporate management has given the U.K. subsidiary formal responsibility to continue to exercise leadership in the development, manufacture, and marketing of teletext on a companywide basis. The Croydon plant is recognized as Philips' center of competence and international sourcing plant for teletext-TV sets."¹¹

Among other factors, this case suggests that having direct access to manufacturing facilities is also a very important factor to develop localized subsidiary innovation. In the same research, Bartlett and Ghoshal (1986) have provided the support with an example of Philips in Japan.

"After years of unsuccessfully trying to penetrate the captive distribution channels of the principal Japanese manufacturers, headquarters settled for a Japan 'window' that would keep it informed of technical developments there. But results were disappointing. The reason, according to a senior manager of Philips in Japan, is that to sense effectively, eyes and ears are not enough. One must get "inside the bloodstream of the business," he said, with constant and direct access to distribution channels, component suppliers, and equipment manufacturers.

Detecting a new development after it has occurred is useless, for there is no time to play catch-up. One needs to know of developments as they emerge, and for that one must be a player, not a spectator. Moreover, being confined to window status, the local company is prevented from playing a strategic role."¹²

¹¹ This case is drawn from Bartlett, C. A. and S. Ghoshal (1986). "Tap your subsidiaries for global reach." Harvard Business Review (Nov-Dec): 87-94. Page 90.

¹² This case is drawn from Bartlett, C. A. and S. Ghoshal (1986). "Tap your subsidiaries for global reach." Harvard Business Review (Nov-Dec): 87-94. Page 91-92.

Bartlett and Ghoshal (1986) concluded that the Japanese subsidiary had to build the internal capabilities in order to be competitive, through acquisition of or alliances with local companies.

To highlight the contextual factors of the product development in Philips U.K., I develop a summary table (Table 4-2). I assume that as a national organization (NO), Philips U.K. shares the same cross-functional structure characteristics as the rest of the MNC:

“Within the NOs, the management structure mimicked the legendary joint technical and commercial leadership of the two Philips brothers. NOs were led by a technical manager and a commercial manager. In some locations, a finance manager filled out the top management triad that typically reached key decisions collectively. This cross-functional coordination capability was reflected throughout the organization. On the front lines, product teams, comprising junior managers from the commercial and technical functions, set product policies and carried out administrative functions. Cross-functional coordination also occurred at the product group level through group management teams, whose technical and commercial members met monthly to review progress and resolve inter-functional differences. Finally, the senior management committee of each subsidiary (with top commercial, technical and financial managers) reviewed progress to ensure that product group directions fit with national strategies and priorities.”¹³

4.4 Acer America and Aspire¹⁴

Acer America (AAC) started as a sourcing and purchasing agent in 1977. About ten years later, it was converted into a sales office and it later acquired two network computer manufacturers (Counterpoint and Altos) and a customer service organization (Service Intelligence). The acquisitions plunged AAC into losses in 1988. Acer had been in the retail market in the United States since 1990. In 1992, it introduced the Acer Acros, a slightly reconfigured version of the Acer Power, the company's commercial desktop PC. Losses continued in the early 1990s as industry-wide price cuts severely reduced margins. Thanks to the efforts of cost controls, inventory reductions, and increased flexibility, AAC finally recorded its first profit in 1994. The Milestone for Acer in 1995, however, specifies: “The popular Aspire

¹³ Harvard Business School Case 399-102. (Bartlett, C. A. 1999. Philips and Matsushita 1998: Growth of Two Global Companies.)

¹⁴ This case is drawn from Harvard Business School Case 399-011 (Bartlett, C. A. and A. S. George. 1998. “Acer America: Development of Aspire.”). Additional information is collected from <http://www.acer.com>.

| Contextual factors | Characteristics | Illustrations |
|--|---------------------------------|--|
| Local customer preference | Special need of local customers | TV receivers were required to accept and decode the broadcast of text and simple diagrams from British TV companies. |
| Corporate support | Lack of support | "They spurned teletext as a typical British toy - fancy and not very useful. " |
| Subsidiary top managers team | Multiple functions | "Within the NOs, the management structure mimicked the legendary joint technical and commercial leadership of the two Philips brothers." |
| | Perseverance | In the face of poor market acceptance (the company sold only 1,000 teletext sets in its first year), the U.K. subsidiary did not give up. |
| | Risk-taking | "Commercial possibilities of teletext were highly uncertain" |
| In-house resource availability | R&D not available | The top officers of Philips U.K. "persuaded Philips' component manufacturing unit to design and produce the integrated-circuit chip for receiving teletext." |
| | Manufacturing available | The top officers of Philips U.K. "commissioned their Croydon plant to build the teletext decoder"; "Croydon factory to find ways of reducing costs and improving reception quality." |
| Local authority to create new products | High | "Philips's U.K. subsidiary, however, was convinced that the product had a future and decided to pursue its own plans." |
| Consequence | Achieve leading role | Corporate management has given the U.K. subsidiary formal responsibility to continue to exercise leadership in the development, manufacture, and marketing of teletext on a companywide basis. The Croydon plant is recognized as Philips' center of competence and international sourcing plant for teletext-TV sets. |

Table 4-2 Within-Case Summary – Philips U.K.

multimedia PC brings Acer closer to the consumer electronics markets.” The Aspire multimedia PC was a pride of AAC, being created out of its local inspiration. Bartlett and George (1998) have explained the details of the product development.

“In 1993, as the world began to take note of developments in the Internet, the World Wide Web, and new audio, telecom, video, and computing technologies, several companies saw the potential for an advanced multimedia home PC. Among those sensing this opportunity was Michael Culver, AAC's Director of Product Management. With the newly granted authority to create local products, the 29-year-old MBA who had joined Acer 2.5 years earlier leaped into action with his vision to create ‘the first WinTel-based PC that could compete with Apple in external design, ease-of-use features, and multimedia capabilities.’

To test his ideas, Culver put together a project team, which began running focus group studies to examine market needs. One clear outcome of this research was a belief that, in addition to enhanced multimedia capabilities, consumers wanted a home PC that had a different look and feel than the standard putty-colored, boxy PCs that sat in offices throughout the world.

Not having local design capabilities (AAC had a staff of 20 engineers, mainly focused on software design and product testing) and believing that Acer's Strategic Business Unit (SBU) staff did not have the appropriate skills, Culver and his team looked to external design firms for help. Frog Design, a local Silicon Valley firm that had designed everything from bicycles to consumer electronics, appealed to the Acer team because of its reputation for "thinking outside of the box." At this point, Culver went to Chwang (note: Dr. Ronald Chwang, President of Acer Technology Ventures) for \$200,000 to fund the design phase and approval to go ahead with the project. "The process was incredibly informal," related Culver. "It literally took place in one 20-minute discussion in the hallway in late November."

The Aspire product management team and the designers visited computer retail stores and brainstormed the product's external design. In two months, Frog Design developed six foam model prototypes. In January 1995, the AAC team chose the final design: a sleek low-profile shape with rounded edges presented in a choice of colors—charcoal gray or emerald green (Note: Exhibit omitted)”

Meanwhile, the team had been defining the multimedia capabilities built into the computer. One significant innovation was to be voice-recognition software that would enable users to manipulate programs by voice commands. But the innovations presented significant design challenges. In addition to the microphone and speakers built into the monitor, the PC would also have fax and telephone capabilities with a built-in modem and answering machine.”

When he viewed the design in February 1995, Stan Shih, the CEO of Acer, reacted positively and enthusiastically to the innovation. His support was echoed with the heads of RBU (Regional Business Units). Michael Mak, Managing Director of Acer Hong Kong, confirmed that “From the first time I saw Aspire, I knew we had to have this product.” The SBU executives were, however, somewhat concerned with engineering issues in the product development, when Culver and Chwang set out to present Aspire to them in Taiwan. Thus, four Taiwanese engineers from the Information Products Group (IPG) and Acer Peripherals (API) were sent to the United States in March to aid in the mechanical design. Then came the greatest challenge in integrating the components and subassemblies into the final product. Culver explained:

“Different product managers across the globe were responsible for different subassemblies. One might be in charge of the speakers, another in charge of the voice-recognition software. I was in charge of overseeing the entire product development and had to coordinate over 70 different contacts... The delays in integration caused us to delay manufacturing.” (cite a reference)

By early 1996, Taiwan had developed sufficient production capacity to begin a worldwide phased rollout of Aspire during the spring. However, each RBU argued that the U.S. product would have to be adapted to suit its local markets. For an instance, most consumers in Hong Kong were concerned by the \$3,000 price tag. Michael Mak added, “At this stage, we realized we had to make some local modifications.” By the time the Aspire had been launched in more than thirty countries, local adaptations had created over 100 different configurations.

The summary table (Table 4-3) highlights the contextual factors for the development of Aspire in Acer America.

4.5 Motorola in China

Motorola is a learning company. We have great respect for education and training. From the people we do business with and employ, we learn.

-- Motorola (China) Electronics Ltd.

I/O theory suggests that market structure determines firm performance (Porter, 1980). The research stream in competition dynamics suggests that competitive actions influence firm

| Contextual factors | Characteristics | Illustrations |
|--|---|---|
| Corporate internationalization | Moderate | By the time the Aspire had been launched in more than thirty countries |
| Local customer preference | Leading the trend | "in addition to enhanced multimedia capabilities, consumers wanted a home PC that had a different look and feel than the standard putty-colored, boxy PCs that sat in offices throughout the world." |
| Local competition | High | "Losses continued in the early 1990s as industry-wide price cuts severely reduced margins." |
| Corporate support | Support | "His [Stan Shih, the CEO] immediate reaction was positive and enthusiastic...commitment to provide significant funds" |
| Subsidiary top managers team | Actively looking for new opportunities | "Culver put together a project team which began running focus group studies to examine market needs." |
| | Multiple nationalities | "Michael Culver, AAC's Director of Product Management"; "Culver went to Chwang for \$200,000 to fund the design phase and approval to go ahead with the project."; "Culver and Chwang set out to present Aspire to SBU executives in Taiwan"* |
| In-house resource availability | R&D not available | "Not having local design capabilities (AAC had a staff of 20 engineers, mainly focused on software design and product testing) and believing that Acer's SBU staff did not have the appropriate skills" |
| | Manufacturing available | "Culver explained: The delays in integration caused us to delay manufacturing." |
| Local authority to create new products | Yes | "With the newly granted authority to create local products, the 29-year-old MBA who had joined Acer 2.5 years earlier leaped into action with his vision to create 'the first Wintel-based PC that could compete with Apple in external design, ease-of-use features, and multimedia capabilities.' " |
| Local partner | A local design firm | "Culver and his team looked to external design firms for help. Frog Design, a local Silicon Valley firm that had designed everything from bicycles to consumer electronics, appealed to the Acer team because of its reputation for "thinking outside of the box." |
| Consequence | Transfer to other subsidiaries with local adaptations | "From the first time I saw Aspire, I knew we had to have this product"; "At this stage, we realized we had to make some local modifications." |

* Since "Chwang" is a Chinese-sound name, and it is the common practice to have top managers from the home country/economies, I assume that "Chwang" was AAC's president from Taiwan.

Table 4-3 Within-Case Summary – Acer America

performance (Gimeno and Woo, 1999). Thus, to discuss the contextual factors of new mobile phones developed in Motorola China, I start to examine the market structure and competitive actions in the mobile phone market in China. Based on a conversational interview with an informant in Motorola China, I then focus on the contextual factors of knowledge transfer from the headquarters, of localization, and of local R&D partnership, in addition to some background information of Motorola China.

4.5.1 The mobile phone market in China¹⁵

As a developing country, China saw its mobile phone market growing no much earlier than 1999. The competition landscape in the market, however, evolves dramatically. The following discussion begins with the market structure, specifying the growing market demand, market share of major competitors, and special characteristics of a growing market instilled with foreign technology. It then focuses on specific competitive actions in the market in terms of capacity expansion, price reduction, new product development and marketing strategy.

4.5.1.1 Market structure

At the end of July 2001, China became the biggest mobile phone market in the world. Wang Lijian, a spokesman for the Ministry of Information Industry confirmed that China had 120.6 million mobile phone users, soaring 42% from the previous year. It was the first time that China market surpassed that in the United States where there were 120.1 million users according to the Cellular Telecommunications and Internet Association.¹⁶ The growth of mobile phone market in China has been significant. Figure 4-2 depicts the annual growth of the market.

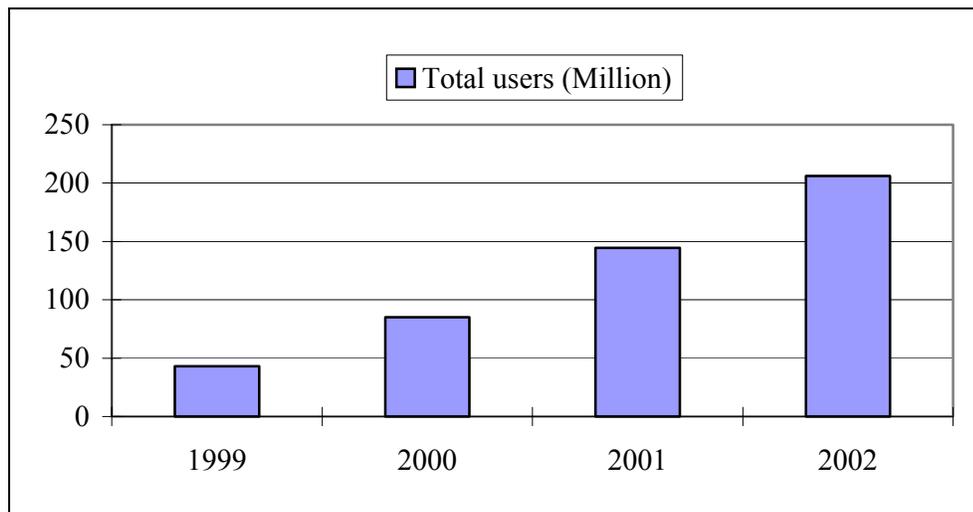
The number of mobile phone manufacturers in China surged from 5 in 1997 to 37 in 2002. These manufacturers are clustered around three areas: nine of them in Beijing-Tianjin region which account for 40.7% of total production, nine in Guangdong region accounting for 27.8%,

¹⁵ Unless specified, information in this section is from the Ministry of Information Industry, China.

¹⁶ *Bloomberg News*, August 15, 2001.

and six in the East region of China accounting for 25.6%. The manufacturers located in these three areas total 94.1% of total production.

The mobile phone industry in China is one of the industries with the highest foreign investment. The foreign investment was US\$1.9 billion in 1999 and increased to US\$4 billion. The major mobile phone manufacturers in the world (e.g., Motorola, Nokia, Ericsson, Samsung Electronics, LG, Sony) all have established themselves in China. Motorola, Nokia, and Siemens have long dominated the market. The concentration ratio of top two producers (i.e., Motorola and Nokia) in China dropped from 71.7% in 1999 to 43.9% in 2002. The Chinese mobile phone manufacturers have consistently won over the market share, leaping to 39.4% in 2002 from a



Data source: The Ministry of Information Industry, China

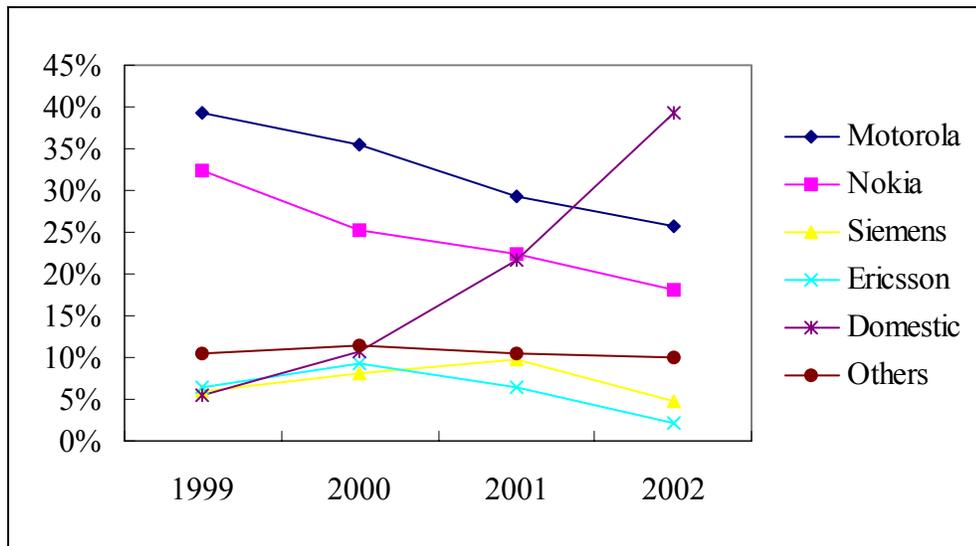
Figure 4-2 Mobile Phone Users In China, 1999-2002

humble start of 5.46% in 1999. Figure 4-3 highlights the growth of market share of the domestic manufacturers from 1999-2002. TCL Mobile Communication Co., a Hong Kong-listed manufacturer in Guangdong province, and Ningbo Bird Co, Ltd. are the leaders among the fast-growing domestic manufacturers. According to CCID Data Co. Ltd. under the Ministry of Information Industry, TCL became the leading domestic manufacturer and increased its market share to be 9.7% in 2002.¹⁷ As a licensed mobile phone producer, Eastcom, a state-owned

¹⁷ *Business Week*, Jan 21, 2003.

enterprise near Shanghai, will shift its focus to mobile phone production and competes with its Eastcom-branded handsets. Eastcom is a major partner of Motorola in China and mainly produces mobile equipment and mobile phones for Motorola. It produces its self-branded mobile phones as well.¹⁸ The Chinese government accredits the growth of Chinese mobile phone manufacturers to its specific requirements for foreign-invested companies regarding technology transfer, production, the ratio of domestic to export sales, and the percentage of local sourcing.

Among the major companies, Motorola, Ningbo Bird, Haier, and Panasonic have provided the best customer service satisfaction. The 2002 survey of customer service satisfaction conducted by CCID Data Co. Ltd. under the Ministry of Information Industry created three customer service satisfaction awards and covered 29 major mobile phone brands in China. "The Best Users Service Satisfaction Award" went to Motorola, and Ningbo Bird. Haier and Panasonic won "The Best Service Commitment Fulfillment Award." "The Best Innovative Service Award" was presented to Haier and Motorola.



Data source: The Ministry of Information Industry, China

Figure 4-3 Market Share Of Mobile Phone Manufacturers In China, 1999-2002

¹⁸ "Eastcom to launch 12 new mobile phone models this year." Interfax China IT & Telecom Report. May 24, 2002.

In addition to the uprising challenges from domestic firms, competition among foreign-invested mobile phone manufacturers intensifies. The mobile phone market in China becomes a battlefield for global competition as the industry regulation loosens. Nokia, the world's number one mobile phone maker, is investing between \$10-billion and \$12-billion to build an industrial park outside of Beijing to make handsets and cellular base stations to catch up with Motorola in China. The company has poured \$2.4 billion into China and has a giant complex making cell phones and components near Beijing.¹⁹ LG of South Korea aims to position itself as the leading brand for mid-to high-end CDMA Development Group handsets in China. Being the global pioneer of CDMA, LG will target the youth segment and young adults.²⁰ It would result in direct competition with Samsung and Motorola in China.

The domestic firms have also served as a vehicle for the global competition on technology. Ningbo Bird's growth path can provide a good illustration.²¹ When Ningbo Bird started its mobile phone operation in September 1999, Motorola, Nokia, Philips, Siemens, and Ericsson all had their own operations in China. Ningbo Bird needed a partner, while Sagem from France wanted to enter China market but the Chinese government wasn't allowing any more foreign companies to come in. The cooperation between Ningbo Bird and Sagem provide a solution. Thus, Ningbo Bird relied on France's Sagem for its system designs at the beginning. Ningbo Bird bought production equipment from Sagem and paid a royalty for each phone that they produced, about \$1 to \$2 per phone. Since 2000, the arrangement changed and Ningbo Bird now buys the modules from Sagem. Half of the Bird's current twenty phones are from Sagem. In 2002, Ningbo Bird set up a joint venture with Sagem on production and R&D. Besides the partnership with Sagem, Ningbo Bird started to develop technology partnerships with others since 2000. The company outsources components from BenQ of Taiwan, Quanta of Taiwan, and LG of South Korea. Ningbo Bird has R&D cooperation with Bellware and Mobile Link. "There are a lot of Taiwanese and Korean design companies that, nonstop, are designing new products. But they themselves can't produce or sell them. We can cooperate with them", added Ma Sitian, the deputy general manager of Ningbo Bird. As in the case of Ningbo, "almost each of Chinese mobile phone manufacturers has a Japanese or Korean mobile phone manufacturers standing on

¹⁹ *Bloomberg News*. 15 August 2001.

²⁰ "LG Telecom taps Euro for national CDMA campaign." *Media*. 14 June 2002.

²¹ This illustration is based on "How Ningbo Bird Became a High-Flier." *Business Week*, January 21, 2003.

the back”, said Xiaodong Wan from the Ministry of Information Industry. For an instance, mobile phones with color screens have been popular mainly in the Japanese and Korean markets. In line with the trend, TCL and Ningbo Bird have planed to switch 60% of their mobile phone production to color-screen models in 2003.²²

The last observation is that foreign-invested manufacturers in China serve the global market as well. The export of mobile phones, mainly from foreign-invested companies, increased 225 times from 1998 to 2001. Figure 4-4 illustrates the production and export share of mobile phone manufacturers in China. According to the Korean Herald, Nokia produces 53 percent of their handsets and Motorola produces 62.5 percent through their production lines in China. Samsung and LG have only about 10 percent of their mobile phones manufactured in China.²³

4.5.1.2 Competitive actions

Capacity expansion To enlarge their market share, Chinese mobile phone manufacturers set for aggressive production schedules. TCL and Ningbo Bird have continued to boost production in 2003. TCL has planned to boost its annual mobile phone capacity from the 3 million to 12 million units in 2002. The company has set up a 100,000-square-meter mobile information industry park in Huizhou in order to achieve the goal.²⁴ Ningbo Bird Co., currently ranked No. 6 in China, has made more than 7 million phones in 2002. It is only the third full year of its mobile-phone production. Ningbo Bird has just opened two new factories that boost its capacity to 20 million phones annually.²⁵ Motorola and Nokia expand their production in China as well. Motorola has planned to invest \$10 billion worth of production in China by the end of 2006. Nokia is investing about \$10 billion on production on the top of its \$2.4 billion investment in China.

²² Tamao Kikuchi, Nikkei Market Access. May 7, 2003. Nikkei BP Consulting, Inc.

²³ “IT export drive laid low by SARS” Infotech News, May 12, 2003 at <http://www.koreaherald.co.kr>.

²⁴ Industry News, posted on September 13, 2002 at <http://www.telecom.globalsources.com>.

²⁵ “Winning in China: Can Motorola hang on to its top spot as local rivals come on strong?” *Business Week*. January 27, 2003.

Price reduction Along with the expanded industry capacity, the price is driven down dramatically. The average price of a phone in China fell by 15% to \$170 in 2002 alone, according to Beijing-based Norson Telecom Consulting.²⁶ Samsung Electronics, Panasonic, and Alcatel offer even up to 40% of price reduction. Ningbo Bird, Panda, and Legend are among the companies that offer price reduction. Ningbo Bird is confident on price competition. Ma Sitian, the deputy general manager of Ningbo Bird, explains, "The China market is growing, but prices are falling. Motorola and Nokia need to have their profit margins at certain levels. Compared to them, we can have lower profit margins and still make money... We're a local company, so we can more effectively control labor costs."²⁷

New product development The intensive competition in China focuses on new product development as well. In the fall of 2002, Nokia consecutively released new model of MMS (multimedia message service) handset -- Nokia 7650 in Kunming, Nokia 7210 in Chengdu and it has planned to launch 3 models of MMS handsets in November. Motorola reacted swiftly to Nokia's market move. On the day right after Nokia launched 7210, Motorola introduced a CDMA handset with Karaoke function -- Motorola V730 and a model of GSM handset.²⁸ Eastcom plans to launch 12 new models of mobile phones in an effort to further explore China's potential mobile phone market.²⁹ It sells a \$425 phone that's covered in specially treated fish skin. TCL in Guangdong features a diamond-encrusted handset. To fight back, Motorola has introduced a faux-diamond-studded handset. "In the past, Motorola's reputation was more for good quality. Now it's much more trendy," says Tim Chen, Beijing-based chairman of Motorola's China operations. Motorola tries to provide features that local rivals would have a hard time matching, features like Chinese-language text messages and functions of karaoke machines or e-books.³⁰

The R&D investments increase along with the competition. Motorola has planned to increase \$1 billion on research & development investment on the current \$0.3 billion scale by the

²⁶ "Winning in China: Can Motorola hang on to its top spot as local rivals come on strong?" *Business Week*. January 27, 2003.

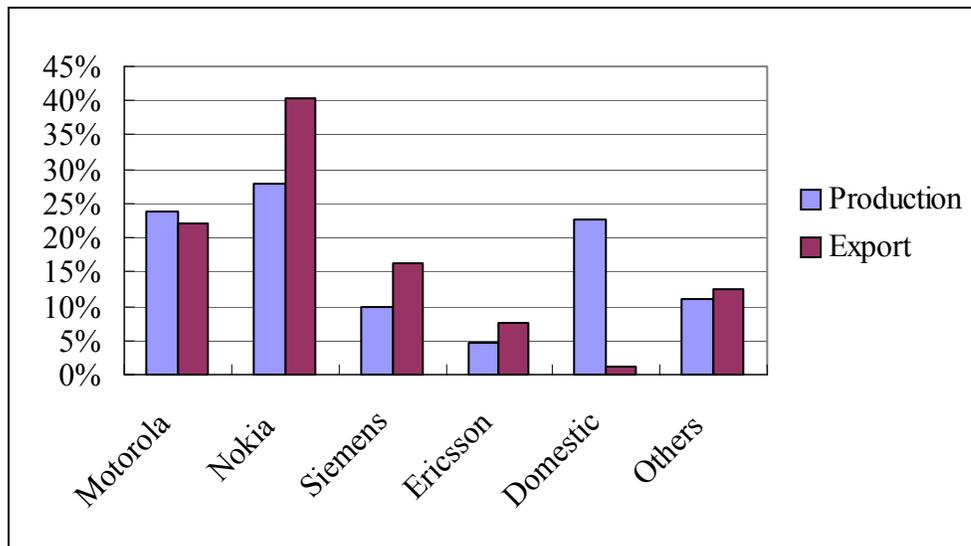
²⁷ "How Ningbo Bird Became a High-Flier." *Business Week*, January 21, 2003.

²⁸ "Nokia Competes with Motorola in China." SinoCast China Business Daily News. November 4 2002.

²⁹ "Eastcom to launch 12 new mobile phone models this year." Interfax China IT & Telecom Report. 24 May 2002.

³⁰ "Winning in China: Can Motorola hang on to its top spot as local rivals come on strong?" *Business Week*. January 27, 2003.

year of 2006.³¹ TCL will increase its R&D investment from 6 percent to 10 percent.³² Ningbo Bird began its own R&D for new products in 2002. One million out of the 7 million phones Ningbo Bird made in 2002 were designed completely by Bird.³³



Data source: The Ministry of Information Industry, China

Figure 4-4 Production And Export Share Of Mobile Phone Manufacturers In China, 2002

Marketing strategy Bundling sales with mobile phone service providers have been successful in China. Motorola joined China Unicom's market promotion of bundling sale and achieved outstanding performance in 2002. Nokia has been continuously negotiating with China Mobile on bundling sales project.³⁴ Eastcom has reached an agreement with Jilin Unicom and Zhejiang Unicom, regional subsidiaries of China Unicom, to provide 18,000 CDMA handsets.³⁵

Positioning is another aspect of the marketing strategy. LG aims to position itself as the leading brand for mid-to high-end CDMA handsets in China, competing directly with Samsung and Motorola,³⁶ whereas Ningbo Bird decides to target small cities and rural areas. As Ma Sitian, the deputy general manager of Ningbo Bird has explained, “Motorola and Nokia are in the big

³¹ <http://www.motorola.com.cn>.

³² Industry News, posted on September 13, 2002 at <http://www.telecom.globalsources.com>.

³³ “How Ningbo Bird Became a High-Flier.” *Business Week*, January 21, 2003.

³⁴ “Nokia Competes with Motorola in China.” SinoCast China Business Daily News. November 4, 2002.

³⁵ “Eastcom to launch 12 new mobile phone models this year.” Interfax China IT & Telecom Report. May 24, 2002.

³⁶ “LG Telecom taps Euro for national CDMA campaign.” *Media*. June 14, 2002.

cities, but in the rural areas and small cities, they have not focused enough. So we think that Chinese companies can grow very quickly by concentrating on those areas. Bird is putting a lot of energy into those smaller cities and the countryside.”³⁷

4.5.2 Motorola in China³⁸

During a brief conversational interview that I had in Beijing in June 2001, Mr. Ning of Motorola suggested the factors that he thought contributing to the local innovations of Motorola China: timely transfer of leading technology from the HQ before other markets; 18 R&D centers with 945 employees; collaboration with local R&D institutions and universities; the importance of China market to Motorola; localization, developing good relationship with local suppliers and sharing the costs and growth; and training local technological talents.³⁹ After the interview, I have searched for archival documents to validate Ning’s suggestions and supplement them with details. The following offers a more detailed elaboration on the contextual factors for the innovations of Motorola China.

4.5.2.1 Introduction

Motorola Inc., a global leader in offering integrated communication solutions and embedded electronic solutions, was founded in 1928. From its humble beginnings making rectifiers and mobile radios, Motorola grew up in the 1940s and 1950s, and in the 1960s, it began to develop overseas markets and gradually became a global company. Currently Motorola has operations in 69 countries and over 95,000 employees across the globe. Its business covers wireless communications, semiconductors, automobile electronics, broadband and Internet access products. Motorola is a technology leader in the fields of mobile phones, pagers, two-way radios and commercial GSM and CDMA systems. In 2002, Motorola had a total sales volume of US\$ 27.3 billion.

³⁷ “How Ningbo Bird Became a High-Flier.” *Business Week*, January 21, 2003.

³⁸ Unless specified, the information is from <http://www.motorola.com>, and <http://www.motorola.com.cn>.

³⁹ The phone interview lasted for fifteen minutes. The language is Chinese, my native language. I took notes during the interview. I asked the informant if Motorola China has developed any of its own innovations, and I further asked a few open-ended questions to explore contextual factors. The informant is a PR manager, thus knowledgeable of overall background of the company. The breadth of his knowledge, however, may bear a tradeoff with the depth. Thus, his view may not reflect the specific details deep down in the organization.

Motorola established its first representative office in China in 1987. Since then, Motorola has invested \$3.4 billion in manufacturing and research and development facilities there, more than any other Western company. In April, 1998, Motorola moved its north Asian office from Hong Kong to Beijing. Currently Motorola's facilities in China include a wholly-owned company, a holding company, 9 joint ventures and 24 subsidiaries, with more than 12,000 employees. It is the largest foreign investor in China's information industry. It claims sales of US\$5.7 billion in China in 2002, becoming the largest foreign company⁴⁰ in China on the top of all the Fortune 500 companies that have invested in China. "Our goal is to expand the Chinese market itself", stresses Fred Shlapak, executive vice president of Motorola. According to Bear Stearns, Motorola's market share in handsets has slipped from about 50% to 30% in the U.S. and from more than 30% to less than 10% in Europe since the mid-'90s. On the other hand, China accounts for 30% of the mobile phone sales of Motorola. "This is our most important market," says Scott A. Durchslag, Motorola's corporate vice-president for strategy and business development.⁴¹

In June 2002, Motorola China President Tim Chen formally announced a new five-year strategy called "2+3+3" strategy. The "2" means two centers (i.e., to make China into a global production base and a global R&D base for Motorola). The first "3" refers to three growth areas in China, including digital trucking communication systems (the mobile-communications systems used by police, taxi drivers, and delivery fleets), semiconductors, and broadband. The final "3" explains three US\$10 billion targets by the end of 2006 that Motorola has set: an accumulative investment of US\$10 billion in China (including investment from joint venture partners and suppliers), an annual output of US\$10 billion in China, and US\$10 billion for accumulative local sourcing.

4.5.2.2 R&D investment of Motorola in China

The Chinese edition of *Fortune* magazine has recognized Motorola as the most innovative and best adapted to the Chinese market in 2002. As of 2001, Motorola has invested

⁴⁰ *People's Daily*. December 06, 2001.

⁴¹ "Winning in China: Can Motorola hang on to its top spot as local rivals come on strong?" *Business Week*. January 27, 2003.

\$300 million on R&D in China. In next five years, Motorola plans to invest additional \$1 billion on R&D in China. Motorola's research and development (R&D) strategy in China forms and integral part of Motorola's global R&D drive. Established in line with Chinese policies to develop national strength through science and education, Motorola China R&D Institute aims to combine China's uniquely rich talent pool with Motorola's cutting-edge technology, to bolster China's competency in the world's telecommunication industry.

According to Fred Shlapak, executive vice president of Motorola, the Motorola China R&D Institute, founded in November 1999, is committed to promoting Motorola's long-term success in China through technological development and innovation. With an investment of 218 million U.S. dollars, the institute administers 18 R&D centers with 1,000 employees in China.⁴² The R&D centers are located in Beijing, Tianjin, Shanghai, Suzhou, Nanjing and Chengdu. Motorola China R&D Institute provides the strategic and technological vision for Motorola China to become the leader in the telecommunications and semiconductor industries through technology development and innovation. It provides the world with end-to-end solutions from chip sets to system integration and appliance development. With the additional \$1 billion investment, Motorola China R&D Institute aims to house 4000 R&D engineers by year 2006.

Among the R&D centers, the R&D of Personal Communications Sector (PCS) Beijing Design Center focuses on mobile phones. It engages in touch-screen smart phones and platform development, refreshes of GSM cellular phones, and localization of CDMA cellular phones. In March 1999, the PCS Beijing Design Center was established by consolidating two R&D centers in Beijing under the previous Greater China Cellular and Paging Groups. The objective of PCS Beijing R&D Center is to design and develop the products required for success by PCS PRC businesses, leveraging the common core platforms to incorporate regional customer needed features, and break new ground. As one of the four PCS R&D centers based in Asia-Pacific region, it enjoys investment of more than US\$10 million each year on project development, equipment procurement and training. There are about 300 engineers conducting research on software, electrical, mechanical and industrial design development. Until now, PCS China's R&D center has developed a series of innovative PDA handset models that are very popular in

⁴² *People's Daily*. March 21, 2002.

business circles. PCS China has introduced a variety of mobile phone models to the market, including A6288, 388, T191, C289, C300, V8088, V60, V66, V70□V8060 and V730, which have successfully met the diverse requirements of consumers. Motorola aims to make Beijing one of its world-wide research and development centers, according to Jenny Wang, vice-president of Motorola and chief representative of Motorola (China) Electronics Ltd.⁴³ Motorola recently announced a \$100 million expansion of an R&D center in the capital.⁴⁴

4.5.2.3 Technology transfer of Motorola in China

In December 1995, Motorola, the world's leading manufacturer of advanced telecommunication equipment, joined forces with Shanghai Radio Communication Equipment Manufacturing Co., Ltd. to produce its world famous paging products. The resulting joint venture, Shanghai Motorola Paging Products Co., Ltd. manufactures world-class pagers based on Motorola's unique FLEXTM paging protocol, which was adopted in 1996 as a nationwide standard for advanced messaging applications in China. The FLEXTM protocol was the leading technology at the time. Comparing with other technologies, it increased the subscriber capacity for five times, and interference-resistance for 10 times. It enabled a battery to last 5 times longer. It improved the reliability of information acceptance by greatly reducing signal error.

Hangzhou Motorola Cellular Equipment Co., Ltd. and Hangzhou Eastcom Cellular Phone Co., Ltd., were established in 1996, jointly funded by Motorola (China) Investment Ltd., Eastern Communications Co., Ltd. and China PTIC Information Industry Corp with total investment of US\$128 million. They both introduced the world-leading technology of Motorola, manufacturing CDMA mobile phones and systems. They were the first production base of CDMA products in China and Motorola's first overseas CDMA manufacturing site. On December 8, 1995, a ribbon-cutting ceremony was held to mark the establishment of Motorola's Asia Manufacturing Research Center. Motorola invested \$750 million to build the Center of Excellence in Tianjin. The center has a materials lab, a production procedure lab, an analytical lab, and software and

⁴³ *People's Daily*. November 14, 2001.

⁴⁴ "Winning in China: Can Motorola hang on to its top spot as local rivals come on strong?" *Business Week*. January 27 2003.

equipment labs. It is Motorola's first manufacturing research laboratory outside the United States.⁴⁵

“Motorola has set the standard in China as a company which strongly contributes to a significant transfer of technology through product development and manufacturing,” said, Guanhua Xu, Vice Minister of Ministry of Science and Technology.⁴⁶ Hymer (1960) has observed that MNCs transfer their products and technology overseas with a time lag, relatively shorter for developed countries and longer for developing countries. As the technology capabilities of China grow, Motorola transfers technology and products with reduced time lag. Ning, the informant in Motorola claimed that Motorola “transfers leading technology from the HQ to be used in the China market before other markets.”

Training local technological talents plays an important role in Motorola's transferring its technology to China. When it first entered China, Motorola realized that at the time, Chinese students didn't learn how to turn principles into innovative new products in universities. “Their knowledge of basic science is very strong, but they don't know how to apply it,” says Ko Ching-wen, Motorola's personnel director in Tianjin. Besides sending 30 engineering recruits to its facilities in the U. S., Singapore, and Hong Kong, Motorola spent millions on in-house training programs, preparing for the startup of its design centers for integrated circuits and telecommunication products in China.⁴⁷

Besides transferring product and process technology, Motorola has training programs for management leadership. In 1994, the China Accelerated Management Program (CAMP) was set up to train a certain number of Chinese people with the potential to form the future management of Motorola China. Twelve employees received the training in the first year, twenty-seven in 1995, forty-eight in 1996, and forty-five in 1997. The training program has increased the localization of management in Motorola China. The number of Chinese managers increased from 12 in 1994 to 528 in March 2001. The ratio increased from 11% to 72% correspondently. Among the ten top managers with “China” in the title listed on the Motorola China webpage, nine are

⁴⁵ Motorola Annual Report, 1997.

⁴⁶ <http://apspg.motorola.com/china/>.

⁴⁷ “Motorola In China: A Great Leap Forward.” *Business Week*. 17 May 1993.

Chinese and one is American. The other eight top managers listed have corporate top managers and top managers with “Asia-pacific” in their title.

4.5.2.4 Local R&D partnership of Motorola in China

Motorola China has actively developed R&D partnership with local research institutions, universities, and companies in China. It claimed that cooperation was a key to their strategy of instilling Motorola with Chinese characteristics. As P.Y. Lai, the previous President of Motorola (China) Electronics Ltd. explained,

We have a sense of responsibility in China. Combining our development orientation with the technology modernization of China, Motorola adheres to the localization of talent by developing in-country semiconductor expertise. Chinese researchers work on all projects, and Chinese talent is beginning to take the lead on research projects with world-level significance.⁴⁸

Collaboration with local R&D institutions/universities Motorola China has developed extensive and tight cooperative relations with leading research institutions and universities in China. Institute of Physics, Chinese Academy of Sciences and National Key Laboratory for Solid State Microstructure, Nanjing University are both world leaders in fundamental semiconductor materials research. DigitalDNA Laboratories of Motorola China developed key strategic research partners with them. Currently they are working on developing high K gate dielectric materials and processes using PVD, MOCVD and laser MBE to meet the gate leakage requirements for low power IC applications. In December 1999, the Motorola R&D Center in Beijing joined a research cooperation project to develop third generation (3G) mobile communications technology. The participants included China's Research Institute of Telecommunications Transmission and Motorola R&D Centers in Swindon (England), and Beijing (China). The projects aimed to gain a better understanding of the unique third generation needs of the Chinese market, including applications, standards, network design and implementation.⁴⁹

⁴⁸ <http://apspg.motorola.com/china/>.

⁴⁹ Reuters News, 8 December 1999.

Motorola China has developed numerous joint research projects with top universities in China. With Tsinghua University, the joint research projects included Material Analysis of SAW, T2000 Materials Sintering Characterization, and joint research on EEG-computer interface. With Zhejiang University, they collaborated on the projects for VLR Video Coding (Very-Low Rate Model based video coding). Motorola worked on the projects for Car Noise Cancellation In Mobile Telecommunications, and A Novel Technique for Improving Speech Privacy of Mobile Phone Users with Nanjing University. With Tianjin University, Motorola collaborated on the research project of Automated Finite Element Simulation for Cellular Phone Virtual Drop Test. Since September 2000, DigitalDNA Laboratories of Motorola China and Institute of Mathematics Sciences, Peking University have been working on the joint project "methodology Study of Inverse Modeling" to investigate the uniqueness of inverse modeling of MOSFET (metal oxide semiconductor field effect transistor). The joint research projects like these can go on and on.

Beside the joint research project, Motorola China has set up numerous joint research labs with top universities in China. The Institute of Microelectronics at Tsinghua University was one key base for the fundamental and application research of China's microelectronics industry, Motorola cooperated with the Institute of Microelectronics at Tsinghua University by various means. In March 1998, Motorola presented super large-scale integrated circuit facilities to support education and research of Tsinghua University. Meanwhile, the two parties developed joint research projects in the fields that could attract both sides. In the same month, Peking University--Motorola Semiconductor Joint Lab was established. Motorola provided equipment, samples and research funds for projects. Seven doctors and four masters from Peking University participated in these projects successively.

Developing joint ventures and strategic alliances. Besides collaborating with research institutions and universities, Motorola has actively sought opportunities to establish joint ventures and cooperation projects with local companies. Motorola has 9 joint ventures in China, which produce cell phones, CDMA equipment, semiconductors and other high-tech products. They are Guangzhou Jinpeng Cellular System Co. Ltd., Shanghai Motorola Telecom Products Co. Ltd., Beijing Human Smartcard System Manufacturing Co. Ltd., Hangzhou Eastcom

Cellular Phone Co., Ltd., Leshan-Phoenix Semiconductor Co. Ltd., Human Smartcard System Co. Ltd., Hangzhou Eastcom Cellular Equipment Co. Ltd., Shanghai Zhongmei Automotive Electronics Co. Ltd., and Motorola Qiangxin (Tianjin) IC Design Co. Ltd.

In addition to joint ventures, Motorola China has set up long-term alliances with local companies. Among them are Xi'an Datang Telephone Co. Ltd., Huawei Technology Co. Ltd., and China Mobile Communications Corporation. Xi'an Datang Telephone Corp. is a subsidiary company of Datang Telecom Technology Co., Ltd. located in Xi'an Hitech Industry Development Zone, Xi'an Datang Telephone Co. Ltd. mainly focuses on R&D, production, sales, and service of telecom and information products. Motorola & Datang started cooperation History in 1995. In December 1995, Motorola & Datang signed Memorandum of Understanding (MOU) of CDMA technical cooperation. They went through the first milestone in June 1996, making the first successful CDMA call between Motorola BSS (base stations) and Datang MSC (mobile switching center). In December 1998, they finished Tianjin-Datang CDMA Trial Test. In March 2000, Motorola and Datang signed 7 new RDV (Rapid Deployment Vehicle) contracts.

The cooperation between Huawei Technology Co. Ltd. started in 1999. Founded in 1988, Huawei Technology Co. Ltd. is a high-tech enterprise dedicated to the research, development, manufacturing and marketing of telecom equipments and one of the largest network solutions providers in Asia. Motorola and Huawei collaborated on GSM and CDMA technology. Their milestones in collaboration included an interface test in Beijing Motorola R&D lab in April 1999, and an interface and dual band test in Shandong in May 2000 regarding GSM. In March 2000, Motorola and Huawei signed a Memorandum of Understanding (MOU) for CDMA technical cooperation.

On February 18, 2002, Motorola and China Mobile Communications Corporation announced the signing of a cooperative agreement to begin a third-generation (3G) business service dimensioning research project in China. China Mobile Communications Corporation is the largest mobile phone network operator in China. Under terms of the agreement, the two sides will jointly study possible services and their characteristics on China's future 3G networks. The research focuses on finding the most cost-effective network solutions for the China market and

will study the relationship between service behaviors and the related network resource consumption. The major areas of research include 3G applications, service behavior patterns and wireless network resource consumption.

4.5.2.5 Local sourcing of Motorola in China

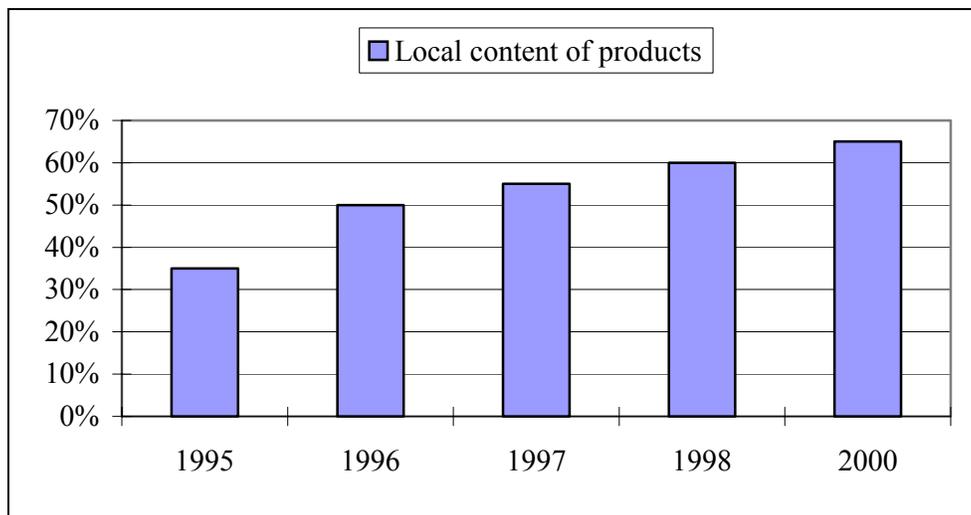
"We take pride in viewing ourselves as a very local company in China," says COO Zafirovski of Motorola.⁵⁰ Besides training local managers, Motorola has increased local sourcing of Motorola China over the years. The local sourcing has increased from US\$260 million in 1996 to US\$1.4 billion in 2000. *People's Daily* confirmed, "In 2000, Motorola and its operations in other countries and regions purchased 1.55 billion U.S. dollars worth of locally sourced equipment and parts from China."⁵¹ The number of local suppliers of Motorola China has grown from about 130 to 700. The increasing purchase of components and materials from local suppliers raises the local content of products produced by Motorola China. The local content of its telecommunication products grows from 35% in 1995 to 65% in 2000 (Figure 4-5). The products sourced locally are battery chargers, power transformers, printed circuit boards, connectors, rubber key pads, leather case, slide switches, crystal filters/oscillators, printed manuals, tunable coils, plastic injection molding, metal stampings/lanyard, loud speakers/transducers, sub-assemblies, gold Wires, industrial gases, packaging materials, sub-motor, chemical articles, IC piece arts, among others. The domestic suppliers include MEWA 3522 Factory, Printronics; Meihang Printing House, Halian-Sub-Assembly, Multi-Board Factory, Sanguoxin Keyboard Factory, Taihe Factory, Ningbo FST, Electronics Plastics Plant, and the Fifth Paper Box Plant, among others.

In order to increase the local content of its products, Motorola China has actively developed local suppliers. Motorola established long-term cooperation with the local companies that were able to meet the quality standard of Motorola. Motorola helped them then develop plans for upgrading equipment, improve production technology and management, and establish quality control system. Motorola provided them with technical assistance and training as well. In

⁵⁰ "Winning in China: Can Motorola hang on to its top spot as local rivals come on strong?" *Business Week*. January 27, 2003.

⁵¹ *People's Daily*. March 21, 2002.

1997, Motorola offered training of 5800 person times to local suppliers for free. The overall support to local suppliers in technology, management and training helped them become not only the preferred suppliers of components for Motorola, but also raise their technical level and allow them to expand their growth in other directions, more rapidly. “We are striving hard to develop twenty domestic suppliers into large-scale enterprises, or even multinational enterprises”, said P.Y. Lai, previous President of Motorola (China) Electronics Ltd. For an instance, Yiya Electronic Ltd. in Hebei province produces LCD and LCM. Motorola provided in-class training for the company, and meantime sent engineers, technicians, and managers to provide on-site instructions on the improvement of operational management and technology, and quality control system. In February 1997, Yiya Electronic Ltd. became a supplier of Motorola, producing parts and components for the pagers of Motorola. In 1999, Chinese government recognized it as a major company for “National localization project of mobile communication products.” Yiya Electronic Ltd. became a world-class supplier of mobile phone LCDs. Motorola has also actively helped Yiya Electronic Ltd. cooperate with well-known international companies.



Data source: http://www.motorola.com.cn/news/2001/03/0312_01.asp

Figure 4-5 Local Content Of Products Produced By Motorola China

In March 2002, Fred Shlapak, executive vice president of Motorola flew to China to sign a cooperation agreement on the new generation of mobile telecommunications technology between Motorola and Eastcom, a subsidiary of China Putian Corporation, China's largest communications equipment manufacturer. Motorola was to provide a platform to Eastcom, in

order to shorten the technological development period for Eastcom and cut costs by 40 percent. Fred Shlapak confirmed, “Every thing we do has a long-term vision. We had relations with Eastcom 12 years ago.”⁵² Motorola adopts the Six Sigma program to continuously improve customer satisfaction and product quality.⁵³

Thus, I finish discussing the context for Motorola in China. I have discussed both external environments and internal practices as much as I can gather. The data sources vary from media news, company web pages, annual reports, and a conversational interview. The various data sources can improve the confidence on the information reliability. The contextual factors for the product innovations in Motorola China are highlighted in the summary table (Table 4-4).

4.6 Novozymes North America, Inc.⁵⁴

Novozyymes North America, Inc (Novozyymes NA) is quite different from Motorola (China) Electronics Ltd. One is in biotechnology industry and the other is in telecommunication industry. One is a mid-size company with about 3,700 employees, whereas the other is a giant with 95,000 employees. The host countries of the two subsidiaries are quite different. One is in a leading country in the world, whereas the other is in a developing country. Interestingly, localized learning has not been a focus in Novozymes NA. Instead, Motorola China has well focused on it. Thus, the comparison of the contextual factors of Novozymes NA with those of Motorola and of other two cases would more likely highlight the antecedents of localized subsidiary innovation, even though Novozymes NA is as successful as others.

I check on the contextual factors of Novozymes NA in the following, from global industrial enzyme market, to corporate background, and finally to subsidiary characteristics.

⁵² *People's Daily*. March 21, 2002.

⁵³ <http://www.motorola.com.cn/en/about/inchina/university.asp>, <http://muexternalpartnership.motorola.com/>.

⁵⁴ Unless specified, this case is based on the annual reports (1995-2002), the site report of Franklinton, and the WebPages (<http://www.novozymes.com>) of Novozymes A/S. In November 2000, Novozymes A/S was established by way of a demerger from Novo Nordisk A/S. Before November 2000, the Novozymes business in Novo Nordisk A/S was a division called Enzyme Business. For simplicity, I refer both of them as Novozymes.

| Contextual factors | Characteristics | Illustrations |
|--|---|---|
| Market significance | High | "This is our most important market" |
| Corporate internationalization | High | Currently Motorola has operations in 69 countries and over 95,000 employees across the globe |
| Local customer preference | Trendy | To fight back, Motorola has introduced a faux-diamond-studded handset. "In the past, Motorola's reputation was more for good quality. Now it's much more trendy," says Tim Chen, Beijing-based chairman of Motorola's China operations. |
| Local competition | Increasing | The concentration ratio of top two producers (i.e., Motorola and Nokia) in China dropped from 71.7% in 1999 to 43.9% in 2002. |
| Corporate support | Timely transfer of technology | "transfers leading technology from the HQ to be used in the China market before other markets." |
| Subsidiary top managers team | Multiple nationalities, highly local | Among the ten top managers with "China" in the title listed on the Motorola China webpage, nine are Chinese and one is American. |
| Local authority to create new products | High | The objective of PCS Beijing R&D Center is design and develop the products required for success by PCS PRC businesses,... |
| Learning orientation | High | "From the people we do business with and employ, we learn" ... The objective... is ...leveraging the common core platforms to incorporate regional customer needed features, and break new ground. |
| In-house resource availability | R&D available | There are about 300 engineers conducting research on software, electrical, mechanical and industrial design development. ... more than US\$10 million each year on project development, equipment procurement and training... |
| Local partnership | Many (with suppliers, universities, research institutions, competitors) | Motorola China has actively developed R&D partnership with local research institutions, universities, and companies in China. It claimed that cooperation was a key to their strategy of instilling Motorola with Chinese characteristics. ... Besides collaborating with research institutions and universities, Motorola has actively sought opportunities to establish joint ventures and cooperation projects with local companies. |
| Consequence | Transfer to South Asia, Europe | "Motorola A6288 has been transferred to Southeast Asia and Europe" |

Table 4-4 Within-case Summary – Motorola in China

4.6.1 Global industrial enzyme market

Market overview The global industrial enzyme market was worth over \$1 billion a year in 1995.⁵⁵ Few major manufacturers dominated the markets with several smaller ones. The largest enzyme manufacturers were Gist-brocades, Novozymes, and Genencor International. The smaller global enzyme producers included Systems Bio-Industries, Christian Hansen Laboratories, and Rhone-Poulenc. However, the ongoing strong pricing competition soon resulted in a new competition landscape. Gist-brocades and Solvay both sold their technical enzymes businesses. Rochester, N.Y.-based Genencor International purchased the industrial enzyme business from the Belgian giant Solvay, which had shared the U.S. enzyme market with Genencor and Novozymes. Novozymes acquired Showa Denko's patents and know-how following the company's decision to leave the industrial enzyme market. Novozymes launched several other initiatives to improve its position as a low-cost producer in order to survive through the rigorous cost cutting at the time.

Novozymes and Genencor survive through the price war and become the current market leader. Novozymes enjoys a market share of 44% followed by Genencor at 22% and DSM at 9%. Novozymes and Genencor become the only two companies who compete in the entire range of market segments. Most of others focus on specific segments of the market. The numerous smaller participants in the industrial enzymes market include Diversa, Chr. Hansen, Danisco Cultor, AB Enzymes (formerly Rohm Enzyme GmbH), Degussa, and the Japanese producers Amano, Asahi and Hayashibara, among others. The entry of new companies has increased pressure on prices. The global industrial enzyme market is estimated to be worth \$1.6-2 billion.⁵⁶ While consolidating, the end-user markets have increased their purchasing power. There is also increased regulatory compliance required in applications with high growth potential.⁵⁷

The new applications and demand from emerging markets have currently driven the demand in the global market. The volume growth of industrial enzymes runs at 3 to 4 percent.

⁵⁵ *Financial Times*. November 29, 1995. Confirmed by *Chemical Marketing Reporter*. January 22, 1996; July 19, 1996.

⁵⁶ *Chemical Market Reporter*. April 28, 2003.

⁵⁷ PR Newswire. October 5, 1998.

The decreasing prices, however, keep the value growth constant. "There is significant downward pricing pressure due to severe competition among the many smaller players," says Leo Hepner, president, L. Hepner and Associates, a London-based consultancy.⁵⁸

The key success factors in the industrial enzyme industry require market and customer-driven innovation, global presence, and manufacturing excellence, according to Tom Pekich, group vice president of bioproducts at Genencor.⁵⁹ The availability of new tools in biotechnology drives up R&D expenses in the industry. Mr. Pekich notes, "This is a sophisticated, high-tech business. The innovation that has gone into enzymes in the last 10 to 15 years has been phenomenal."⁶⁰ The industrial enzyme market gradually shifts its focus from commodity to proprietary enzymes, with increasing demand for enzymatically-modified functional ingredients, and the growth of novel protein engineering techniques that aid enzyme development.⁶¹ Leading players in the market compete with a continuous stream of innovative products. The consolidated end-user applications markets drive their product development focus. The companies also turn to acquisitions and joint ventures to strengthen their market position.

Major segments The major segments of industrial enzyme market are food enzymes and laundry detergent enzymes. The food enzyme segment accounts for 40 percent of the global market, based on 1995 estimates. The starch processing and dairy represent the largest part of the food enzyme market, accounting for 75 percent of food enzyme sales.⁶² Novel enzymes and new applications have been driving growth in the food enzyme industry. More than 450 companies worldwide produced industrial quantities of food enzymes, according to Richard Taylor, president of TC Associates, in a report for Decision Resources.⁶³ With sales of about \$500 million per year, the detergent enzyme segment accounts for approximately 40 percent of the \$1.2 billion industrial enzyme market.⁶⁴ The trade magazine of detergents claims that enzymes research is one of the hottest topics in the development of detergents. The opportunity for product development growth for the detergent industry is vast, and enzyme research is vital to

⁵⁸ *Chemical Market Reporter*. 28 April 2003.

⁵⁹ *Chemical Market Reporter*. 28 April 2003.

⁶⁰ *Chemical Market Reporter*. 21 January 2002.

⁶¹ PR Newswire. 5 October 1998.

⁶² *Chemical Market Reporter*. 19 July 1996.

⁶³ *Chemical Market Reporter*. 22 June 1998.

⁶⁴ *Chemical Market Reporter*. 22 January 1996.

detergent development. From the desert sands to the depths of the sea, enzyme discovery seems limitless, as are the various combinations of enzymes that can be utilized.⁶⁵

The United States is the largest market for industrial enzymes.⁶⁶ The U.S. market for industrial enzymes totaled about \$515 million in 2000, growing at 4.1 percent per year, according to Business Communications Company, a market research firm in Norwalk, Connecticut. The largest end use was food and animal feed at \$250 million, with a growth rate of 3.2 percent. Pulp and paper, though the smallest end market, is the fastest growing, at 6.5 percent.

Major competitors- Genencor Genencor International Inc. is the largest enzyme manufacturer after Denmark's Novozymes. Genencor was established in 1982 as a joint venture between Genentech Inc. and Corning Inc. Since its founding, Genencor has grown to become a leading biotechnology company, with over \$350 million in year 2002 revenues, more than 250 biotechnology products in commerce, and over 3,400 owned and licensed patents and applications. Genencor has principal offices in Palo Alto, California; Rochester, New York; and Leiden, the Netherlands.⁶⁷ It employs more than 1,500 and operates eight manufacturing sites around the world, including three sites in the US, three in Europe, one in Latin America and one in China.⁶⁸ In addition, Genencor is in the process of building a clinical products manufacturing facility in Rochester, N.Y.⁶⁹

Genencor offers industrial enzymes to traditional markets including cleaning, grain processing, feed, food and specialties, and textiles. The company is currently working to develop significant new markets in the areas of personal care and biomass. Tom Pekich, group vice president of bioproducts at Genencor, noted:

“While some of this investment is directed at new market areas such as silicon biotechnology, biomass and personal care, a substantial portion is dedicated to meeting the unmet needs of our current markets. We believe that market growth

⁶⁵ *Soap & Cosmetics*. 1 October 2001.

⁶⁶ *Chemical Market Reporter*. 22 June 1998.

⁶⁷ <http://www.genencor.com>.

⁶⁸ *Chemical Market Reporter*. 21 January 2002.

⁶⁹ *Chemical Market Reporter*. 28 April 2003.

in industrial enzymes and for that matter in industrial biotechnology, is dependent upon the market participants' sustained R&D investment.”⁷⁰

Genencor launched nine products in 2002 and plans further introductions in 2003 including new enzymes for the food, feed and specialty sectors. The firm allocates over 12 percent of product revenues in R&D for its bioproduct business.

In addition to the focus on R&D, Genencor has extensively used acquisitions and alliances to develop its market position. Back in 1996, Genencor acquired the Belgian giant Solvay, which had shared the U.S. enzyme market with Genencor and Novozymes, to consolidate its position in industrial enzymes.⁷¹ In January of 2003, Genencor announced the acquisition of Rhodia's brewing and enzyme business. “This acquisition is part of our overall strategy to seek out market segments where growth will substantially exceed the market average,” says Mr. Pekich, “We expect that acquisitions will continue to play a role in accelerating our growth and enhancing our presence in key market segments.”⁷²

Genencor is also developing alliances to capture opportunities. Partnering with major customers ensures markets for Genencor. With laundry detergents a major focus, Genencor has worked with Procter & Gamble for 20 years. Recently, it signed a five-year supply contract with Procter & Gamble, under which Genencor will supply the soaper with proteases for laundry and dish detergents. Genencor estimates the value of the agreement at about \$600 million in product revenues over the life of the contract. Genencor also partners with traditional chemical companies to add value to its biotech-based portfolio. For an instance, Genencor started a collaboration with Dow Coming in 2001, aiming to combine the advantages of biotech with those of silicon.⁷³ On March 12, 2001, Genencor and DuPont announced the signing of an agreement to expand their multiyear research and development collaboration in the area of metabolic pathway engineering. The collaboration began in 1995. Genencor and DuPont have focused on the bioproduction of 1,3-propanediol, a key monomer used for the production of new DuPont Sorona™ polymer and fiber. Under the terms of the agreement, Genencor receives research and development funding, potential milestone payments and royalties on product sales.

⁷⁰ *Chemical Market Reporter*. April 28, 2003.

⁷¹ *Chemical Market Reporter*. January 22, 1996.

⁷² *Chemical Market Reporter*. April 28, 2003.

⁷³ *Chemical Market Reporter*. January 21, 2002.

Using Genencor's DesignPath™ technology, scientists from Genencor and DuPont successfully combined DNA from three different microorganisms into one production strain and in doing so, achieved greater than a 500-fold improvement in productivity during the initial phase. "Our work with DuPont represents a major breakthrough in the development of chemicals from clean, renewable raw materials and is another example of how Genencor leverages its core technologies into new markets," said W. Thomas Mitchell, chairman and chief executive officer of Genencor.⁷⁴

4.6.2 Innovations in Novozymes A/S

Corporate overview Novozymes A/S is the largest player in industrial enzyme market. It was spun off from Novo Nordisk in November 2000. Novozymes holds approximately 40 percent of the world market and more than 20 percent of the US market.⁷⁵ The Company's principal activities are the development, production and marketing of a complete range of enzyme products. It offers more than 100 types of enzymes and almost 700 different products to more than 20 different industries in the food, feed and technical sectors.⁷⁶ Based in Denmark, Novozymes sells its products in more than 130 countries. Almost a third of its sales go to North America, a fifth to Asia Pacific. The production facilities of Novozymes spread in Denmark, Switzerland, Brazil, China and the United States. Novozymes has more than 3,700 employees in over 20 countries, of which 20 percent work on R&D, 50 percent on production & procurement, 27 percent on sales and marketing, and administration. Approximately 2,000 employees of Novozymes are located in the home country.

Novozymes divides its products into three categories: technical enzymes, food enzymes and animal feed enzymes. Among the sales of about \$630 million in 2001, technical enzymes accounted for 66%, food enzymes 26%, and feed enzymes 8%. Animal feed and food enzymes, together totaling 34%, constitute a growing share of total sales. The total sales grew 5.6% in 2002 and the share of feed and food enzymes continued to grow larger. Each of the technical

⁷⁴ <http://www.genencor.com>.

⁷⁵ *Chemical Market Reporter*. June 22, 1998.

⁷⁶ *Chemical Market Reporter*. April 28, 2003.

enzyme segments has its own characteristics. The technical enzyme segment is characterized by a short development and approval time for new products (1-2 years). The development of new products is often made in partnership with large customers in the appropriate industries. By contrast, the food and animal feed enzyme segments both require longer development and approval time for new products (4-5 years). The food enzyme segment contains many differentiated sub-segments. Expertise in nutrition is the crucial factor in the animal feed segment. Novozymes is the largest producer in all these three segments.

Innovation performance In spite of the challenges presented by consolidation around 1995 and 1996 in the industrial enzyme industry, Novozymes remained the number one player with sound strategies including developing new products, expanding the company's geographical base, and finding new applications for existing products.⁷⁷ At that time, Novozymes started to build its strategic production facilities in Tianjin, China.

Novozymes have achieved tremendous success in developing new products and finding new applications. The company proudly claimed that it has been behind almost every major discovery in the industry in the last 40 years. The number of its patent families⁷⁸ has been over 750, although it decreased from 787 in 2000 to 760 in 2002. "I like the fact that we have a strong commitment to Research & Development," says Per Falholt, executive vice president, head of R & D. Novozymes has around 650 employees working in R&D and each year invests 11-13% of its sales in finding and developing enzymes. The company has researchers at laboratories in Denmark, China, Japan and the USA. The focus on R&D is essential for Novozymes to remain the world leader in enzymes. It has brought about a large number of new products and constant improvements in productivity in Novozymes. In late 1990s, Novozymes has launched 34 new enzyme products, which account for more than 30% of sales. Since 2000, the company has launched seven to eight new products each year. Among the eight new enzyme products launched in 2002, five are technical enzymes and three food enzymes. The functions of these new products vary across industries: to help filtration processes in the starch industry, dissolve impurities in the production of recycled paper in the paper industry, increase the yield and reduce

⁷⁷ *Chemical Market Reporter*. January 22, 1996.

⁷⁸ A patent family typically covers a number of individual patent applications and granted patents, all based on the same original application.

the cost in the fruit juice industry, improve the properties of egg whites in mayonnaise, remove protein-based stains from grass, blood, egg and sweat in the laundry detergent industry, improve stability in liquid detergents, removes stain from potatoes and pasta, remove stains in a single wash, and so on. The company is also developing a laccase enzyme for odor removal in non-traditional applications such as halitosis.⁷⁹

Besides new product introductions, the length of time from initial idea to the launch of a new enzyme also constitutes a critical success factor. Novozymes has been continuously improving the project management in order to bring down the time taken to develop new products. The fastest developed product to date is Mannaway®, a detergent enzyme that took just 26 months from idea to delivery.

Innovation Process Novozymes divides its innovation process of developing new enzymes into six stages. From an idea to a product, the company needs, first, to get the idea. Customers can be the source of ideas. When customers want to solve a problem, e.g. to remove grease stains on laundry at low temperature, Novozymes starts the research process. After getting the ideas, Novozymes needs to search for the right enzyme. At this second stage, Novozymes collects microorganisms from nature all over the world. Followed is the third stage, to find the right enzyme. Using advanced robots, Novozymes examines thousands of different microorganisms to find the single one that produces the desired enzyme. Then it starts the fourth stage, enhancing the enzyme. In the laboratory, the gene that codes for the enzyme is transferred into the production organisms so that the enzyme can be produced in large quantities. On the fifth stage, the microorganisms are grown in huge fermentation tanks, producing enzymes. The enzymes are recovered from the fermentation broth and are ready for use. Reaching the sixth stage signals a conclusion and an accomplishment. Now the problem on the first stage is solved. The enzyme is used in, for example, detergents that can remove stains at low temperature, saving water and energy and reducing pollution.

Organizing for innovations The innovation process highlights the importance of customers in R&D in industrial enzyme industry. To be able to deliver a steady stream of new

⁷⁹ *Chemical Market Reporter*. April 28, 2003.

ideas and products, Novozymes has to know the specific needs of its customers. Novozymes works systematically on gathering knowledge about customer needs and making this knowledge broadly available throughout Novozymes. To achieve the tasks, Novozymes develops its customer relationship management (CRM) system to contain contact information, customer plans and site visit reports. The number of sales and marketing employees who use the CRM system increases from about 330 in 2001 to about 420 in 2002. Virtually all employees in Sales & Marketing use the system regularly now. After the introduction, the number of R&D employees who use the system has significantly boosted, from about 30 in 2001 to 140 in 2002.

In addition, Novozymes starts to emphasize the integration of R&D and marketing together for new focus areas. In 2001 Novozymes decided to focus on a handful of selected areas and organize them in a new way as independent teams. So far teams have been established within the following areas: Oils & Fats, Pulp & Paper, Processed food and Enzyme applications in Asia. In the independent teams, employees from R&D and marketing work closely together in order to develop new enzymes and get them into the market quickly. In many ways, the teams are like small businesses within the company. They will play an important role in developing enzymes for new areas, and employees have shown great interest in this set-up.

Novozymes realizes the importance of creating an environment where the right people can meet together and dedicate themselves to generating new thoughts and angels on a particular problem. In order to facilitate idea generation, one of the practices that Novozymes has implemented is to bring together 30-40 specialists with expertise in a particular product area at a remote conference center in beautiful surroundings. These experts stay there for a few days, far from phones and email. Via a local computer network, they present their own ideas in addition to their comment on others' ideas. Typically in just a few intense hours, the network can register several hundred new ideas. After the brainstorming, all the ideas are carefully examined and sorted. The ideas with the greatest promise and relevance to customer needs are then tried out first.

Alliances for innovation Novozymes values partnership in innovations. The company has developed extensive partnership with both its customers and companies in biotech industry.

In recent years, Novozymes has experimented with various processes for generating new ideas. They have found that cooperating with customers closely is one of the most effective vehicles to explore bright ideas for new enzyme applications and improvements to existing enzyme products. Among the 34 new enzyme products that Novozymes launched in late 1990s, many were developed in close cooperation with its largest customers. Developing alliances with its customers has become a key strategy of Novozymes in leveraging its technology to new products and processes.

One example is the successful development of Mannaway®. Novozymes developed the product in close cooperation with Procter & Gamble, which has exclusive rights to the enzyme. Mannaway is a mannanase, an enzyme specific for the substance mannan. Mannan essentially glues dirt to clothing, particularly fabrics made of cotton. Mannaway frees that dirt by breaking down mannan. Novozymes used its advanced technology to develop and produce the enzyme for P&G. Mannaway is now part of leading P&G liquid detergents worldwide.⁸⁰ Besides the successful function of the new enzyme, the length of time from initial idea to the launch of Mannaway is also record-breaking. It is the fastest developed product to date. The detergent enzyme took just 26 months from idea to delivery. Customers and Novozymes both have access to their project management system. Working closely with the development partners, Novozymes continuously improves the system in order to bring down the time taken to develop new enzymes. The strategic alliance of Novozymes starting in 2000 with the Roche group's Vitamins and Fine Chemicals Division to develop and market feed enzymes is also successful.

In addition to having a close relationship with customers, Novozymes can develop innovations through close collaboration with other companies in related fields. Novozymes has launched three products which have been developed using the MolecularBreeding(TM) directed evolution technologies of Codexis, Inc. Located in Redwood City, CA, Codexis, Inc. is a provider of biocatalysis and fermentation processes and products to the life science and fine chemical industries. The new products of Novozymes address a range of customer needs in the food processing, pulp and paper, and laundry detergent markets. In addition, benefited from the

⁸⁰ *Chemical Market Reporter*. January 21, 2002.

use of Codexis' technologies, Novozymes has advanced several additional products into late phases of development for application in the food and industrial markets.⁸¹

Novozymes also aggressively uses acquisition to develop new markets and applications. In 2001 and 2002, the company made four acquisitions within industrial microorganisms and one in the biopharmaceutical area.⁸² In 2001, Novozymes bought Sybron Biochemicals in Virginia, U.S. (now Novozymes Biologicals). In 2002, Novozymes made the acquisition of U.S.-based George A. Jeffreys and Interbio in industrial microorganisms. The two companies were integrated into Novozymes Biologicals. In the same year, Novozymes acquired BioGaia Fermentation, Sweden (now Novozymes Biopharma). The acquisition marked Novozymes' first step into the pharmaceutical field.

4.6.3 Novozymes North America Inc. (Franklinton)

Subsidiary overview In December 1977, Novozymes A/S (then Novo Nordisk A/S) invested \$15 million to build Novozymes North America Inc. (then Novo Biochemical Industries, Inc.) at its purchased 187-acre site in Franklin County, North Carolina. The first product was produced in February 1979. There were 50 employees at the time. Since then, the Franklinton plant has expanded three times respectively in 1981, 1984, and 1994. The last expansion cost \$120 million and tripled the production capacity of the plant. After this expansion, Novozymes North America Inc. (NZNA) became the largest multi-purpose enzyme manufacturing plant in the United States. The growing demand from U.S. detergent manufacturers drove the expansion.⁸³ In 1995, Sales, Marketing and Technical Services functions from Danbury, Connecticut relocated in Franklinton.

Currently, the Franklinton site serves as the North American headquarters for Novozymes A/S. It is one of the three strategic production sites of Novozymes A/S. The subsidiary produces virtually the whole range of Novozymes' enzyme products, primarily for the North American

⁸¹ PR Newswire. February 24, 2003.

⁸² *Chemical Market Reporter*. April 28, 2003.

⁸³ *The News & Observer* (Raleigh, NC). April 21, 1992, and May 1, 1992.

market. The markets include the detergent, corn sweetener, fuel alcohol and food processing industries, among others. In addition to the large production plant, the site houses sales and marketing, applied discovery, technical service, pilot plant and site support groups. Among the 349 employees, there are 228 in production, 19 in marketing, 53 in management, and 49 in administration.

Process innovations Although Novozymes A/S is very active and successful in product innovations, NZNA has only played a limited role in it. Product innovation is centralized in Denmark. The small R&D group in NZNA is mainly for application research and technical service given the advantages of having close contact with customers. The goal of NZNA is to increase sales and to optimize manufacturing efficiency, according to the informant at NZNA.⁸⁴ Thus, process innovations are the major innovations in NZNA. Its process innovations focus on production efficiency and manufacturing technology to accommodate various enzymes requirements. Low-cost production is important because of the strong competition in the commodity-like enzyme segments. Novozymes A/S needs to maintain its leadership in those segments in order to pave the way for its advanced products with higher margins and profitability.

The product efficiency has increased over the years in NZNA. The production of enzymes requires large amounts of water, energy and raw materials. The objective for 2001 on water and energy consumption was to increase the production per unit of energy and water consumed (m³ for water and GJ for energy) by 5.6% compared to 2000 for each. Primarily through yield improvements and due to changed product mix, a 15% improvement in the water eco-productivity index was obtained. A 12% improvement in the energy eco-productivity index was achieved, primarily through energy-saving projects in fermentation and through yield improvements. The raw materials consist of agricultural produce such as sugar, starch and potato

⁸⁴ The phone interview lasted for one hour and was in English. I took notes during the interview. I asked the informant if NZNA had developed any of its own innovations, and I further asked a few open-ended questions to explore contextual factors. The informant is a research engineer, thus quite knowledgeable of the research aspect of the organization.

protein and other nutrients used for fermentation.⁸⁵ Filter materials, organic and inorganic chemicals such as acids, bases and salts, are used for recovery and purification, and the granulation requires cellulose, kaolin and salts. Finally, different types of packaging for the products are used, such as big bags and drums. In 2001, agricultural produce accounted for 58% of consumed raw materials, inorganic chemical compounds 26%, filter materials 9%, and organic chemical compounds 7%. NZNA used genetically modified microorganisms to reduce resource consumptions. In addition, NZNA was also the winner of the 2000 North American Maintenance Excellence Award and has made significant improvement over its environmental performance.

NZNA mainly relies on its in-house research resources for innovations. There are nine Ph.D.s and research scientists. Most of them are American. There are two Danes, one senior and one junior. The subsidiary owns a pilot plant. The informant used “enough” to describe their research resources in NZNA. His view is echoed by Owe Forsberg, Maintenance Manager. “For a long time our organization was introspective. We thought we had everything we needed in house and that we could do it all ourselves” commented Mr. Forsberg. He quickly added that “all our people are really motivated and smart.”⁸⁶ Ann Jenkins, a research engineer in the pilot plant was quite satisfied with the climate in NZNA in terms of supporting openness. “It's quite unique that the management supports open debate. They really believe that together we can create the right solutions. I was honestly surprised the first time I saw the staff magazine, where constructive criticism was put forward quite openly. Good decisions require open communication”, she commented. From the phone conversation, I can tell that the informant really enjoyed working for NZNA. Compared with his experience, he credited it to the similar culture between Denmark and American. To make the comparison, the informant gave me an

⁸⁵ Enzyme production can be divided into three essential phases: fermentation, recovery and formulation. Fermentation takes place in large tanks where the selected microorganisms are propagated as intensively as possible. The enzymes are separated from these microorganisms. High yields require perfect growing conditions, an art of adding nutrients and oxygen. The nutrients used for fermentation are natural materials such as starch and soya. Recovery involves extracting the enzymes from the microbial culture and consists of several steps. First solid elements are removed by filtration and centrifugation. The resulting enzyme solution is then concentrated through a number of process steps, such as evaporation, ultrafiltration or precipitation. The recovered concentrate is then stabilized with additives to maximize the enzymes' performance and shelf life. Formulation is the work involved in making the enzyme ready for sale. This can be in a solid form, such as a granulate, or in a liquid form. For example, enzymes for use in washing powders have to be granulated. This means encapsulating the enzymes in a water-soluble wax that ensures that the enzymes do not have any effect until the detergent is in the washing machine.

⁸⁶ <http://www.idcon.com/articles/novo.htm>.

example in a chemical subsidiary acquired by a Japanese company. American employees were frustrated with not being able to get straight answers and with their hand-off approach.

Linkages with other sites in Novozymes A/S The communication between NZNA with the headquarters in Denmark and subsidiaries in other production sites (e.g., in China and Brazil) is quite intensive. All business functions in NZNA, including Production, Pilot Plant, Quality Control, Engineering, Sales, Tech Services, Marketing, Research & Development, Finance, Purchasing, Regulatory, Information Technology and Human Resources, work closely with their counterparts in Denmark. The informant confirmed that he frequently communicated with Denmark via emails everyday. There are also plenty of opportunities for site visits. The informant has stayed in Denmark for 18 months. Purchasing has been coordinated across countries. For an instance, NZNA purchased from Brazil for trial supplies in the week when I conducted my interview. Cross-functional communication happens more when launching new products, among manufacturing, marketing, and purchasing departments. As a research engineer, the informant has worked with marketing people in Denmark. He saw no need to talk with purchasing people in Denmark, though. Talking to local purchasing would be sufficient for him. The collaboration between NZNA and other three U.S. sites has only been occasional because they produce different products.

The exchange of knowledge worldwide across sites in Novozymes A/S is facilitated by the LUNA electronic archive, and by electronic quality management and process descriptions. LUNA is structured for easy knowledge sharing, while an access restriction ensures that sensitive information is protected and only shared among relevant people. The growth in employees' use of LUNA has been significant: from about 850 in 2000, to about 1300 in 2001, to about 1980 in 2002. In addition, knowledge is also shared at a number of international conferences. In the week prior to my interview, all manufacturing scientist held a worldwide technology meeting to share new ideas and best practices. The practices have well facilitated knowledge transfer across sites. NZNA had transferred a few process innovations to the Tianjin site in China, said the informant. However, the driving forces for the transfer, according to the informant, are the vision and values of Novozymes A/S to cultivate the right attitudes: All the sites have mutual respects for each other as a part of the whole company.

Novozymes A/S institutes the board of directors for subsidiaries. The local board is responsible for stockholders and report to Board in Denmark. As Novozymes requires, the local boards must include a representative of the line management, the local general manager and a representative of Legal Affairs or Finance Department. Regarding nationalities, the local board of NAZA includes three American and two Danes, according to my interview.

Linkages with other companies in the U.S. The self-sufficiency attitude reflected by NZNA employees explains limited linkages that NZNA has. Among the limited linkages, it is worthy of highlight that NZNA was awarded of a grant by the National Renewable Energy Laboratory under the US Department of Energy. As part of a collaboration with High Plains Corporation, NZNA has been granted USD 2.2 million for the development of methods to convert biomass to ethanol and for the development of enzymes for the production of fuel ethanol. Starting in January 2001, it is a three-year sub contract of the project "Pre-Commercialization of a Biomass-derived Process Technology." The project was launched by the High Plains Corporation and has been awarded USD 17.7 million in total by the US Department of Energy. NZNA will leverage the technology coming from this subcontract in developing cost-effective carbonhydrases and explore the techno-economic feasibility of producing ethanol from biomass.⁸⁷

Nevertheless, the location advantage in knowledge captured by NZNA mainly includes employees recruited from local labor market, the United States. There seem more potential advantages for NZNA. North America is the largest enzyme market. It accounts for 30 percents of sales for Novozymes A/S. According to the informant, more than half of sales of the products produced by NZNA occurred in the U.S. market. Moreover, the new enzymes ideas are mainly customer-driven, market-driven. Marketing people, who are also scientists, are responsible for knowing about local customers. The close contact and knowledge of local customers of NZNA, thus, can provide justifications for NZNA engaging more in local product innovations. The informant inclined to have more local product innovations in NZNA by taking advantage of the huge local market and the best practices of local companies. In addition to the potential

⁸⁷ PR Newswire. October 28, 2002.

advantage in local product innovations, the informant viewed potential cost-saving in local purchasing occasionally. For instance, sugar in local market is cheaper and requires no shipment cost. Local supply can be more timely to NZNA. The major contextual factors for the product innovations in NZNA are highlighted in the summary table (Table 4-5).

4.7 Case discussion and conclusions

These four mini-cases provide a broad description of the context in which subsidiaries of MNCs created innovations. A cross-case analysis can highlight the common themes or patterns among the jungle of details in cases of various contexts. I conduct a cross-case pattern search among the four cases, and then I check on the generalizability of the cross-case findings by examining the pharmaceutical industry in the United States, which has the highest ratio of subsidiary knowledge outflow among all the industries. I summarize the conclusions of this case research at the end, followed by a discussion on the limitation of this multiple-case research.

4.7.1 Cross-case analysis

Based on the details of each individual case, (i.e., Motorola (China) Electronics Ltd., Novozymes North America Inc. (Franklinton), Acer America, and Philips U.K.), I search for shared themes or patterns across the four cases. I conduct pair-case comparisons and list the similarities and differences between each pair (Yin, 1989; Eisenhardt, 1989) suggestion. The advantage of the pair-case approach is that the method forces me to look for subtle similarities and difference between cases. The similarity in a seemingly different pair, and difference in a seemingly similar pair too, can not only reduce the influence of my presumptions or bias on the process of searching for patterns, but also can lead to more sophisticated understanding. Moreover, the pair-case comparison particularly works for this study, because the four cases are naturally in pairs. The cases of Motorola (China) Electronics Ltd., and Novozymes North America Inc. (Franklinton) discuss the overall innovativeness of subsidiaries and focus on

| Contextual factors | Characteristics | Illustrations |
|--|--------------------------------|--|
| Global competition | Moderate | Few major manufacturers dominated the markets with several smaller ones. ...Low-cost production is important because of the strong competition in the commodity-like enzyme segments. Novozymes A/S needs to maintain its leadership in those segments in order to pave the way for its advanced products with higher margins and profitability. |
| Corporate culture | Highly innovative | Novozymes have achieved tremendous success in developing new products and finding new applications. The company proudly claimed that it has been behind almost every major discovery in the industry in the last 40 years. |
| Corporate internationalization | High | Based in Denmark, Novozymes sells its products in more than 130 countries. Almost a third of its sales goes to North America, a fifth to Asia Pacific. The production facilities of Novozymes spread in Denmark, Switzerland, Brazil, China and the United States. Novozymes has more than 3,700 employees in over 20 countries, ... |
| Market significance | High | It accounts for 30 percents of sales for Novozymes A/S. According to the informant, more than half of sales of the products produced by NZNA occurred in the U.S. market. |
| Subsidiary top managers team | Multiple levels, nationalities | Local board: 3 American and 2 Danes, be responsible for stockholders and report to Board in Denmark |
| Local authority to create new products | No | Although Novozymes A/S is very active and successful in product innovations, NZNA has only played a limited role in it. Product innovation is centralized in Denmark. |
| Learning orientation | Moderate | The goal of NZNA is to increase sales and to optimize manufacturing efficiency, according to the informant at NZNA. |
| In-house resource availability | R&D available | There are nine Ph.D.s and research scientists. |
| Local partnership | Limited | The informant used “enough” to describe their research resources in NZNA. His view is echoed by Owe Forsberg, Maintenance Manager. “For a long time our organization was introspective. We thought we had everything we needed in house and that we could do it all ourselves” commented Mr. Forsberg. |
| Consequence | Transfer to China | NZNA had transferred a few process innovations to the Tianjin site in China, said the informant. |

Table 4-5 Within-Case Summary – Novozyme North America, Inc. (NZNA)

current context. The data sources are conversational interview validated by and combined with archives. The cases of Acer America and Aspire, and Philips U.K. and Teletext, center on a historical innovation incident of each subsidiary. The data sources are the existing business cases by other researchers.

Following the pair-case comparison, I compare the two pairs and iterate the same search process (i.e., searching for similarities and differences, between the pairs). Similar findings can validate the searched pattern, while different findings can lead to more sophisticated understanding. Eisenhardt (1989) advocated the advantages of arranging multiple researchers in a case study. Although there are no other researchers in this case research, comparing cases of different authors can leverage the advantages of multiple researchers by reducing my own presumptions or bias.

Table 4-6 summarizes the pair-case comparisons. Comparing the case of Motorola and Novozymes, I use the **bold fonts** to highlight the subtle differences. The similarities and differences can contribute to primary contemplations for answering the research questions. When comparing this pair with the other pair (i.e., Acer America, and Philips U.K.), I use the bold fonts to indicate the confirmation of prior contemplations. The *italic fonts* highlight the inconsistency to the hypotheses. The detailed pair-case comparison and elaboration of the primary contemplations are as follows.

I use the localized subsidiary innovation to indicate the extent to which a subsidiary creates innovations. Motorola (China) Electronics Ltd. has launched many new mobile phone models in China. Thus I note “many” for its localized subsidiary innovations. Novozymes North America Inc. has some process innovations in terms of production efficiency and manufacturing technology. Thus I note “some” for its localized subsidiary innovation. Since I try to investigate the factors that influence localized subsidiary innovation, the difference in the same contextual factors between these two cases would more likely be candidates for future hypotheses. The similarity between the two cases is tricky, though, since the two cases are not at the end of a continuum of localized subsidiary innovation. Nevertheless, I should be less confident on the influence on the factors that appear similar to both of the cases. The cases of Acer America and

Philips U.K. can serve as a tool for validation on the influence of the factors that emerge. These two cases happened in the past, and in different countries. More importantly, other researchers prepared them. A caution should be raised on the validation, though, since these two cases center on specific examples of localized subsidiary innovation. On the other hand, given that Acer and Philips compete in the same industry, as does Motorola, the caution can be scaled down.

| Contextual factors | <i>Motorola (China) Electronics Ltd.</i> | <i>Novozymes North America Inc. (Franklinton)</i> | <i>Acer America</i> | <i>Philips U.K.</i> |
|--|--|---|----------------------|---------------------|
| Localized Subsidiary innovation | Many | Some | Aspire case | Teletext case |
| Local competition | Oligopoly, but competition increasing | Oligopoly | High | — |
| Local market/customers | Large | Large | <i>Leading</i> | <i>Special need</i> |
| Local partnership | Many | Limited | A design firm | — |
| Top management team | Heterogeneous | Heterogeneous | Heterogeneous | Heterogeneous |
| In-house R&D resources | High | Some | <i>No</i> | <i>No</i> |
| Corporate support | Moderate | — | <i>High</i> | <i>Low</i> |
| Local authority to create new products | Yes | No | Yes | Yes |
| Learning orientation | High | Moderate | — | — |
| Corporate internationalization | High | High | <i>Moderate</i> | — |

Table 4-6 Cross-Case Pattern Searches

Local authority to create new products, local partnership, and local competition are the three contextual factors that differ subtly between the first pair (Motorola and Novozymes) and of which the suggested influence is confirmed by the second pair (Acer and Philips). Although it is a subsidiary in a developing country invested by a MNC based in the world-leading country,

Motorola (China) Electronics Ltd. has the authority to develop its own products. On the other hand, even though it is located in the leading country, Novozymes North America Inc. does not have the authority to develop its own products.

The importance of local authority to create new products is confirmed in the second pair of cases. Both Acer America and Philips U.K. had authority to pursue new product opportunities. The influence of local partnership emerges in comparison of the first pair of cases. Motorola (China) Electronics Ltd. has allied many local partners with local universities, local competitors, local suppliers, and other local companies in China, whereas Novozymes North America Inc. has few alliances in the United States. The case of Acer suggests the importance of local partnership on localized subsidiary innovation too. A local design firm in California collaborated with Acer America on the design of Aspire.

The subtle difference in local competition in the first pair of cases is highlighted by the case of Acer America in the second pair. Motorola (China) Electronics Ltd. has a dominating position in the mobile phone market in China. The local competitors have significantly increased competitive initiatives and market share. On the other hand, Novozymes has survived an intensive competition around 1996. Current competition for Novozymes North America Inc. is quite stable. It enjoys a dominant position in the U.S. enzyme market. The Aspire of Acer America was born out of intensive competition in the computer industry in the United States.

Due to lack of information in the second pair, the influence of the learning orientation remains to be confirmed. The difference in the first pair does not appear subtle, though. Even though Motorola is a leading global company, Motorola (China) Electronics Ltd. does not boast its superiority in China. It claims that it can learn from the local market and talents. The goal of Motorola (China) Electronics Ltd. is not only to leverage the leading technology of the parent company, but also to claim an ambitious vision – to break new ground. By contrast, Novozymes North America Inc. does not have the aggressiveness. Its goal is to increase sales and optimize manufacturing efficiency. Although the leading market of U.S. can provide abundant opportunities for learning, Novozymes North America Inc. appears more self-sufficient and bears only moderate level of learning orientation.

The influence on localized subsidiary innovation of in-house R&D resources and corporate support is not consistent. There is a clear difference in the first pair of cases in terms of in-house R&D resources, one with a high level and the other with less. The second pair of cases, however, disconfirms the suggested influence. Both of the cases in the second pair did not have in-house R&D resources when they developed their new products. As for the influence of corporate support, I am not able to conduct a comparison in the first pair due to lack of information. Nevertheless, I sense that Motorola (China) Electronics Ltd. is encouraged to be more aggressive in trying out new ideas, but it is not the case for Novozymes North America Inc. My intention of suggesting the influence of corporate support is discouraged by the second pair, though. There appears a clear difference between these two cases. Thus, the importance of in-house R&D resources and corporate support requires further investigation.

The local market or customers appear similar in the first pair of cases. Both of the local markets are large and important, China for Motorola and the U.S. for Novozymes A/S. It applies to the Acer America case in the second pair. However, the second pair seems to imply another theme about local market, the difference in local customer needs. Acer identified the leading customer need in multimedia and fashionable WinTel-based PC in the United States, and Philips U.K. identified the special need for teletexts in U.K. Thus the addition insight from the second pair of cases suggests that different customer needs may present opportunities for localized subsidiary innovation.

The influence of top management team and corporate internationalization appears to be minimum. The top management teams in both pairs of cases are heterogeneous either in nationality or in functions. Novozymes North America Inc. still has some localized subsidiary innovation. I need more evidence to compare the heterogeneity of top management team in a company with few localized subsidiary innovations in order to reach the conclusion that it has no influence on localized subsidiary innovation. Nevertheless, I can suspect that the influence of top management team heterogeneity would not be high. Corporate internationalization would not have a significant impact on localized subsidiary innovation either, because both companies in the first pair of cases have significant internationalization. The case of Acer America can

confirm the contemplation because Acer had less internationalization than Novozymes A/S in the correspondent cases. I do not have the information on the internationalization of Philips when its U.K. subsidiary launched the teletext. Based on my understanding of the history of Philips, it would be relatively high.

Table 4-7 summarizes my discussion. The validation of the cross-case patterns from foreign firms in the U.S. pharmaceutical industry follows in next section.

| Contextual factors | Cross-case patterns | Confirmation from pharmaceutical industry |
|--|----------------------------|--|
| Local authority to create new products | ● | + |
| Local partnership | ● | + |
| Local competition | ● | + |
| In-house R&D resources | ◐ | + |
| Learning orientation | ◐ | |
| Corporate support | ◐ | |
| Local market/customers | ◐ | ○ |
| Top management team | ⊖ | |
| Corporate internationalization | ○ | ○ |

Legend:

The shade in the circle indicates the level of confidence on its influence on localized subsidiary innovation.

- Difference in the first pair, and suggested influence confirmed by the second pair
- ◐ Difference in the first pair, but suggested influence disconfirmed by or lack of support from the second pair
- ◑ Similarity in the first pair, but additional insights from the second pair
- ⊖ Similarity in both the pairs
- Similarity in the first pair. The lack of influence is further confirmed by the second pair
- + Evidence from pharmaceutical industry confirms the influence.
- Evidence from pharmaceutical industry does not confirm the influence.

Table 4-7 Summary Of The Multiple-case Research

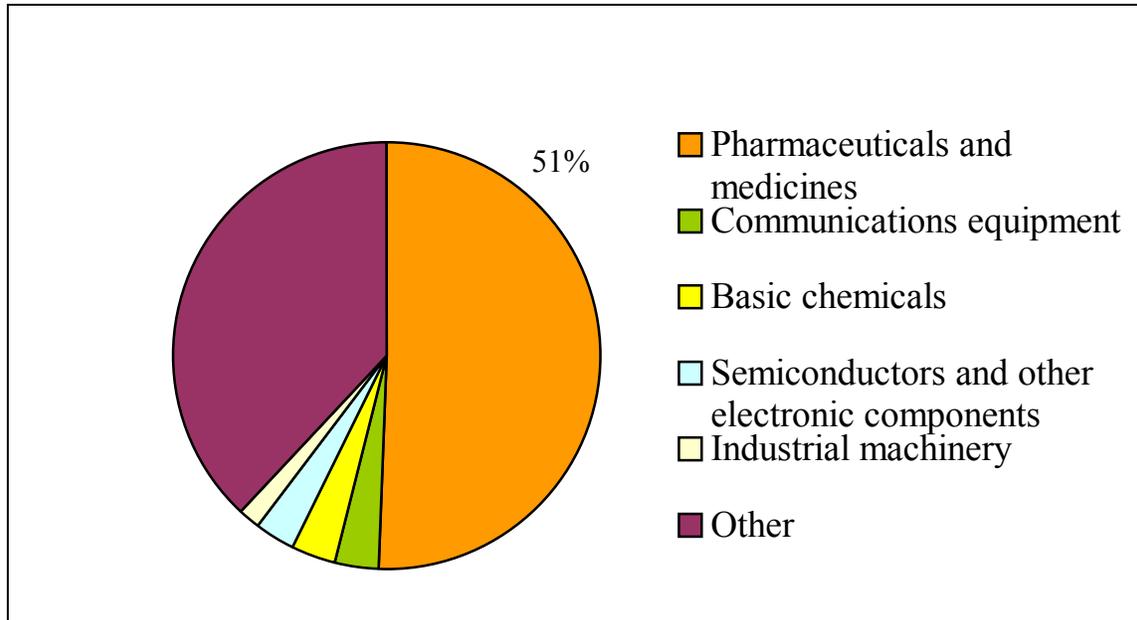
4.7.2 Validation from foreign firms in the U.S. pharmaceutical industry

I choose the foreign firms in the U.S. pharmaceutical industry to validate the cross-case patterns because it is characterized with the highest knowledge outflow from foreign subsidiaries. The United States boasts to be the top country in the world regarding both outward and inward foreign direct investment (FDI). The internationalization of the pharmaceutical industry has proceeded largely through foreign direct investment (Li, 1995). High tariff and non-tariff barriers such as the regulations of the U.S. Food and Drug Administration (FDA) have presented significant obstacles for exporting by foreign companies. More importantly, while the United States maintains a free market system and owns one of the most advanced markets in the world, foreign firms in the U.S. experience high intra-firm transactions. Particularly, the pharmaceutical industry boasted to be the top industry in both receipts and payments of subsidiaries regarding intra-firm royalties and license fees in 1999 (Bureau of Economic Analysis). The aforementioned receipts account for 50.5 percent of those in all manufacturing industries (Figure 4-6). The assets of subsidiaries in pharmaceutical industry, however, only account for 9 percent of total foreign assets in all manufacturing industries in the United States (Figure 4-7). The high amount of knowledge outflow can indicate a high level of localized subsidiary innovation at an industry level. Thus, looking into the contextual factors of foreign pharmaceutical subsidiaries in the U.S. can provide a good opportunity of highlighting the factors that influence localized subsidiary innovation.

I conducted two brief interviews and a quick content analysis on archival news to validate the cross-case patterns, from an industry or aggregated level.⁸⁸ I asked the two informants to comment on innovations of foreign subsidiaries in U.S. pharmaceutical industry. Based on their comments, I further asked a few open-ended questions to explore contextual factors. The two informants are both veteran in the U.S. pharmaceutical industry, thus knowledgeable of the industry overall. One of the informants is a sale manager in a foreign pharmaceutical subsidiary, and the other is a CEO in a domestic pharmaceutical company. Their observations highlight

⁸⁸ The two phone interviews were conducted in different companies at different time. One lasted for about one hour and the other twenty minutes. The language is English. I took notes during both the interviews.

significant patterns in the industry instead of dwelling into organizational details. The advantage well serves the validation purpose from an industry level.



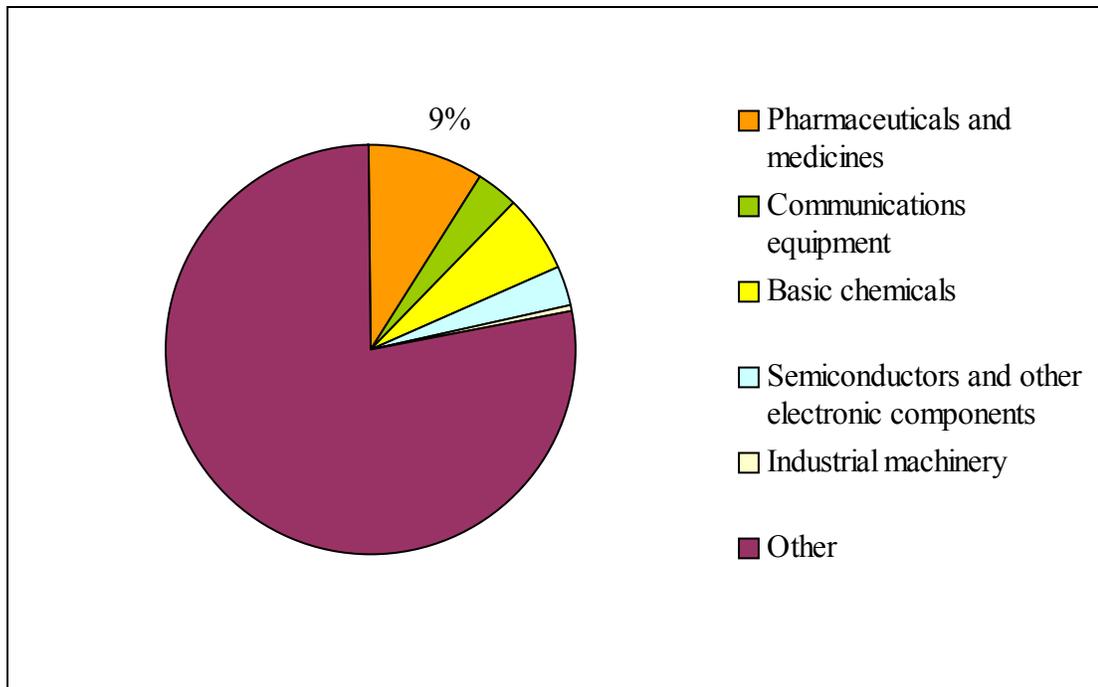
Data source: U.S. Bureau of Economic Analysis, 1999

Figure 4-6 Royalties And License Fees Receipts Of Foreign Affiliates
In The U.S. Manufacturing Industries

Since one informant mentioned Hoffmann La Roche as a successful innovation example; I further conducted a primary content analysis on the subsidiary of a Switzerland-based MNC. I follow the content analysis routine (Krippendorff, 1980; Neuendorf, 2002) (i.e., determining a sampling plan, selecting the unit of analysis, developing coding schemes, and coding the material). After comparing *Dow Jones Interactive*, *LexisNexis*, and *ABI/inform* with trial retrieval, I decide on *Dow Jones Interactive* (later changing name to *Factiva*) for the sampling plan due to its broader coverage and retrieved 86 news reports.⁸⁹ The headline and leading paragraph serve as the unit of analysis, because they provide the key issue of the reports and also render a manageable task for coding. The coding schemes bear no confusion for this content analysis,

⁸⁹ I used Factiva Intelligent Indexing™ to select the indexing following categories with Boolean expressions: (HOFFMANN LA ROCHE and Pharmaceuticals and United States) and (Best Practice or Capacity/Facilities or Knowledge Management or Management Moves or New Products/Services or Plans/Strategy or Profiles of Companies or Research/Development). In the option for “Search for free-text terms in”, I chose headline and leading paragraph. I used the subsidiary name as free-text terms (i.e., HOFFMANN LA ROCHE). Besides checking “Exclude: Republished news”, I did not make any other specific options.

because I am coding for big contextual categories. Ferrier, Smith, and Grimm (1999) partly confirms my coding schemes. While coding the material, I discarded the reports bearing repeating information. Thus, I end up with forty-eight valid reports. I prepared a frequency table to identify significant patterns for the subsidiary in the industry, including the coding schemes (Table 4-8).



Data source: U.S. Bureau of Economic Analysis, 1999

Figure 4-7 Assets Of Foreign Affiliates In The U.S. Manufacturing Industries

Obviously Hoffmann La Roche has the authority to create new products. Based on his observation, an informant cites Hoffmann La Roche as an example for high localized subsidiary innovation. When I ask him the contributing factors for the performance, he suggests that Roche subverts their Swiss identity by giving Hoffmann La Roche a fair amount of decision-making autonomy, particularly innovation decisions. Of the 48 valid news reports, I find that forty percent are dedicated to new product development activities. The significance of new product development activities can be further highlighted in comparison with other functional activities. Hoffmann La Roche manages a full line of business functions. It discovers, develops, manufacturing and marketing reaches only ten percent in the content analysis. Besides the typical

coding schemes for new product development, “trial” is a special coding scheme for pharmaceutical industry. An informant explains that it is “hard to get drug approval” in the U.S., and the sequential clinical trials required by Food and Drug Administration (FDA) are quite “competitive” and lengthy. As a matter of fact, the informant was quite busy with a clinical trial during the week of my interview. The focus on the clinical “trials” and other new product development activities in the media further supports new product development as a key success factor in the industry. The authority to create new products of subsidiaries is critical in the industry, thus confirming the correspondent cross-case patterns from the earlier case research (Table 4-7).

| Category | Frequency | Percentage | Coding schemes |
|-------------------------|------------------|-------------------|---|
| New product development | 19 | 40% | Launch, roll out, develop, [clinical] trial |
| Local alliances | 7 | 15% | Partnership, agreement, alliance |
| Manufacturing | 3 | 6% | Production, job cut, manufacturing |
| Marketing | 2 | 4% | Market, program |
| Rival product | 1 | 2% | Bioequivalent to |
| International | 2 | 4% | Europe |

Note: Forty-eight valid cases in total, between 2000 and 2002

Table 4-8 Content Analysis (Hoffmann-La Roche Inc., 2000-2002)

Local partnership also appears important in the industry. The number of alliances among pharmaceutical companies has increased from 311 to 680 from 1991 to 1998 in the United States, and more dramatically, the number of alliances between pharmaceutical companies and biotechnology companies has leaped from 156 to 595.⁹⁰ Foreign subsidiaries have actively participated in the increase. According to my content analysis, 15 percent of news reports mentioned local alliance formation. Those alliances range from new product development alliances, marketing alliances, and research technology alliances. Most of them are new product development alliances. Beside the 15 percent of local partnership, two additional alliances are

⁹⁰ Windhover's Strategic Transactions database.

with international companies, and one is with a local firm but only for a one-year deal. Altogether, more than 20 percent of reports focus on alliance formation. Besides allying with local companies, collaboration with universities becomes significant. Both of the informants have mentioned that close contacts with local universities bear importance for foreign subsidiaries. For instance, AstraZeneca has a Boston site, which follows up on every new discovery of a university. Novartis sets up a new R&D unit next to MIT. European and Japanese subsidiaries similarly build R&D units next to local universities. Thus, the importance of local partnership on localized subsidiary innovation is confirmed in the pharmaceutical industry.

I have found few reports that focused direct competitive interactions in my content analysis, except one rival product introduction report. However, when I ask about the local competition, both of the informants suggest that the competition is intense. The sale manager comments that the market is “extremely intense.” The CEO emphasizes the consolidation undergoing in the industry. He adds that the consolidations have involved “not only sales centers” but “research and clinical development centers.” Although lack of direct competitive interactions in the news report, the large number of reports on new product introduction can also serve as a sign of intensive competition in the industry. Competitive dynamics research considers new product development and correspondent signaling as competitive actions (e.g., Ferrier, Smith, and Grimm, 1999). Thus, the influence of local competition intensity is somewhat confirmed.

The in-house R&D resources should be significant in foreign pharmaceutical subsidiaries in the U.S. market. The R&D investment of foreign MNCs have been increasing. European pharmaceutical companies have reduced their R&D investments in the EU to 59 percent of their worldwide investment in 1999, down from 73 percent in 1990. The discrepancy mainly flows to the United States.⁹¹ Figure 4-8 highlights the high foreign R&D investments in the United States. Thus, the importance of in-house R&D resources can be confirmed.

⁹¹ European Federation of Pharmaceutical Industries and Associations, *Pharmaceutical Industry Chartbook* (Brussels, Belgium: EFPIA, 2001).

I have not found any special customer preference in the U.S. pharmaceutical market. The market is huge. One informant explains that backed with a mature health care delivery system, the market is providing “more to a wider customer group.” Another informant brings up a key characteristic of the local market – no price control. In countries like Canada, the price control makes the medicine “very cheap or even free”, resulting in “no motivation for pharmaceutical companies to do R&D.” The *Industry Profile 2003* of PhRMA (Pharmaceutical Research and Manufacturers of America) confirms the view of this informant. The document considers the price control as a major reason for foreign R&D investment, noting “greater R&D investment flowing to the United States instead of Europe and Japan, where price control policies have stifled new product development.” Therefore, lack of influence of special local customer preference does not appear as critical for localized subsidiary innovation. Corporate internationalization of Roche is quite high. Roche employs more than 60,000 people and sells its products in over 150 countries.⁹² Thus it does not provide any further insight in terms of the influence of corporate internationalization on localized subsidiary innovation.

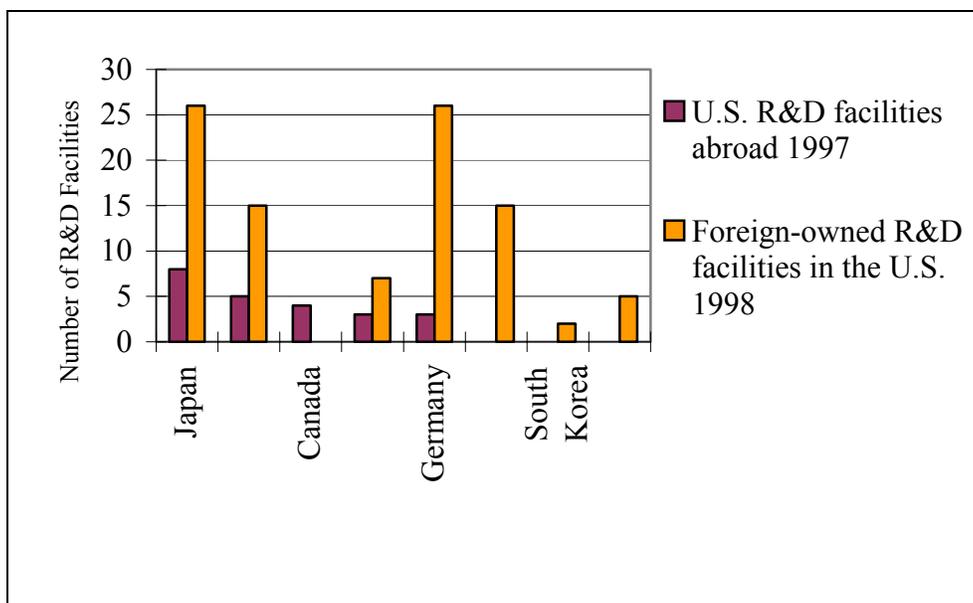


Figure 4-8 Foreign R&D Facilities In The Drug And Biotechnology Industry⁹³

⁹² <http://www.roche.com>.

⁹³ Data source: U.S. Department of Commerce, 1999.

I do not have information to validate the influence of learning orientation, corporate support, and top management team on localized subsidiary innovation in the U.S. pharmaceutical industry. The *Industry Profile 2003* of PhRMA suggests that another major reason for foreign R&D investment in the U.S. is the “greater opportunities for innovation because of advances in scientific knowledge and tools.” A learning orientation is somewhat implied. As for corporate support, Ranbaxy, an India-based pharmaceutical MNC emphasizes its importance. Parvinder Singh, the chairman and CEO, was “always a scientist-entrepreneur at heart.” He protected new product developments, even when “every time urgent domestic needs appeared to overwhelm R&D priorities.”⁹⁴ The evidence is not sufficient enough to confirm the prior contemplation, though. Thus, I leave the confirmation open for further investigation in later stage of this research.

Besides the contextual factors that I have identified through multiple-case research, an informant, the sales manager suggests that the years and experience of foreign subsidiaries in the U.S. may contribute localized subsidiary innovation. He also suggests that entry mode such as M&A may contribute to acquire knowledge of local market. Before offering these additional insights, the informant emphasizes that he does not know the contributing factors to localized subsidiary innovation. The other informant, the CEO, believes that entry mode does not necessarily contribute to localized subsidiary innovation. “It varies by company,” he says. I further test the controversy in a later stage of this research.

4.7.3 Conclusions

This multiple-case studies explore the wide range of localized subsidiary innovations. The examples in the real world cases support the prevalence of the phenomenon of localized subsidiary innovation. The interviews confirm the significance of the research questions in that the industry has the need to understand them. The performance implication of those localized subsidiary innovations further supports the importance of a better understanding of the phenomenon. Among the examples of localized subsidiary innovations, I choose four with high

⁹⁴ Bartlett, C. A. and S. Ghoshal (2000). “Going global: Lessons from late movers.” *Harvard Business Review* March-April: 132-142. p141.

variations in order to examine the full details of each. Some themes or patterns across the cases emerge after I compare these within-case analyses. To validate the cross-case patterns, I switch the research context to the pharmaceutical industry.

The major contextual factors suggested by the multiple-case studies include authority to create new products, local partnership, local intense competition, in-house R&D resources, learning orientation, and corporate support. Both the authority to create new products and corporate support are within the domain of corporate entrepreneurial culture, as suggested in chapter three. Learning orientation is similar to the learning strategy with a focus of knowledge exploration. Local partnership is within the domain of local embeddedness. Local intense competition corresponds to competition intensity in the proposed model in chapter three. Thus, the majority part of the proposed model finds its support in the multiple-case studies, except the subsidiary factor. The model suggests top management team heterogeneity as the subsidiary factor. The case studies seem to highlight the importance of in-house R&D resources. The case research also brings up other contextual factors, including different customer preference, corporate internationalization, subsidiary age, and entry mode. The evidence of their influence, however, is either not consistent, or lack of variance, or absent. Thus, it remains uncertain if they have impact on localized subsidiary innovation. They become the potential control variables for the following survey research. Given the data availability, I finally use in-house technology resources, subsidiary age and size, and corporate internationalization as the control variables.

The data collection for this multiple-case research includes four interviews, one content analysis, and extensive search for archives. The various sources of data, or triangulation, can increase the external validity of the findings (Yin, 1989). The cases bear significant variation with each other. The variation in country, industry, nature of innovations and time makes it hard to search for cross-case patterns, but on the other hand, makes the emerging patterns more robust and generalizable. The combined use of existing case studies, my personal interviews, and archives also reduces the potential impartiality of any one of the researchers, thus increasing the confidence on the finding of the multiple-case studies.

The advantage of the multiple-case studies is to build juxtaposition with detailed real life examples and achieve a new gestalt, or a new theoretical vision, by reconciling contradictions across cases (Eisenhardt, 1989). The cross-case patterns emerging from these case studies indeed provide insights on the phenomenon of localized subsidiary innovation that go beyond a specific theory camp, thus improving the internal validity of the model. The limitations of a case study, on the other hand, lie at the idiosyncratic nature of cases and lack of parsimony due to the rich and detailed data (Eisenhardt, 1989). By variation maximization of case selection and further validation in a different industry, I somewhat reduce the impact of idiosyncrasy. The lack of parsimony still persists in this case research. The limited number of selected cases and some missing background information also result in some uncertain findings in this research.

In next chapters, I will examine the existing literature, develop a set of hypotheses, and conduct hypothesis-testing research. This deductive approach can complement and validate the inductive insights from this exploratory research, thus reducing the limitations of the exploratory research and also achieving a fuller understanding of the phenomenon.

Chapter 5 Survey Design And Methodology

In this chapter, I start to design survey research to test the hypotheses proposed in Chapter three. I first review the existing quantitative studies that tightly relate to this research in order to highlight the similarity and difference between those studies and this research. Sample selection follows in section two. Section three focuses on the details of survey design. Section four explains the survey implementation of this research. I end this chapter with summary and conclusions in section five.

5.1 Introduction

This section first reviews the methodologies of three reported empirical studies on subsidiary innovations, and then compares these methodologies with my research design and methodology in terms of a number of factors. These factors include research design, year of data, sample, valid observations, methods and measures, and dependent and independent variables.

There are very few empirical studies related to subsidiary innovations. Ghoshal and Bartlett (1988), Birkinshaw, Hood, and Jonsson (1998), and Belderbos (2001) are three seminal empirical studies. Investigating the creation, adoption, and diffusion of subsidiary innovations, Ghoshal and Bartlett (1988: 381) conduct case research in nine companies, as well as survey research with multiple respondents in three companies, and with a single respondent in 66 North American and European multinationals. In their large-scale single-respondent survey research, they use Stopford's (1983) *World Directory of Multinational Enterprises*, and mail questionnaires to 438 North American and European MNCs. In the 66 valid responses, the majority of respondents are the CEO, chairman, or corporate vice-president responsible for all international operations. Thus, the subsidiary innovation measured in this study represents only the perceptions of a senior manager in the headquarters for all the subsidiaries of the company. Moreover, the perceptual measures include only one single indicator. The construct validity, however, increases because of the confirmation from their multiple-respondent survey of twenty subsidiaries in three companies. Furthermore, the measure of headquarter perception naturally

leads to a focus on MNC's internal management of subsidiaries. Ghoshal and Bartlett (1988) find that organizational socialization influences a MNC subsidiary's ability to contribute to the different innovation tasks. The influence of external or local environments of subsidiaries is absent from the study. In addition, Ghoshal and Bartlett (1988) comment that the subsidiary's ability to diffuse innovations, and the density of inter- and intra-communications of subsidiaries are not available due to the measurement design.

Birkinshaw, Hood, and Jonsson (1998) survey subsidiary top managers in 229 manufacturing subsidiaries of large MNCs in Canada, Scotland, and Sweden in order to investigate the contribution role of subsidiaries and subsidiary initiatives. Despite its relevance to subsidiary innovation, the construct of subsidiary initiatives focuses more on entrepreneurship, e.g. "successful bids for corporate investments", and "new corporate investments in R&D or manufacturing attracted by Swedish management" (Birkinshaw et al., 1998: p239). It also includes the localized subsidiary innovation that has international implication, e.g., "new product developed in (e.g.) Sweden and then sold internationally", "enhancements to product lines which are already sold internationally", and "new international business activities that were first started in Sweden" (Birkinshaw et al., 1998: p239). Moreover, Birkinshaw and his colleagues (1998) find that specialized subsidiary resources and industry globalization strongly influence subsidiary initiatives. Subsidiary leadership slightly influences subsidiary initiatives. Subsidiary entrepreneurial culture does not significantly influence subsidiary initiatives. Thus, the study only investigates the influence of subsidiary-level variables beside an industry characteristic. Furthermore, in terms of the generalizability of the findings, the study can be "meaningful to other 'peripheral' countries in developed areas" (Birkinshaw et al., 1998: 229). The generalizability to a major country remains unexplored.

Belderbos (2001) investigates the influence of internationalization of MNCs on their overseas innovations. The samples of the study include large and medium-sized Japanese electronics firms. Belderbos (2001) examines the patent of the parent firms and subsidiaries granted by the U.S. Patent Office during 1990–1993. Since the dependent variable, patent grants, is a count variable, Belderbos (2001) uses a negative binomial count model. As a firm can apply for a patent grant in many countries, a patent cannot clearly signify the origin of an innovation.

Thus, the overseas innovations measured by U.S. patent grants are not necessarily the innovations created by subsidiaries. They are rather the R&D appropriation in the United States of Japanese MNCs. I can expect that internationalization of Japanese MNCs would influence their international R&D appropriation in the United States. However, the factors that influence subsidiaries to innovation in a foreign country remain under-investigated. A subsidiary-level investigation of subsidiary innovations is necessary.

I summarize their research methods in Table 5-1. To highlight the contribution and limitation of this study, I include the methods of this study in the summary table.

The case research in the early stage of this study requires evidence of generalizability. McGrath (1982) recognize that research design choices imply trade-offs. The trade-offs include generalizability, precision in measurement and control of the behavioral variables, and realism of context. Whereas the details in case research increase realism of context, sample surveys maximize population generalizability but are low on realism of context and precision of measurement. Scandura and Williams (2000) suggest using both qualitative data (interviews) and survey data to improve the generalizability of interview data. Thus, I design a sample survey research in this chapter. A special caveat for the findings of this study should go to the measurement issues. Combining both case research and sample surveys, I have to compromise on the last “horn” of the “three-horn dilemma” (McGrath, 1982) (i.e., precision in measurement). Poorly-designed questions, memory errors, subjectivity of perceptions, knowledge of the issues, and social desirability can all contribute to measurement errors in survey research (Rossi, Wright, and Anderson, 1983). I use the existing instruments to the largest extent in order to reduce the measurement errors. Self-administered survey mode can reduce the influence of social desirability (Sudman and Bradburn, 1974).

In the following sections, I start with sample selection. Section three explains the details of survey design, including questionnaire construction and pretest, operationalization of key constructs, decisions on choice of survey mode, and the use of structural equation modeling as the analytical tool. Section four focuses on the survey implementation of this research. It

| | Ghoshal and Bartlett (1988) | Birkinshaw, Hood, and Jonsson (1998) | Belderbos (2001) | This study (2003) |
|------------------------------------|---|--|--|---|
| Research design | Case research and survey | Survey | Secondary data | Case research and survey |
| Year of Data | N.A. (before 1987) | 1995 | 1990–1993 | Fall 2002- Fall 2003 |
| Originally potential sample | 438 North American and European multinationals* | 674 manufacturing subsidiaries of large MNCs in Canada, Scotland, and Sweden** | Japanese electronics firms | 240 Foreign pharmaceutical subsidiaries in the U.S; 1584 U.S. Subsidiaries from top five home countries |
| Valid observations | 66 | 181 | 231 | 31 (Pharma); 153 (Top five)**** |
| Methods | Correlation | Partial least squares (PLS) | Negative binomial count model | Structural Equation Modeling |
| Measures | Perceptions of a senior manager in the headquarters for all the subsidiaries of the company | Perceptions of subsidiary managers | Patent counts, and other secondary data | Perceptions of subsidiary managers |
| Dependent variables | Subsidiary creation | Subsidiary initiatives*** | Overseas innovations | Localized subsidiary innovation; knowledge outflow |
| Independent variables | Subsidiary resources, subsidiary autonomy, normative integration through socialization, headquarter-subsidiary communication. | Specialized subsidiary resources, industry globalization, subsidiary leadership, subsidiary entrepreneurial culture. | R&D intensity, export intensity, overseas manufacturing intensity, operating experience in greenfield manufacturing subsidiaries overseas, and entry mode. | Corporate entrepreneurial culture, learning strategy, combinative capability, local embeddedness, local competition intensity |

* I focus on the third phase of the study here only, due to its highest generalizability.

** I calculate the potential sample size based on the related figures provided in the study, i.e. (229 responses)/(34% response rate)=674.

*** "Contribution role of subsidiary" is the ultimate dependent variable of the study. I focus on "subsidiary initiatives" due to its relevance to localized subsidiary innovation.

**** Sixteen completed questionnaires belong to both "Pharma" and "Top five."

Table 5-1 Methodology Comparison Of Empirical Studies Related To This Study

discusses various ways to improve response rate, and report the sample obtained for this study. A summary concludes this chapter.

5.2 Sample selection

Sudman (1983) emphasizes the importance of making explicit the population of a sample. So far, all of the theory development and statement of hypotheses had the purpose of generalizability. In other words, the theory should stand independently of the context in which it is tested. Although the constructs themselves are general, their implementation can be industry-specific in order to make it meaningful to the industry at hand (Gemino and Woo, 1999) and to render it more realism of context. Moreover, international research should be particularly context-bound (Melin, 1992). Also, considering the time and financial constraints, it is not realistic to take a random sampling approach to test the proposed model. Sudman (1983) suggests that a small study well-designed and executed is preferable to a badly-executed, large national study. Related studies of MNCs typically use special populations, as in Birkinshaw et al. (1998) and Belderbos (2001). The reason lies mainly on the lack of a global list of MNCs, and also the tremendous efforts required for translating into a wide range of languages and for international mails. Dillman (1983) acknowledges that the difficulty of accessing an up-to-date listing of a particular population represents a major barrier to the use of mail questionnaires. Sudman (1983) suggests that a small study works better under resource constraints, if the use of a special population is necessary to test theory. Thus, given my resource constraint, I decide to use two special populations, one with industry focus, and the other with host-country focus.

Special population 1: foreign subsidiaries in U.S. pharmaceutical industry. As the top country in the world regarding both outward and inward foreign direct investment (FDI), the United States experience more intra-firm transactions within MNCs. Also maintaining a free market system and being one of the most advanced markets in the world, the United States offer more variance among the practices of MNCs. In the United States, the pharmaceutical industry is the top industry in both subsidiaries' receipts and payments regarding intra-firm royalties and license fees in 1999 (Bureau of Economic Analysis). The aforementioned receipts account for 50.5 percent of those in all manufacturing industries. The corresponding payments account for 35.7 percent of those in all manufacturing industries. The active knowledge exchange within

MNCs in the pharmaceutical industry provides a rich background to investigate factors that influence subsidiaries' learning from local environments. Moreover, the internationalization of the pharmaceutical industry has proceeded largely through foreign direct investment (Li, 1995). High tariff and non-tariff barriers such as the regulations of the U.S. Food and Drug Administration (FDA) have presented significant obstacles for exporting by foreign companies. Furthermore, due to high R & D expenses, the appropriation of intellectual property is critical for pharmaceutical firms. The importance of ownership rights over the technology embodied in new products (Li, 1995) allows for a clear record of innovations in pharmaceutical industry.

Two lists are available with industry classifications. One is the Directory of Foreign Manufacturers in the United States (Arpan and Ricks, 1993). Within the pharmaceutical industry (SIC: 283), there are 154 subsidiaries. The other is a customized service offered by Dun & Bradstreet (D&B). There are 96 subsidiaries within four 4-digit SIC codes related to pharmaceutical industry (2834-Pharmaceutical Preparations; 2833-Medicinals and Botanicals; 2835-Diagnostic Substances; 2836-Biological Products, Except Diagnostic). The report date range from July 1st 1999 to June 30th 2002. I decide to use Dun & Bradstreet because their list provides the up-to-date information.

The small number of foreign subsidiaries in U.S. pharmaceutical industry was the next concern. Hair, Anderson, Tatham, and Black (1998) suggest that structural equation models (SEM) produce valid results with a sample of fifty although it is not recommended, and that "the minimum sample size to ensure appropriate use of a SEM is 100 samples." Paxson, Dillman, and Tarnai (1995) recommend the use of Dillman's (1978) Total Design Method in surveying business establishments in order to achieve a response rate ranging from 45 percent to 95 percent. Thus, the minimum potential sample size should be about 222 subsidiaries. Dillman's (1978) has suggested the importance to the response rate of having personal contact names. Because the Dun & Bradstreet offer one to four contact names for each subsidiary, there are 331 contact names on their customized list.

Sudman (1983) suggests that a way to handle omissions in customized lists is to use the list with supplementation. With the name of subsidiaries, and/or parent company, I could find the

webpage of parent companies in most cases. The webpage of parent companies typically includes the information on their global presence, including their subsidiaries in the United States. Going through the webpage of each subsidiary on the D&B customized list, I found additional 144 foreign subsidiaries in U.S. pharmaceutical industry. Thus, I have 240 subsidiaries as my potential sample size in the special population of U.S. pharmaceutical industry, exceeding the minimum requirement calculated according to the response rates reviewed by Paxson, Dillman, and Tarnai (1995). A potential caveat to this approach is that the potential sample may bias towards the MNCs that operate a website and provide contact information for their U.S. operations. Fortunately, it is the case for the majority of MNCs on the D&B list.

Special population 2: Manufacturing and R&D subsidiaries in the United States from the top five home countries To test the generalizability of the first special population, I expanded the industry scope to all subsidiaries that have manufacturing and/or R&D facilities. The *Directory of Foreign Firms Operating in the United States* (Uniworld, 2002) lists subsidiaries by host countries. Interested in a country comparison study, I decided to focus on the top five home countries. They are UK, Japan, Netherlands, Germany, and France. According to the Bureau of Economic Analysis, the foreign direct investment of these top five countries in the U.S. accounts for 63.5 percent of the total in 2000. The *Directory of Foreign Firms Operating in the United States* lists the business of each subsidiary with “mfr” denoting manufacturing. I choose all the subsidiaries with “mfr” “research”, or “development”, with the exception of “development” of software. For a pharmaceutical subsidiary, I checked if I had it on my first special population. If I have obtained a response from them, I dropped it this time. I ended up with 1584 subsidiaries.

5.3 Survey design

In this section, I start with the technical details of questionnaire construction and pretest process in this study. The implementation of key constructs follows. I adopt the approach of self-administered questionnaires via mail. Structural equation modeling will be the analytical tool in this study. I articulate the reason of the choice on the mode of survey administration and analytical method.

5.3.1 Questionnaire construction and pretest

Given the size of the potential sample, interviewing becomes unrealistic. I had to design a standardized instrument so that I can collect data from the potential sample simultaneously (Sheatsley,1983). The major limitations of a standardized questionnaire include that: (1) people understand the questions differently, and (2) respondents have no opportunity to qualify their answers or to explain their opinions more precisely. Albeit the lack of alternatives to use standardized questionnaires in large-scale surveys, I can reduce the influence of the limitations by paying close attention to the crafting of questionnaire in addition to extensive review and pretest.. Moreover, standardized questionnaire reduces the personal bias of interviewers in the case of interviewing, and avoids the overwhelmed mass of idiosyncratic material.

Questionnaire construction The multiple-case research and literature review at the early stage of this study contribute to the preparation of questionnaire design. Dillman (1978), Sheatsley (1983), and Converse and Presser (1986), among others, provide detailed guide on questionnaire construction. I review the questionnaire construction in this study in the order of words, questions, question ordering, and questionnaire format.

Terms. The choice of some terms like subsidiaries presents a challenge in this study. Converse and Presser (1986) suggest using common and specific language in writing questions. Although terms like subsidiaries and alliances are general terms with relatively high uniform meaning in academic, I found during my pretest that this is not the case in the practitioners' world. Thus, I asked for common terms that practitioners typically use. I included a mini glossary on the questionnaire instruction in order to reduce confusion and increase a uniform understanding. The pretests with experienced academic scholars and practitioners significantly reduced the ambiguity of the questions. Through working on the dozen of drafts and iterations, I continued to balance the tradeoff between specific instructions and questionnaire length, and the tradeoff between the generalizability of findings and the accurate match to the idiosyncratic nature of each business in MNCs. The lack in the latter matter would likely discourage survey responses. An offer of "NA" answer can encourage respondents to move along in answering the questionnaire.

Question design. To test the hypotheses, I collected survey instruments for existing constructs, and modify them to the context. I particularly paid attention to the common errors in question writing suggested by Sheatsley (1983). I wrote short questions and avoid double-barreled questions by using a single question for only one piece of information. Overlapping alternatives that are not mutually exclusive can produce confusion. I checked the alternatives to avoid the overlapping alternatives. In the case of multiple answers to a question, I asked the respondents to tick all the applicable answers. To avoid social desirability bias, I needed to make clear to respondents that “no opinion” is a legitimate answer. Also, I avoided words that may imply researcher bias or strong attitude. In few questions, I used negative statements to change the direction of questions. However, this might result in a “double negatives” effect. As Sheatsley (1983) explains, double negatives may suggest the response "I disagree that the statement is false", which could lead to an accurate response. Regarding the formatting of questions, Dillman (1978) suggests using lowercase letters for questions and uppercase letters for answers. In the pretest, however, I received strong opinion against the use of uppercase letters. I added “others” as an alternative in order to be inclusive.

Question ordering. I followed Dillman’s (1978) suggestion on question ordering. Dillman (1978) suggests putting the most interesting and topic-related questions at the beginning of a questionnaire. Potentially objectionable questions follow later. And the questions requesting demographic information should come last. Sheatsley (1983) particularly emphasizes the importance of the first question. He suggests “the first question is crucial because it is the respondent's first exposure to the interview and sets the tone for the nature of the task to be performed.” Thus, the first question should apply to everyone, be interesting, and be easy to answer. It should also be easy and non-threatening, so that respondents are encouraged to continue. Grouping questions is another issue. As Sheatsley (1983) suggests, I put together the questions relating to the same subject. I prepared a brief section introducing each subject and suggest respondents a shift in attention. I placed questions of the same subject in the same page (Dillman, 1978).

Question scale is another factor of grouping. To minimize the length of a questionnaire, I use a table format instead of repeating the five-point Likert or summative scale for each question. It is easier for respondent since they can keep their thinking frame and do not have to read new alternatives each time. The table format, however, suffers because respondents need to move back and forth across the page, rather than the more straightforward approach of answering in a straight vertical line (Dillman, 1978). Nevertheless, Jobber (1986) suggests that “a potential industrial respondent may be much more sensitive to the length of the questionnaire (and the time it takes to complete it) than a member of the general public completing it at home.” Particularly, the potential respondents in this study are CEOs or general managers, whose time is very valuable. Moreover, a shorter questionnaire should lower mailing costs.

Questionnaire format. Dillman (1978) suggests the format of questionnaire. Dillman (1983) suggests a booklet format of 6.5 x 8.25 inch. The cover page should include no questions, but solely for “an interest-getting title, a neutral but eye-catching illustration.” The back cover should include no questions either, but for inviting additional comments and express appreciation to the respondent. I followed all the instructions except the size of the format. I used the regular-sized (8.5 x 11 inch) pages due to convenience.

Pretest Converse and Presser (1986) emphasizes the importance of expert review and pretest in developing a questionnaire. Experts can help discover ambiguous wording in questions, and problematic variation. They can test the task difficulty, respondent interest and attention, timing, and flow and order of questions. They can also challenge assumptions of researchers. Sheatsley (1983: 203) suggests that pretests with representatives of the target population “will often provide researchers with a glimpse of reality that may sharply alter some of their preconceptions. Researchers may find that some consideration thought to be important seems to be quite irrelevant to the people they are talking to, or that they have deep concerns that were not previously realized.” Out of one or more of these kinds of efforts, researchers can usually develop a fairly good outline of the kinds of information they need to obtain from the survey instrument. I conducted pretest interviews with practitioners after expert reviews by academics.

I started with expert reviews. After the early drafts of the questionnaire, I asked experienced academic scholars and colleagues to do an expert review on the questionnaire individually. They are from both within management field and outside the field. Later, I asked a manager in a domestic firm for his expert review. I conducted pretest interviews with three divisional managers in foreign subsidiaries located in China and one in a foreign subsidiary located in the United States. The gender, age, education, and functional expertise vary among them. Checking the questionnaire for clarity and relevance, they all provide insightful feedback and new ideas on the format, wording, and content of the survey.

Expert review and pretest interviews of practitioners are particularly beneficial due to their check on my assumptions and their case-specific orientation. For example, a parent company acquires a subsidiary in the United States in order to acquire local advanced knowledge. It suggests a learning initiative according to the perspective of the MNC. But to the perspective of the acquired subsidiary, it is not a learning experience at all. The subsidiary keeps the same except the ownership. According to the valid suggestion, I later changed the title from subsidiary learning to subsidiary innovativeness to better elicit the sense making for respondents.

I made extensive modifications on the questionnaires based on the feedback I received from both pretest and expert review. As Sheatsley (1983: 223) put it, “at the end of every survey, the researcher is prepared to write a better questionnaire than the one sent into the field, but of course by then it is too late.” On one hand, his comment highlights the importance of carefully preparing for the questionnaire and pretest. On the other hand, it suggests that there is no end for perfecting a questionnaire. One can always learn from experience in this domain.

5.3.2 Definition and operationalization of key constructs

I used 5-point Likert scales in the survey instrument. Likert scales are among the most commonly used scaling methods in social research. After each statement, there is an agreement scale. The main advantages of Likert scaling lie in three aspects (Bohrstedt, 1983). First, it is easy to accomplish. Secondly, it makes only a few assumptions. The assumptions are generally

plausible, for example, the assumed operating curve. Thirdly, it is subject to statistical analysis. However, Likert scales, like other attitude measurement techniques, depend heavily on the original set of statements used. This is a disadvantage of Likert scales. I used survey instruments from existing literature as much as possible to reduce the lack of reliability. Moreover, I can increase the precision of self-report measurement by using multi-item measures (Scandura and Williams, 2000). Statistical tests of reliability can highlight the amount of error in the measurement of a construct. The last disadvantage of Likert scales is the lack of reproducibility. Given the summated nature of Likert scales, I can obtain the same total score in a variety of ways. The use of structural equation modeling (SEM) can avoid this limitation because it does not require summation of items.

Localized subsidiary innovation Localized subsidiary innovation indicates the extent to which subsidiaries “develop and adopt new product, processes, or administrative systems locally” (Ghoshal and Bartlett, 1988: 365). Current literature has used patents (e.g., Almeida, 1996; Belderbos, 2001), content analysis on new product actions (Ferrier, Smith, and Grimm, 1999), and self-report questionnaire (e.g., McDonough, 1993; Tsai and Ghoshal, 1998) to measure innovation. I searched for patents data, new drug approval data, and news report on new product actions. Unfortunately, I found that the data tend to be at corporate headquarters level instead of subsidiary level. Thus, it does not fit to the purpose of this study well. To investigate the localized subsidiary innovation of a single subsidiary, a self-report measure works better. Thus, I designed questions to ask for impressionistic data from top managers in subsidiaries.

Van de Ven (1986) defines the process of innovation as the development and implementation of new ideas. He suggests that an innovation is a new idea. As long as an idea is perceived as new to the people involved, it is an "innovation," even though it may appear to others to be an "imitation" of something that exists elsewhere (Van de Ven, 1986: 591). Thus, I designed questions tightly related to new ideas. The items are “Our site has many new ideas”, “Our site has adopted many new ideas from the United States”, “Our site has created many new ideas”, and “The new ideas in our site are very beneficial to our performance”, among others. I used a five-point Likert scale from “strongly disagree” to “strongly agree.” The detailed questions appear in the Appendix. I briefly explain the items for each construct in the following.

Local embeddedness I define local embeddedness as the extent to which a subsidiary is connected with local institutions. Local institutions include suppliers, customers, and research institutions. I modify the survey questions from Nobel and Birkinshaw (1998), McEvily and Zaheer (1999), and Rowley, Behrens, and Krackhardt (2000). Local embeddedness involves two aspects. One is connectedness to local institutions. I asked the frequency of contacts of a subsidiary with local customers, suppliers, and research institutions. The other aspect of local embeddedness is tie strength with local institutions. I used the number of local ties as a proxy. I asked respondents to identify the relation type between their subsidiaries and their local customers, suppliers, and research institutions. I listed the following relationship: arm-length transaction, marketing agreement for at least one year, technical assistance agreement, licensing agreement, nonequity alliance, and joint venture. I also listed an “other” option for respondents to specify other important relationship that they value with local institutions.

Learning strategy Learning strategy refers to the extent to which the goal of a subsidiary is to augment the knowledge base of its MNC or exploit the knowledge base (Kuemmerle, 1999; March, 1991). Survey questions are modified from the questions in Nobel and Birkinshaw (1998), and Murtha, Lenvey and Bagozzi (1998). I asked the major task of each subsidiary in the United States. I asked if respondents agree or disagree that “One of the major tasks of our site is to develop market for the products of our parent company in the United States”, and “One of the major tasks of our site is to customize the products of our parent company for the U.S. market.” These two questions demonstrate an exploitation orientation. The following two questions demonstrate an exploration orientation, i.e., “One of the major tasks of our site is to gain access to new scientific or technological information in the United States”, “One of the major tasks of our site is to gain access to well-trained human resources in the United States.” Other relevant items are the number of Ph.D. or research scientists in a subsidiary. The connection to universities or research institutions can also serve as an indicator of learning exploration or orientation.

Competition intensity Competition intensity refers to the level of competitive actions initiated by competitors in local environments. I asked for the perceptions of both overall

competition and competition initiatives. The modified perception items of overall competition come from Birkinshaw et al. (1998). Respondents can agree or disagree with the items, reading like “Competition in our U.S. market is very intense”, and “There are few competitors in our U.S. market.” The items to measure competitive actions originally come from Miller and Chen (1994). According to them, competitive actions involve pricing, advertising, new product or service introductions, and so on. Thus, I asked the frequency of competitive actions of local competitors, including “They introduced new products”, “They initiated promotional activities”, “They expand their U.S. markets”, among others.

Corporate entrepreneurial culture Corporate entrepreneurial culture refers to the willingness to take risk, to learn and to change (Kostova, 1999). This culture will provide legitimacy to innovative efforts that by nature, strive to change (Dougherty and Heller, 1994). It values innovation activities and makes innovation part of individual responsibilities (Dougherty and Hardy, 1996). Thus, I asked questions on the five-scale of agree/disagree, such as “Our parent company encourages us to look for new business opportunities in the United States”, “Our parent company encourages us to try out new ideas”, and “Our parent company relies on our site for new product ideas”, among others. I also modified items from Birkinshaw et al. (1998) to ask if parent companies encourage risk-taking endeavors.

Top management teams heterogeneity Top management team heterogeneity indicates the extent to which chief managers in subsidiaries have different functional and national backgrounds. The top management team includes subsidiary president, and controller, as well as heads of marketing, manufacturing, R & D, finance, and human resources (Hambrick, Cho, and Chen, 1996). I modified survey questions from the items in Hambrick, Cho, and Chen (1996), and Gupta and Govindarajan (2000). The questions include nationality, functional expertise, education, academic background, and tenure.

Knowledge outflow Knowledge outflow refers to the extent to which a subsidiary transfers its innovations to the rest of MNCs. I modified survey questions from Gupta and Govindarajan (2000). I asked the frequency of both technology outflow (“product technology or designs” and “process technology or designs”) and practice outflow (“marketing or distribution

knowhow”, “purchasing knowhow”, and “administrative systems or practices”). I listed the questions of knowledge outflow both to parent companies and to other sites.

Intersubsiary communication Refers to “the exchange of information through various media, including face-to-face contact, telephone, letter, and electronic mail” between a subsidiary and the rest of the MNC (Nobel and Birkinshaw, 1998: 483). I asked respondents to name three other sites of their parent company with which their site has the closest relationship. Then I asked them “How frequently has your site contacted each of them?” The scale includes “Every few months or less”, “Once a month”, “Every few weeks”, “Once a week”, and “Every few days or more.”

Control variables I used subsidiary size, technology resources, and MNC internationalization as control variables. Size has been a typical control variable in strategy studies (e.g., Gupta and Govindarajan, 2000). Size may influence localized subsidiary innovation because of the availability of slack resources. Ghoshal and Bartlett (1988) find the influence of slack resources on subsidiary innovation. Cyert and March (1963), however, realize that organizational problems may make the influence of slack resources on innovation insignificant. There is a long tradition to relate knowledge resources to innovations (e.g., Cohen and Levinthal, 1990; Henderson and Cockburn, 1994; Cardinal and Hatfield, 2000). R&D intensity has significantly influenced overseas innovations of Japanese firms (Belderbos, 2001). In terms of internationalization, Belderbos (2001) finds that the export intensity and overseas manufacturing intensity can predict the overseas innovations of large and medium-sized Japanese electronics firms.

I used the number of employees in a subsidiary as the measure of subsidiary size. In order to dampen the high variability in size and achieve a more normal distribution, I use the natural logarithm of the number of employees in the statistical analysis. I used the number of Ph.D.s and research scientists in a subsidiary as the measure of technology resources. This measure should raise caution in interpreting future results in relating to technology resources, because it may incline to be a double-barrel question. At last, Belderbos (2001) has tested the influence of internationalization on overseas innovation of Japanese MNCs. Egelhoff (1982) makes the

distinction between sales internationalization and production internationalization. Thus, I measured internationalization by the number of countries in which parent companies sell products and also the number of countries in which parent companies manufacture products.

5.3.3 Self-administered questionnaires via mail

The traditional modes of administration are self-administration by the respondent and administration by an interviewer who asks the questions. The self-administration mode carries forward the choice of delivery system, including mail, fax, and internet. The interview mode includes telephone, and face-to-face methods. Dillman (1978; 1983) discusses the choice among mail survey, telephone interviewing, and face-to-face interviewing. Jobber and O'Reilly (1998) compares fax, Internet, telephone, face-to-face delivery to mail delivery. Following is a brief review of the advantages and disadvantages comparing self-administration by the respondent and interview administration. Then, I briefly review the comparison among mail, fax, and internet in the domain of self-administration mode.

Under the self-administered mode, no interviewer is present. Potential respondents receive the questionnaire, read the cover letter and/or instructions, and fill it out anywhere at their convenience. The major advantage of this mode is its low cost. There is no need to hire and train interviewers. It saves travel expenses. The implementation can occur in large scale simultaneously. It reduces the potential bias of interviewers on the responses. Even more important, self-administration mode more likely produces honest answers. Sudman and Bradburn (1974: 66) suggest that, "where a socially desirable answer is possible on attitudinal questions, there is greater tendency to conform on personal interviews than on self-administered questionnaires." The disadvantages of self-administration mode include low response rates, lack of immediate help when respondents have puzzles about the survey, and lack of flexibility to probe for specific or relevant responses. In addition, question order biases may occur. No one can ensure that the person to whom the questionnaire is addressed is the one who fills it out. On the other hand, interview administration mode can avoid these disadvantages. The presence of the interviewer can ensure a high completion rate and the respondent identity. Interviewers can

answer their puzzles, and note down their idiosyncratic information. The costs, however, soar along with these advantages.

The comparison of mail, fax, and Internet mainly hinges upon costs, incentive enclosure, availability of contact information, anonymity issues, and execution time. In terms of costs, Internet survey requires the lowest cost. Following are mail and fax surveys. Fax surveys cost more if one does not own a fax machine. Otherwise, mail surveys cost more due to the need to print many copies of the questionnaire, and also to buy, stuff, and address envelopes. Regarding incentive enclosure, mail surveys solely enjoy the advantage. In terms of contact information, Internet surveys present the highest challenge, because it would typically be difficult to accessing personal e-mail addresses. Moreover, a long survey or complex question format may present additional technical challenges for posting questionnaire on the Internet. Using e-mail attachment can automatically damage the anonymity of responses due to e-mail address. Anonymity can also become a concern for fax surveys. The responding fax machine number can also automatically reveal the identity of respondents. Regarding execution time, mail surveys obviously rank the longest. Jobber and O'Reilly (1998) review the studies that compare the response rates of the various delivery systems. They find inconsistent influence of fax surveys on response rate. Comparing Internet, automated phone, and opscans in organizational surveys, Church (2001) finds no significant difference on the outcomes, including response preference, item completion rate, use of "do not know" responses, item mean and variability. Based on his research, Church (2001) suggests the choice of delivery systems can rely upon "the needs and constraints of the organization-for example, budget, speed of response, ease of use, familiarity with approach, limits of existing infrastructure, Web/Internet access, comfort, or perceived confidentiality concerns" rather than upon some inherent difference in the quality or empirical soundness of the data.

Given the resource constraints, scale of potential sample size, accessibility of contact information, the length of the questionnaire, and potential incentive enclosure, I decided to use mail survey with possibly phone, e-mail and fax supplementation if necessary. Moreover, mail survey may produce more honest answers and ensure anonymity. The response rate becomes the

major concern after I decided to use mail survey. The discussion of response rate follows in the section of survey implementation.

5.3.4 Structural equation modeling

I chose structural equation modeling to test the hypotheses. Using the appropriate statistical test or analytical procedure directly determines the statistical conclusion validity of a research (Cook & Campbell, 1976). Bohrnstedt (1983) suggests that structural equation modeling should have wide appeal to survey researchers employing multiple-item measures of constructs. Structural equation modeling is advantageous for this research for two major reasons. First, given that the model proposed for this research is a path model, structural equation modeling can analyze all paths between constructs simultaneously, rather than through a series of discrete regression models, which may amplify type II error (that is, the model fails to reject the hypotheses tested when a given alternative hypothesis is true). Second, structural equation modeling can test the measurement model and the theory model simultaneously. Individual items for each latent construct do not have to be aggregated. Instead, structural equation modeling can keep them individually and test the measures as part of the whole model. The factor loading of each item on its construct depends on other constructs. That is, the estimated structural coefficients linking the latent constructs of the model together are automatically corrected for attenuation due to measurement error (Bohrnstedt, 1983). The management field has started to see a rise in the use of structural equation modeling. Scandura and Williams (2000) review the methodology shift in management publications between 1985-1987 and 1995-1997. They find that the use of structural equation/path-analytic techniques significantly increased from 3.6% in 1985-1987 to 8.7% in 1995-1997.

5.4 Survey implementation

Dillman (1978; 1983) suggests in the Total Design Method (TDM) to integrate various survey techniques and increase response rate. TDM identifies aspects of survey process affecting quantity or quality, and design them for best response. Paxson, Dillman, and Tarnai (1995)

confirm the applicability of TDM to industrial population. Jobber (1986) and Jobber and O'Reilly (1998) provide detailed reviews on industrial mail survey methods. Jobber (1986) suggests that reactions to various mail survey techniques differ across consumer and industrial samples. A questionnaire to industrial population requires a potential respondent to reveal information that is not his/her own property but that of the company. I prepared the mail package according to Dillman (1978; 1983) and add additional incentives according to Jobber (1986) and Jobber and O'Reilly (1998). In the following, I review the details on the survey implementation for both the special populations.

Special population one I sent out the first set of questionnaires around November 1st 2002. I did not use a prior letter because Jobber (1986) finds that a prior letter has positive impact on response rate for household populations but negative impact for industry population. Instead, I sent to 140 pharmaceutical subsidiaries directly, among which 96 are on the D&B customized list with multiple contact names of managers for each subsidiary. I mailed questionnaire to each contact name. In addition, I found additional subsidiaries on the webpage of a few parent companies. I called the subsidiaries to get contact names. I mailed questionnaires to them and also to those subsidiaries without contact names. I addressed the envelopes and cover letters to chief operating officers and presidents. The mailout package consisted of an 8-page booklet questionnaire with big fonts, cover letter, informed consent sheet, and a business reply envelope. According to Dillman (1978; 1983), the cover letter explains (a) that a socially useful study is being conducted; (b) why each respondent is important; and (c) who should complete the questionnaire. It also promises confidentiality and anonymity. I offer nonmonetary incentives including optional aggregated survey results, research report, and innovation research literature.

As Birkinshaw et al. (1998) have done, I mailed the follow-up surveys three weeks later, this time only to one respondent in each subsidiary on the D&B list, typically the president or vice president. I ended up with 17 responses and 13 subsidiaries invalid for this study. Thus I still had 115 subsidiaries from which I obtain no responses. I searched for additional subsidiaries on webpages and end up with 100 additional subsidiaries. Given the suggested advantage of phone reminder and prenotification (Jobber and O'Reilly 1998), I hired a native speaker to call the 115 subsidiaries for a reminder and also call the 100 additional subsidiaries for

prenotification. She used the contact names on the list. For the subsidiaries without contact names, she contacted the Human Resource department, and asked them whom to contact. I prepared an instruction sheet for her, including a brief explanation of the purpose of this study. Among the 115 subsidiaries, twenty-four asked me to send the questionnaire, thirteen via mail and eleven via fax. Thirteen declined, and seventy-three were not available. Four were invalid for the purpose of this study. Among the new list of 100 additional subsidiaries, eleven asked me to send the questionnaire, six via mail and five via fax. Ten declined, and seventy-seven were not available. Two were invalid for the purpose of this study. Besides sending questionnaire upon requests, I mailed a replacement questionnaire to the “not available” subsidiaries. I enclosed a \$1 bill in the mail surveys according to the findings of Jobber (1986) and Jobber and O’Reilly (1998). Among them, three declined and six returned with a mark “not deliverable” or “send back to sender.” Among the nineteen mail surveys, I received six completed responses. Among the sixteen fax surveys, I received two completed responses. Among the “not available” subsidiaries, I received 6 completed responses. Thus, among the total 240 subsidiaries, I obtained 31 responses.

Intensive competition in pharmaceutical industry may be a reason for the low response rate. The small size of the special population makes foreign subsidiaries cautious. A company asks the caller about the identity of the researcher and checks if I am related to a pharmaceutical company in any ways. Moreover, two companies have called to decline participation because they are completely autonomous subsidiaries in the United States. To encourage participation of this type of subsidiaries, I decide to add NA as an alternative and change the title of the questionnaire to subsidiary innovativeness. Furthermore, Dillman (1978) suggests a social utility appeal. But Jobber (1986) finds in his review that an altruistic appeal in the cover letter results in the highest response rate comparing with a social utility appeal and egoistic appeal. An altruistic appeal emphasizes the importance of a reply to assist the researcher in his investigation. An egoistic appeal emphasizes the importance of the recipient's knowledge of corporate activities and the importance of his firm. Thus, I adopted altruistic appeal in future cover letters.

Other factors might influence the response rate. One is the dilemma between anonymity and personalization. Although Dillman (1978) encourages personalization, a loss on anonymity

may occur in industrial surveys (Jobber, 1986). When a potential respondent receives a survey personally addressed to him, he may be cautious on anonymity even though anonymity is assured on the cover letter. Another possible factor that influences the response rate in this study is the nonmonetary incentives that I offer in terms of innovation literature and aggregated survey results. Jobber and O'Reilly (1998) find that the enclosure of an article and the offer of results may both depress responses occasionally. Both treatments may remind the public use of the information provided by respondents.

In spite of these speculations on the response rate, the response rate that I obtained in special population one is not unusual in cross-cultural industrial mail surveys (Jobber and O'Reilly, 1998). Including the invalid subsidiaries on the list, I still achieved a 13-percent response rate, which is equal to the highest response rate in Jobber and Saunders (1988). They target similar respondents of senior top managers. Dawson and Dickinson (1988) have achieved similar response rates. Thus, a ten-percent response rate in a cross-cultural survey research can serve as a benchmark for response rate expectation. With this expectation in mind, one can make a realistic survey design at the early stage.

Special population two Before sending questionnaire to the second special population in this study, I modified few questions specific to pharmaceutical industry. For instance, I changed biotechnology companies to other companies. I changed the font of the questionnaire and made it fit to three pages with a separate instruction sheet, rather than using an 8-page booklet. As I have mentioned in last section, I changed the title of the questionnaire from "A survey of foreign pharmaceutical companies in the United States" to "A survey of factors influencing foreign subsidiary innovativeness in the United States." I used the term "innovativeness" loosely, indicating innovations and signaling to the potential respondents that the goal of the survey is nothing like market intelligence. On the cover letter, I also changed from a social utility appeal and egoistic appeal to altruistic appeal. I made it explicit that respondents can feel free to skip questions that they do not think applicable to them or note NA on the questionnaire. Moreover, upon permission, I included an associate professor's name on both the cover letter and the envelope.

To encourage responses, I decided to use two possible monetary prizes, which would be administered as two unique conditions with no overlap. I offered \$1 bill and a sweepstake of \$200 cash prize to potential participants. The “on and off” treatments of the two conditions (i.e., \$1 bill and a sweepstakes of \$200 cash prize) resulted in four groups. Within each of the top five home countries, I use systematic sampling to assign the four groups. The sampling interval is naturally four. As a probability sampling, systematic sampling provides every subsidiary in the population a known probability to join a specific group (Sudman, 1983). Moreover, I used stamped return envelopes for UK subsidiaries. While using regular papers for questionnaires to UK subsidiaries, I used the “white paper” (used for color print) for questionnaires to the subsidiaries of other countries. Whereas the impact of monetary incentives has been consistent, the impact of a case-prize sweepstake, and stamped return envelope has not been consistent in the survey literature (Jobber, 1986; Jobber and O'Reilly, 1998; Warriner, Goyder, Gjertsen, Hohner, and McSpurren, 1996). This design provides a rich cross-cultural context to test the impact of each treatment on response rate.

Among the 1584 subsidiaries, 209 returned with a mark “not deliverable” or “send back to sender” and 27 declined to participate. In the remaining 1348 subsidiaries, 153 completed the questionnaire, making a modified response rate of 11.4 percent. Given the time constraints, I could not implement follow-up mailings. Nevertheless, the response rate is close to the response rate expectation in cross-cultural survey research (Jobber and Saunders, 1988; Dawson and Dickinson, 1988). Among the 153 completed questionnaires, seventeen came back much later. Thus I used them to check non-response bias and used only the earlier 136 responses for future analysis. Hair, Anderson, Tatham, and Black (1998) suggest that the minimum sample size to ensure appropriate use of a SEM (Structural equation modeling) is 100 observations.

Armstrong and Overton (1977) suggest extrapolation methods for checking non-response bias. The assumption of extrapolation method is that respondents “who respond less readily are more like nonrespondents” (Armstrong and Overton, 1977:397). Later responses after multiple stimulus tend to resemble non-responses. Thus I compared the last 17 responses’ and the first 17 responses’ demographic characteristics. I obtained the first 17 responses in November 2002 and the last 17 responses in May 2003. The questionnaire format, incentives, and cover letter have

significantly changed between the first 17 responses and the last 17 responses. They even belonged to different special populations. The first belonged to foreign pharmaceutical subsidiaries in the United States, and the last belonged to subsidiaries from top five home countries. There were no pharmaceutical subsidiaries among the last 17 responses. In spite of the differences in all these factors, the demographic characteristics of these two groups did not differ significantly at 0.05 probability level. I used a t-test to compare their year of start, the number of employees, the number of PhDs and research scientists, the number of countries that parent company sell products, and the number of countries that parent company produce products.

5.5 Summary and conclusions

In this chapter, I designed a survey study to collect data from two special populations. Due to resources and time constraints, the special population approach should be more appropriate than a general population. I chose two special populations. The first included foreign pharmaceutical subsidiaries in the United States. The second included all manufacturing and R&D subsidiaries of foreign subsidiaries in the United States from the top five home countries. I decided to mainly use mail surveys. I adopted the survey instruments to the most extent from the existing literature. The question format followed Dillman (1978). I carried out expert reviews and pretest interviews with people of diverse background. Each construct has multiple items to measure. I chose structural equation modeling as the analytical method, because it can take measurement error into account and provide more accurate estimates of casual relationships.

I explained the details on the survey implementation for each of the two special populations. As common in cross-cultural survey research, I have achieved a response rate of more than ten percent. I have adopted various practices from Jobber (1986) and Jobber and O'Reilly (1998) in order to increase the response rate. I have not found significant non-response bias. In next chapter, I will proceed the statistical analysis and present the results.

Chapter 6 Empirical Results

This chapter presents the empirical results of the survey research described in chapter five. The first section focuses on the results for sample one, the foreign subsidiaries in U.S. pharmaceutical industry. It includes descriptive statistics of the sample, and regression results. Given the small sample size, I used a single indicator to represent each variable, and regressed on the effect of each independent variable on localized subsidiary innovation. The second section backs up the results of sample one, with more sophisticated techniques. It focuses on the results for sample two, the foreign subsidiaries in the U.S. from the top five home countries. I compared alternative models to find an optimum one. This chapter ends with a short summary of the major findings.

6.1 Sample one

The thirty-one responses from which I have received completed questionnaire in the first special population (i.e., foreign subsidiaries in U.S. pharmaceutical industry) are very diverse. The host countries include seven different ones with two unknown observations. They are Australia, Denmark, Germany, Italy, Japan, Switzerland, and U.K. Germany accounts for the largest group, about a third of the data, followed by Switzerland. Comparing with sample two from the second population (i.e., foreign subsidiaries in the U.S. from the top five home countries), only Germany and U.K. are overlapping countries in the two samples. U.K. accounts for only 6.5 percent of this small data set.

The starting year of the subsidiaries in the sample ranges from 1950 to 2001. The average starting year is 1986. I use the number of employees to measure subsidiary size. It ranges from 7 employees to 5000 employees. The average size is about 374 employees. The number of PhDs or research scientists in the subsidiaries varies from 0 to 350, with a mean of 28. The internationalization of the parent companies of these subsidiaries is quite diverse as well, ranging from approximately 9 to 300 countries to which the parent companies sell products. The average is 62. The number of countries in which the parent companies manufacture products ranges from

approximately 2 to 50, with a mean of 10. In order to diminish the high variability of these variables and achieve a normal distribution, I use the natural logarithm of these variables in the statistical analysis (Hair, Anderson, Tatham, and Black, 1998).

Given the small size of the sample, I used correlation to test the influence of each independent variable on the dependent variable, localized subsidiary innovation. The descriptive statistics of each variable appear in Table 6-1. Table 6-2 summarizes the correlation between the variables.

| Variables | Mean | S.D. | N | Minimum | Maximum |
|-----------------------------------|-------------|-------------|----------|----------------|----------------|
| Localized subsidiary innovation | 4.29 | 0.64 | 31 | 3 | 5 |
| Competition intensity | 1.58 | 0.81 | 31 | 1 | 5 |
| Top management team heterogeneity | 3.29 | 1.60 | 31 | 1 | 5 |
| Corporate entrepreneurial culture | 4.58 | 0.72 | 31 | 2 | 5 |
| Learning strategy-exploration | 4.07 | 1.14 | 30 | 1 | 5 |
| Learning strategy-exploitation | 3.97 | 1.47 | 30 | 1 | 5 |
| Local embeddedness | 0.56 | 1.05 | 27 | 0 | 4 |
| Knowledge outflow | 1.75 | 1.04 | 28 | 1 | 4 |

Table 6-1 Descriptive Statistics In Sample One

The correlation between localized subsidiary innovation and local embeddedness is significant at 0.05 level. The indicator of localized subsidiary innovation is “Our site has adopted many new ideas from the United States” on a 5-point Likert scale. The indicator of local embeddedness is the variety of alliances. The type of alliances includes alliance with customers, with suppliers, with universities (or research institutions), and with biotechnology companies. Thus, the correlation test provides favorable evidence to support hypothesis one, which predicts a positive relationship between local embeddedness and localized subsidiary innovation.

Hypothesis two proposes that a subsidiary with knowledge exploration as a learning strategy would likely have more localized subsidiary innovation than a subsidiary with knowledge exploitation as a learning strategy. The indicator of knowledge exploration is “To gain access to well-trained human resources in the United States.” The indicator of knowledge

exploitation is “To develop market for the products of our parent company in the United States.” The correlation test suggests that both learning strategies have positive relationship with localized subsidiary innovation. However, the correlation between knowledge exploration and localized subsidiary innovation is higher than the correlation between knowledge exploitation and localized subsidiary innovation. The former is significant at 0.01 level, whereas the latter is significant at 0.05 level. Thus, the correlation test is favorable to hypothesis two.

| | | | | | | | |
|-----------------------------------|---------|--------|------|--------|--------|-------|---------|
| Localized subsidiary innovation | | | | | | | |
| Competition intensity | -0.21 | | | | | | |
| Top management team heterogeneity | 0.31* | 0.05 | | | | | |
| Corporate entrepreneurial culture | 0.42** | 0.03 | 0.23 | | | | |
| Learning strategy-exploration | 0.48*** | -0.01 | 0.01 | 0.39** | | | |
| Learning strategy-exploitation | 0.37** | 0.25 | 0.02 | 0.13 | 0.19 | | |
| Local embeddedness | 0.40** | -0.37* | 0.21 | 0.011 | 0.29 | 0.37* | |
| Knowledge outflow | 0.36* | -0.05 | 0.13 | 0.03 | 0.44** | 0.10 | 0.71*** |

* Correlation is significant at the 0.1 level (2-tailed).

** Correlation is significant at the 0.05 level (2-tailed).

*** Correlation is significant at the 0.01 level (2-tailed).

Table 6-2 Correlation Table Of Sample One (Single Indicator)

Hypothesis three predicts a positive relationship between competition intensity and localized subsidiary innovation. The indicator of competition intensity in this test is “How frequently have your major competitors in the U.S. market introduced new products overall?” Respondents can choose from “once a year or less”, “every few months”, “once a month”, “every few weeks”, and “once a week or more.” The correlation is not significant. The direction of the correlation is negative. Thus, the correlation test does not support hypothesis three.

The correlation between corporate entrepreneurial culture and localized subsidiary innovation is significant at 0.05 level. Thus, the test supports hypothesis four, which predict a positive relationship between the two constructs. The indicator of corporate entrepreneurial culture in this test is “Our parent company encourages us to look for new business opportunities in the United States” at 5-point Likert scale.

Hypothesis five predicts that top management team heterogeneity of a subsidiary can predict its localized subsidiary innovation. The indicator of top management team heterogeneity in this test is “Top managers in our site have different nationality” at a 5-point Likert scale. The correlation between top management team heterogeneity and localized subsidiary innovation is significant at 0.1 level. Thus, hypothesis five obtains partial support.

Hypotheses six examine the impact of localized subsidiary innovation on knowledge flow. The indicator of knowledge outflow in this test is “How often has your site provided product technology or designs to other sites of your parent company?” Respondents can choose from “once a year or less”, “every few months”, “once a month”, “every few weeks”, and “once a week or more.” The correlation between localized subsidiary innovation and knowledge outflow is significant at 0.1 level. Interestingly, knowledge outflow is significantly correlated with local embeddedness and knowledge exploration at even higher levels, with the former at 0.001 level and the latter at 0.05 level. The correlations suggest that knowledge outflow of subsidiaries in the pharmaceutical industries may not a direct result of localized subsidiary innovations. Local sourcing of knowledge may not necessarily result in localized subsidiary innovations before knowledge outflow from the subsidiary occurs. Thus, the correlation test can only partially support hypothesis six.

Nevertheless, after I dichotomized the values of localized subsidiary innovation into high (above mean) and low (below mean), I conducted one-way ANOVA analysis. The *P* value becomes 0.004, indicating a strong positive relationship between localized subsidiary innovation and knowledge outflow. In construct, I dichotomized intersubsidiary communication the same way and the one-way ANOVA test suggests that there is no significant relationship between intersubsidiary communication and knowledge outflow. The *P* value is 0.104. Thus, the one-way ANOVA test strongly supports hypothesis six.

I used ANOVA (Analysis of Variance) to test hypothesis seven, which predicts a moderation effect of intra-unit communication on the influence of localized subsidiary innovation on knowledge outflow. The indicator of intra-unit communication is “How frequently

has your site contacted the site with which you have closest relationship?” Respondents can choose from “every few months or less”, “once a month”, “every few weeks”, “once a week”, and “every few days or more.” I used the dichotomized values of localized subsidiary innovation and intersubsiary communication, and conducted an ANOVA analysis. Although the whole model has significant *P* value, the coefficient of the moderation term is not significant. The output of ANOVA depicts the moderation effect (Figure 6-1). However, the plot is misleading, because there are only three cases of high localized subsidiary innovation with low knowledge outflow. Among the three cases, two of them have missing data for one of the three variables in the ANOVA model. Thus, I concluded that there is no support for hypothesis seven in sample one.

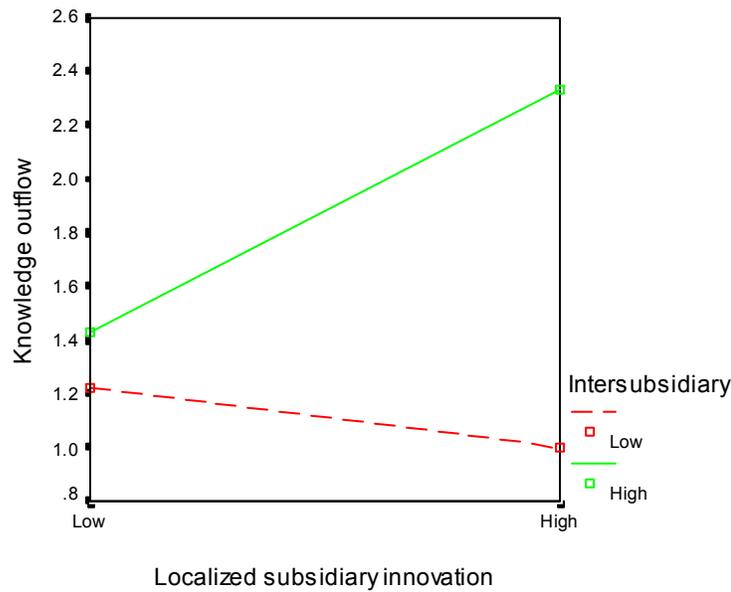


Figure 6-1 Moderation Effect Of Intra-Unit Communication

I tested the correlation between the control variables and localized subsidiary innovation. Technology resources (measured by the number of Ph.D.s and research scientists) are significant correlated to localized subsidiary innovation at 0.1 level. The Pearson correlation is 0.33 and the *P* value is 0.085. The Pearson correlation between localized subsidiary innovation and the internationalization of parent companies measured by the number of countries to which parent companies sell products, is 0.30. The *P* value is 0.101. The size of subsidiaries, and the

internationalization of parent companies measured by the number in which parent companies manufacture products do not correlate with localized subsidiary innovation significantly. The measure of the size is the number of employees in subsidiaries. I used the natural logarithm in the correlation tests.

In spite of the above favorable evidence to the hypotheses, the results are to be taken with caution. The major concern regards the small sample size. Small sample size tends to produce less significant results due to the low degree of freedom. I ran regression analysis by simultaneously including all the single-indicator independent and control variables. The result was less satisfactory. Moreover, the exploratory factor analysis in sample one loads items together that make no theoretical sense. Table 6-3 reports the correlation among the constructs with multiple indicators. The constructs are based on the result of exploratory factor analysis of sample two, which I will explain further in details in next section. In the correlation table, LSI represents local subsidiary innovation, CI_A competition intensity, TMT top management team heterogeneity, ENT corporate entrepreneurial culture, EOI, knowledge exploration, EOR knowledge exploitation, COM communication, LE_T local embeddedness, and KO_T knowledge outflow.

6.2 Sample two

There are 149 observations in sample two, which represent the second special population in this study, i.e., the foreign subsidiaries in the United States from the top five home countries. I started with descriptive sample statistics and checked the normality of the variables. Then, I conducted exploratory factor analysis to find the construct indicators. I used structural equation modeling analyzes both the measurement model and structural model. I used the measurement model to confirm the results of exploratory factor analysis. The calculated internal consistency and discriminant validity provided evidence for construct validity in the model. It also gave an estimate for testing the interaction. Finally, I tested the structural model, which constitutes the constructs from the measurement model. I tested alternative models to find the optimum model.

| | LSI 1 | LSI 2 | LSI 3 | CI A 1 | CI A 3 | CI A 2 | TMT 2 | TMT 1 | TMT 3 | ENT 2 | ENT 1 |
|--------|----------|----------|---------|----------|---------|----------|----------|---------|--------|---------|----------|
| LSI_2 | 0.504*** | | | | | | | | | | |
| LSI_3 | 0.498*** | 0.301* | | | | | | | | | |
| CI_A_1 | 0.186 | -0.207 | -0.092 | | | | | | | | |
| CI_A_3 | 0.137 | 0.140 | 0.222 | 0.45** | | | | | | | |
| CI_A_2 | 0.259 | 0.040 | -0.135 | 0.819*** | 0.466** | | | | | | |
| TMT_2 | 0.258 | 0.155 | 0.322* | 0.081 | 0.149 | 0.226 | | | | | |
| TMT_1 | -0.052 | 0.219 | 0.111 | 0.095 | 0.395** | 0.251 | 0.218 | | | | |
| TMT_3 | -0.022 | -0.032 | 0.142 | -0.378** | -0.068 | -0.461** | 0.332* | 0.212 | | | |
| ENT_2 | 0.070 | 0.416** | 0.171 | 0.031 | 0.249 | 0.200 | 0.371** | 0.391** | -0.058 | | |
| ENT_1 | 0.314* | 0.362** | 0.042 | 0.167 | -0.091 | 0.088 | 0.163 | 0.141 | -0.111 | 0.271 | |
| ENT_3 | 0.216 | 0.436** | 0.236 | 0.165 | -0.065 | 0.102 | 0.444** | -0.026 | 0.049 | 0.251 | 0.624*** |
| EOI_1 | 0.001 | 0.37** | 0.022 | 0.247 | 0.348* | 0.252 | 0.122 | 0.132 | -0.142 | 0.127 | -0.003 |
| EOI_2 | 0.240 | 0.473*** | 0.219 | -0.040 | 0.080 | -0.009 | -0.112 | -0.190 | -0.194 | -0.059 | 0.135 |
| EOR_2 | -0.042 | 0.289 | 0.106 | -0.204 | 0.256 | -0.110 | 0.298 | 0.179 | 0.32* | 0.163 | -0.010 |
| EOR_1 | 0.343* | 0.482*** | 0.361** | -0.007 | 0.329* | 0.175 | 0.594*** | 0.253 | 0.158 | 0.394** | 0.225 |
| COM_2 | 0.234 | 0.071 | 0.199 | 0.275 | -0.044 | 0.139 | 0.334* | -0.047 | -0.112 | -0.072 | 0.234 |
| COM_1 | 0.402 | 0.271 | 0.139 | 0.174 | -0.047 | 0.113 | 0.247 | -0.132 | -0.166 | -0.009 | 0.448** |
| LE_T_3 | -0.118 | -0.134 | -0.106 | -0.156 | -0.026 | -0.277 | -0.059 | 0.154 | 0.369* | -0.336* | -0.296 |
| LE_T_2 | -0.243 | -0.139 | -0.045 | 0.182 | -0.051 | 0.049 | -0.169 | 0.205 | 0.131 | -0.310 | -0.373* |
| LE_T_1 | 0.035 | 0.397** | -0.160 | -0.374* | 0.037 | -0.139 | 0.048 | 0.147 | 0.145 | 0.011 | 0.223 |
| KO_T_1 | 0.256 | 0.363* | 0.071 | -0.053 | 0.198 | -0.009 | 0.109 | 0.151 | 0.095 | 0.032 | 0.321* |
| KO_T_2 | 0.306 | 0.371* | 0.080 | -0.045 | 0.242 | -0.028 | 0.178 | 0.069 | 0.159 | -0.084 | 0.266 |
| KO_T_3 | 0.260 | 0.223 | 0.159 | 0.298 | 0.091 | 0.415** | 0.299 | -0.092 | 0.105 | 0.096 | 0.271 |

Table 6-3 Correlation Table Of Sample One (Multiple Indicators)

| | ENT_3 | EOI_1 | EOI_2 | EOR_2 | EOR_1 | COM_2 | COM_1 | LE_T_3 | LE_T_2 | LE_T_1 | KO_T_1 | KO_T_2 |
|--------|--------|----------|----------|----------|---------|----------|--------|----------|--------|----------|----------|----------|
| EOI_1 | 0.351* | | | | | | | | | | | |
| EOI_2 | 0.255 | 0.508*** | | | | | | | | | | |
| EOR_2 | 0.256 | 0.196 | 0.220 | | | | | | | | | |
| EOR_1 | 0.429 | 0.186 | 0.272 | 0.662*** | | | | | | | | |
| COM_2 | 0.373 | 0.213 | 0.231 | 0.148 | 0.270 | | | | | | | |
| COM_1 | 0.427 | -0.139 | 0.163 | 0.073 | 0.37* | 0.677*** | | | | | | |
| LE_T_3 | -0.200 | 0.102 | 0.233 | 0.269 | 0.168 | 0.204 | -0.106 | | | | | |
| LE_T_2 | -0.211 | 0.243 | 0.072 | -0.112 | -0.188 | 0.311 | -0.048 | 0.636*** | | | | |
| LE_T_1 | 0.238 | 0.367* | 0.334* | 0.230 | 0.290 | 0.232 | 0.163 | 0.264 | 0.016 | | | |
| KO_T_1 | 0.188 | 0.104 | 0.506*** | 0.378** | 0.445** | 0.320 | 0.371* | 0.494** | 0.028 | 0.713*** | | |
| KO_T_2 | 0.218 | 0.124 | 0.508*** | 0.42** | 0.443** | 0.33* | 0.371* | 0.498** | -0.013 | 0.687*** | 0.983*** | |
| KO_T_3 | 0.483 | 0.183 | 0.338* | 0.322* | 0.354* | 0.079 | 0.194 | -0.056 | -0.187 | 0.026 | 0.498*** | 0.533*** |

*** Correlation is significant at the 0.01 level (2-tailed).

** Correlation is significant at the 0.05 level (2-tailed).

* Correlation is significant at the 0.1 level (2-tailed).

Table 6-3, Continued

6.2.1 Descriptive sample statistics and exploratory factor analysis

The 149 observations in sample two are well diverse. Their parent companies are from the top five home countries of foreign direct investment in the United States –Japan, Germany, U. K., France, and Netherlands. The observations from these countries account for 29.5, 29.5, 22.2, 12.1, and 6.7 percent, respectively in the sample. In terms of industry distribution, pharmaceutical industry accounts for 10.7 percent of the second sample. The percentage is close to the total asset percentage (9%) of foreign assets in U.S. pharmaceutical industry. These sixteen observations are the overlaps with sample one.

The starting year of the subsidiaries in the sample ranges from 1874 to 2002. The average starting year is 1978, about eight years earlier than sample one. The size of the subsidiaries varies from 4 employees to 5000 employees. The average size includes 293 employees, which is about 81 less than the average for sample one. The number of PhDs or research scientists in the subsidiaries ranges from 0 to 350, with a mean of 12. The average is 16 less than that for sample one. It is consistent to R&D intensive characteristics of pharmaceutical industry, and also to the high percentage (51%) of royalties and license fees received by foreign subsidiaries in U.S. pharmaceutical industry. The internationalization of the parent companies of these subsidiaries are quite diverse as well, ranging from approximately 3 to 200 countries to which the parent companies sell products. The average is 67, close to the average for sample one. The number of countries in which the parent companies manufacture products varies from approximately 0 to 150, with a mean of 17, about 7 higher than sample one. Given the high variability of these variables, I again used the natural logarithm of these variables in the statistical analysis.

After checking the normality of each variable, I conducted an exploratory factor analysis to extract underlying factors in the data for sample two. I used Principal Component Analysis as the extraction method, and Varimax as the rotation method. The measure of sampling adequacy exceeds 0.50, with 0.61 as Kaiser-Meyer-Olkin Measure of Sampling Adequacy. Thus, it is appropriate to apply factor analysis (Hair, Anderson, Tatham, and Black, 1998).

The exploratory factor analysis produces nine factors, which explain 76 percent of variance in the whole data set. Table 6-4 presents the descriptive statistics and factor loading of each indicator. 0.6 serves as the cutoff point for factor loadings. The normality of each indicator is reasonably adequate. I used natural logarithm in the following analysis for items one and two of competition intensity because their kurtosis is close to 8. I use the raw data for other indicators. The majority of them have an absolute value of skewness and kurtosis under 2. The exceptions are item two of corporate entrepreneurial culture, item one of localized subsidiary innovation, and item one of local embeddedness. Their absolute value of skewness is under 2, but that of kurtosis is between 3 and 4. Thus, slightly high kurtosis calls for cautions in interpreting future analysis. The correlations between the individual items appear in Table 6-5. In next section, confirmatory factor analysis further tests the construct validity of the factors extracted by the exploratory factor analysis.

6.2.2 Measurement model

I used the measure model of structural equation modeling (SEM) to conduct confirmatory factor analysis. The assumptions of SEM include multivariate normality, linearity of causality, multicollinearity and heteroscedasticity (data dependency). However, those assumptions are much relaxed in SEM. SEM is powerful in taking into account multiple latent constructs, each measured by multiple indicators, correlated independent variables, measurement errors and correlation between them. SEM can explicitly specify them. Moreover, Bollen (1989) suggests that maximum likelihood estimation is robust against departures from normality. Lack of multivariate normality usually inflates the chi-square statistic. The inflation can produce a bias toward Type I error (i.e., accepting a model which should not be accepted). Violation of multivariate normality also tends to underestimate standard errors moderately to severely. The deflation may lead to statistically significant results more often than it should be. AMOS is the SEM package used in the study. I used maximum likelihood to estimate the means and intercepts, and to accommodate missing values.

By connecting all constructs through correlations, I tested the measurement model. The resulting fit indices are acceptable. The comparative fit index (CFI) is 0.988, indicating that the

| Constructs | | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----------------------------------|--------|------|------|------|------|------|------|------|------|------|------|------|
| Knowledge outflow | Item 1 | 1.63 | 1.00 | 0.92 | | | | | | | | |
| | Item 2 | 1.75 | 1.05 | 0.87 | | | | | | | | |
| | Item 3 | 1.57 | 0.81 | 0.68 | | | | | | | | |
| Localized subsidiary innovation | Item 1 | 4.41 | 0.70 | | 0.85 | | | | | | | |
| | Item 2 | 3.97 | 0.89 | | 0.80 | | | | | | | |
| | Item 3 | 4.04 | 0.86 | | 0.78 | | | | | | | |
| Competition initiatives | Item 1 | 1.46 | 0.72 | | | 0.85 | | | | | | |
| | Item 2 | 1.35 | 0.81 | | | 0.81 | | | | | | |
| | Item 3 | 2.05 | 0.97 | | | 0.81 | | | | | | |
| Top management team heterogeneity | Item 1 | 4.11 | 0.88 | | | | 0.87 | | | | | |
| | Item 2 | 4.41 | 0.73 | | | | 0.76 | | | | | |
| | Item 3 | 4.15 | 0.90 | | | | 0.76 | | | | | |
| Knowledge exploration | Item 1 | 3.61 | 1.20 | | | | | 0.86 | | | | |
| | Item 2 | 3.29 | 1.23 | | | | | 0.79 | | | | |
| Intra-unit communication | Item 1 | 3.36 | 1.61 | | | | | | 0.91 | | | |
| | Item 2 | 3.80 | 1.52 | | | | | | 0.87 | | | |
| Knowledge exploitation | Item 1 | 3.70 | 1.51 | | | | | | | 0.91 | | |
| | Item 2 | 3.34 | 1.44 | | | | | | | 0.81 | | |
| Corporate entrepreneurial culture | Item 1 | 4.04 | 1.01 | | | | | | | | 0.85 | |
| | Item 2 | 4.45 | 0.91 | | | | | | | | 0.68 | |
| | Item 3 | 3.59 | 1.23 | | | | | | | | 0.64 | |
| Local embeddedness | Item 1 | 0.52 | 0.74 | | | | | | | | | 0.77 |
| | Item 2 | 0.79 | 0.74 | | | | | | | | | 0.75 |
| | Item 3 | 0.94 | 0.81 | | | | | | | | | 0.65 |

Table 6-4 Descriptive Statistics And Exploratory Factor Analysis In Sample Two

| | LSI_1 | LSI_2 | LSI_3 | CI_A_1 | CI_A_3 | CI_A_2 | TMT_2 | TMT_1 | TMT_3 | ENT_2 | ENT_1 |
|--------|----------|----------|---------|----------|---------|---------|----------|---------|--------|---------|----------|
| LSI_2 | 0.504*** | | | | | | | | | | |
| LSI_3 | 0.498*** | 0.301* | | | | | | | | | |
| CI_A_1 | 0.186 | -0.207 | -0.092 | | | | | | | | |
| CI_A_3 | 0.137 | 0.140 | 0.222 | 0.450** | | | | | | | |
| CI_A_2 | 0.259 | 0.040 | -0.135 | 0.819*** | 0.466** | | | | | | |
| TMT_2 | 0.258 | 0.155 | 0.322* | 0.081 | 0.149 | 0.226 | | | | | |
| TMT_1 | -0.052 | 0.219 | 0.111 | 0.095 | 0.395** | 0.251 | 0.218 | | | | |
| | | | | | | | - | | | | |
| TMT_3 | -0.022 | -0.032 | 0.142 | -0.378** | -0.068 | 0.461** | 0.332* | 0.212 | | | |
| ENT_2 | 0.070 | 0.416** | 0.171 | 0.031 | 0.249 | 0.200 | 0.371** | 0.391** | -0.058 | | |
| ENT_1 | 0.314* | 0.362** | 0.042 | 0.167 | -0.091 | 0.088 | 0.163 | 0.141 | -0.111 | 0.271 | |
| ENT_3 | 0.216 | 0.436** | 0.236 | 0.165 | -0.065 | 0.102 | 0.444** | -0.026 | 0.049 | 0.251 | 0.624*** |
| EOI_1 | 0.001 | 0.370** | 0.022 | 0.247 | 0.348* | 0.252 | 0.122 | 0.132 | -0.142 | 0.127 | -0.003 |
| EOI_2 | 0.240 | 0.473*** | 0.219 | -0.040 | 0.080 | -0.009 | -0.112 | -0.190 | -0.194 | -0.059 | 0.135 |
| EOR_2 | -0.042 | 0.289 | 0.106 | -0.204 | 0.256 | -0.110 | 0.298 | 0.179 | 0.320* | 0.163 | -0.010 |
| EOR_1 | 0.343* | 0.482*** | 0.361** | -0.007 | 0.329* | 0.175 | 0.594*** | 0.253 | 0.158 | 0.394** | 0.225 |
| COM_2 | 0.234 | 0.071 | 0.199 | 0.275 | -0.044 | 0.139 | 0.334* | -0.047 | -0.112 | -0.072 | 0.234 |
| COM_1 | 0.402** | 0.271 | 0.139 | 0.174 | -0.047 | 0.113 | 0.247 | -0.132 | -0.166 | -0.009 | 0.448** |
| LE_T_3 | -0.118 | -0.134 | -0.106 | -0.156 | -0.026 | -0.277 | -0.059 | 0.154 | 0.369* | -0.336* | -0.296 |
| LE_T_2 | -0.243 | -0.139 | -0.045 | 0.182 | -0.051 | 0.049 | -0.169 | 0.205 | 0.131 | -0.310 | -0.373* |
| LE_T_1 | 0.035 | 0.397** | -0.160 | -0.374* | 0.037 | -0.139 | 0.048 | 0.147 | 0.145 | 0.011 | 0.223 |
| KO_T_1 | 0.256 | 0.363* | 0.071 | -0.053 | 0.198 | -0.009 | 0.109 | 0.151 | 0.095 | 0.032 | 0.321* |
| KO_T_2 | 0.306 | 0.371* | 0.080 | -0.045 | 0.242 | -0.028 | 0.178 | 0.069 | 0.159 | -0.084 | 0.266 |
| KO_T_3 | 0.260 | 0.223 | 0.159 | 0.298 | 0.091 | 0.415** | 0.299 | -0.092 | 0.105 | 0.096 | 0.271 |

Table 6-5 Correlation Table In Sample Two

| | ENT_3 | EOI_1 | EOI_2 | EOR_2 | EOR_1 | COM_2 | COM_1 | LE_T_3 | LE_T_2 | LE_T_1 | KO_T_1 | KO_T_2 |
|--------|----------|----------|----------|----------|---------|----------|--------|----------|--------|----------|----------|----------|
| EOI_1 | 0.351* | | | | | | | | | | | |
| EOI_2 | 0.255 | 0.508*** | | | | | | | | | | |
| EOR_2 | 0.256 | 0.196 | 0.220 | | | | | | | | | |
| EOR_1 | 0.429** | 0.186 | 0.272 | 0.662*** | | | | | | | | |
| COM_2 | 0.373** | 0.213 | 0.231 | 0.148 | 0.270 | | | | | | | |
| COM_1 | 0.427** | -0.139 | 0.163 | 0.073 | 0.370* | 0.677*** | | | | | | |
| LE_T_3 | -0.200 | 0.102 | 0.233 | 0.269 | 0.168 | 0.204 | -0.106 | | | | | |
| LE_T_2 | -0.211 | 0.243 | 0.072 | -0.112 | -0.188 | 0.311 | -0.048 | 0.636*** | | | | |
| LE_T_1 | 0.238 | 0.367* | 0.334* | 0.230 | 0.290 | 0.232 | 0.163 | 0.264 | 0.016 | | | |
| KO_T_1 | 0.188 | 0.104 | 0.506*** | 0.378** | 0.445** | 0.320 | 0.371* | 0.494** | 0.028 | 0.713*** | | |
| KO_T_2 | 0.218 | 0.124 | 0.508*** | 0.420** | 0.443** | 0.330* | 0.371* | 0.498** | -0.013 | 0.687*** | 0.983*** | |
| KO_T_3 | 0.483*** | 0.183 | 0.338* | 0.322* | 0.354* | 0.079 | 0.194 | -0.056 | -0.187 | 0.026 | 0.498*** | 0.533*** |

*** Correlation is significant at the 0.01 level (2-tailed).

** Correlation is significant at the 0.05 level (2-tailed).

* Correlation is significant at the 0.1 level (2-tailed).

Table 6-5, continued

model can reproduce 98.8 percent of the covariation in the data. The normed fit index (NFI) is 0.963, indicating the model improves fit by 96.3 percent compared to the null model with random variables. Both fit indices in this model are above 0.9. The root-mean-square error of approximation (RMSEA) is 0.057, lower than 0.08. RMSEA is one of the fit indexes less affected by sample size. Chi-square is 320.8, significant at 0.05 level. It is under expectation, since measurement model is usually the null model in SEM. Nevertheless, the Chi-square/*df* ratio is 1.485. It is good because it stays in the range of 1 and 2 (Hair, Anderson, Tatham, and Black, 1998).

With satisfactory fit indices of the measurement model, I proceed to assess internal consistency and discriminant validity of the constructs in the measurement model. I use the equations suggested by Fornell and Larcker (1981a; 1981b). This approach is superior to Cronbach's alpha because it takes into account of measurement error, whereas Cronbach's alpha use the Pearson correlation of the raw data. The equation for assessing internal consistency for each construct is: $(\sum \lambda_{yi})^2 / (\sum \lambda_{yi})^2 + \sum \varepsilon_i$, where λ_{yi} is the loading for each item on the construct and ε_i is the measurement error for each item (Fornell and Larcker, 1981a). In order to assess discriminant validity, Fornell and Larcker (1981b) suggest to compare the square root of variance extracted for a construct with the correlations between this construct and other construct. If the former is the highest, it provides the evidence for discriminant validity. The equation for variance extracted is $\sum \lambda_{yi}^2 / \sum \lambda_{yi}^2 + \sum \varepsilon_i$, where λ_{yi} is the loading for each item on the construct and ε_i is the measurement error for each item. Table 6-6 displays the internal consistency and the discriminant validity of each construct. The internal consistency of each construct exceeds 0.5, thus acceptable. On the columns of "Variance extracted within construct and Correlation between construct", the diagonals show the square root of the variance extracted for the construct. The off-diagonals show the correlations between constructs. Since the diagonal elements are greater than all other entries in the same row and column, the discriminant validity is acceptable.

The theoretical model suggests a moderation effect of intra-unit communication on the influence of localized subsidiary innovation on knowledge outflow. I calculated the estimates for the moderator according to Ping (1996). This approach avoids adding variables or constraint

| Constructs | Internal consistency | Variance extracted within construct and Correlation between construct | | | | | | | | | | | | | | | | | | |
|--|-----------------------------|--|-------|-------|------|------|------|-------|------|------|--|--|--|--|--|--|--|--|--|--|
| Competition intensity | 0.82 | 0.77 | | | | | | | | | | | | | | | | | | |
| Local embeddedness | 0.67 | 0.37 | 0.65 | | | | | | | | | | | | | | | | | |
| Top management team heterogeneity | 0.73 | -0.06 | 0.11 | 0.69 | | | | | | | | | | | | | | | | |
| Corporate entrepreneurial culture | 0.74 | -0.04 | -0.12 | 0.22 | 0.70 | | | | | | | | | | | | | | | |
| Knowledge exploration | 0.81 | 0.10 | 0.29 | 0.17 | 0.31 | 0.82 | | | | | | | | | | | | | | |
| Knowledge exploitation | 0.88 | 0.03 | -0.17 | -0.04 | 0.08 | 0.03 | 0.89 | | | | | | | | | | | | | |
| Intra-unit communication | 0.86 | 0.18 | 0.09 | -0.18 | 0.19 | 0.08 | 0.22 | 0.87 | | | | | | | | | | | | |
| Knowledge outflow | 0.87 | 0.26 | 0.17 | 0.00 | 0.27 | 0.35 | 0.22 | 0.29 | 0.83 | | | | | | | | | | | |
| Localized subsidiary innovation | 0.77 | 0.06 | 0.29 | 0.22 | 0.37 | 0.50 | 0.12 | -0.05 | 0.22 | 0.72 | | | | | | | | | | |

Table 6-6 Internal Consistency And Discriminant Validity Of Constructs

equations, which can produce specification tedium and errors or estimation difficulties (Ping, 1996). A measurement model without the moderation variable first produces measurement parameters for indicator loadings and errors of linear latent variables. Then, these estimates are used to calculate values for the indicator loadings and error variances of the moderation latent variable. The equation for calculating the indicator loadings is $a_{ij} = \lambda_{xi} \lambda_{zj}$. The equation for calculating the error variances is:

$$\text{Var}(b) = \lambda_x^2 \text{Var}(X) \text{Var}(\varepsilon_z) + \lambda_z^2 \text{Var}(Z) \text{Var}(\varepsilon_x) + \text{Var}(\varepsilon_x) \text{Var}(\varepsilon_z)$$

In this study, λ_x s are the indicator loadings of localized subsidiary innovation. According to the measurement model, they are 1, 0.876, and 0.608. λ_z are the indicator loadings of knowledge outflow, respectively, 1 and 0.838 in this study. $\text{Var}(X)$ and $\text{Var}(Z)$ are the variances of localized subsidiary innovation and knowledge outflow, respectively, 0.507 and 2.145. $\text{Var}(\varepsilon_x)$, and $\text{Var}(\varepsilon_z)$ are the error variances of those indicators, respectively, 0.263, 0.339, 0.3 for indicators of localized subsidiary innovation, and 0.137, 1,106 for indicators of knowledge outflow. Table 6-7 displays the parameter estimates for moderator. These calculated values are specified as constants in the structural model containing the moderation variable (Ping, 1996). The resulting fit indices are 0.252 for CFI, 0.251 for NFI, and 0.419 for RMSEA. The Chi-square is 8773 and, the Chi-square/df ratio is 27. Thus, the fit indices by AMOS for the moderation effect are not acceptable. It should not be a surprise, since AMOS has limited capability to test nonlinear relationship. Thus, I will use regression to test the moderation effect. I will also check if structural models can significantly improve the fit indices.

| Indicators | Loadings | Errors | Variance |
|-------------------|-----------------|---------------|-----------------|
| a21 | 1.000 | b21 | 0.670 |
| a22 | 0.838 | b22 | 1.248 |
| a31 | 0.876 | b31 | 0.827 |
| a32 | 0.734 | b32 | 1.316 |
| a41 | 0.608 | b41 | 0.710 |
| a42 | 0.510 | b42 | 0.991 |

Table 6-7 Parameter Estimates For The Moderator

6.2.3 Structure models

After the test of construct validity, I proceeded to test the path of the structural model. I first tested the proposed model with all the control variables. Then I develop two parsimonious models by sequentially dropping the constructs which are not significantly related to localized subsidiary innovation. Model 1 includes all the constructs that are significantly correlated with localized subsidiary innovation. Model 2 drops the constructs that are not significant in Model 1. In both models 1 and 2, I compare the effect of moderation on the fix indices. I ended with the model that obtains the best evidence in this study.

6.2.3.1 The Proposed Model

Table 6-8 summarizes the results of SEM, which tests the proposed model with multiple-indicator constructs. The table displays standardized coefficient of each path, and the *P* value. The model fit indices provide additional information on the plausibility of the tested model. The model fit indices are satisfactory. Both CFI and NFI exceed 0.94. RMSEA is below 0.08. The proposed model explains 32.7 percent of variance in localized subsidiary innovation. Localized subsidiary innovation explains 7.7 percent of variance in knowledge outflow. I did not add any additional constraints to the test of proposed model.

Hypothesis one predicts that local embeddedness would positively influence localized subsidiary innovation. The coefficient of local embeddedness is 0.225, significant at 0.05 level. Thus, hypothesis one is supported. Hypothesis two suggests that subsidiaries with knowledge exploration as a learning strategy can have more localized subsidiary innovation than those with knowledge exploitation. The coefficient of knowledge exploration is significant at 0.001 level, whereas the coefficient of knowledge exploitation is not significant. Thus, hypothesis two is supported. Hypothesis three predicts that competition intensity exerts positive influence on localized subsidiary innovation. The coefficient of competition intensity is not significant at all. Thus, hypothesis three is not supported. Hypothesis four predicts the relationship between

corporate entrepreneurial culture and localized subsidiary innovation. The coefficient is 0.242, significant at 0.05 level. Thus, hypothesis four is supported. Hypothesis five, which predicts a positive influence of top management heterogeneity on localized subsidiary innovation, is not supported, because the coefficient of top management team heterogeneity is not significant in the test. Hypothesis six predicts that localized subsidiary innovation would positively impact knowledge outflow. The coefficient of 0.277, significant at 0.01 level. Thus hypothesis six is supported. The coefficients of all the control variables are not significant.

| | Hypotheses | Standardized coefficient | P value | Support for Hypotheses |
|-------------------|--|--------------------------|---------|------------------------|
| H1 | Local embeddedness - Localized subsidiary innovations | 0.225 | 0.037 | Yes |
| H2a | Learning strategy/exploration - Localized subsidiary innovations | 0.441 | 0.000 | Yes |
| H2b | Learning strategy/exploitation - Localized subsidiary innovations | 0.052 | 0.891 | Yes |
| H3 | Competitive intensity - Localized subsidiary innovations | -0.003 | 0.974 | No |
| H4 | Corporate entrepreneurial culture - Localized subsidiary innovations | 0.242 | 0.014 | Yes |
| H5 | Top management team heterogeneity - Localized subsidiary innovations | 0.053 | 0.572 | No |
| H6 | Localized subsidiary innovations - Knowledge outflows | 0.277 | 0.004 | Yes |
| Control variables | | | | |
| | Size | -0.008 | 0.926 | – |
| | Technology resources | 0.036 | 0.673 | – |
| | Internationalization-sales | 0.106 | 0.212 | – |
| | Internationalization-manufacturing | 0.074 | 0.384 | – |

* Chi-square = 546.58 ($P < 0.001$), Chi-square/ df = 1.872. Fit indices: CFI 0.971, NFI 0.94, RMSEA 0.077.

Table 6-8 Summary Table Of Results: The Proposed Model

Hypothesis seven suggests the moderation effect of intra-unit communication. Given the limitation of AMOS, I use multiple regression to further test the interaction effect. I use

summed variables to represent each construct in the model. Table 6-9 explains the descriptive statistics of the summed variables and the pair-wise correlations among them. After centering the variables of LSI (localized subsidiary innovation) and COM (inter-subsidiary communication), I create a product term to test the moderation effect. The coefficients of both LSI and COM are significant. The coefficient of LSI is 0.205 with the *P* value of 0.033. The coefficient of COM is 0.270 with the *P* value of 0.004. The coefficient of the moderation is, however, not significant. The coefficient is 0.057 with the *P* value of 0.552. LSI and COM can explain 11.6% of variance of knowledge outflow. The R square change of the moderation is only 0.3%. Thus, there is no evidence for the moderation effect in this test.

6.2.3.2 The Parsimonious Models

In order to improve the fit indices, I developed parsimonious models by dropping the constructs that do not significantly add the power of explanation to the model. I used the correlation coefficients (Table 6-9) as the reference. Model one includes only the constructs that are significantly correlated with localized subsidiary innovation. I ran the SEM for each pair of multiple-indicator constructs, and found no difference from the significance of correlation coefficients of summed variables. Among the control variables, technology resources are the only one that is significantly correlated with localized subsidiary innovation. The *P* value is 0.035. Thus, Model one includes local embeddedness, learning strategy with knowledge exploration, corporate entrepreneurial culture, top management team heterogeneity, and knowledge outflow. In this model, I specified theoretical plausible correlations between independent variables. I suspected that high top management team heterogeneity would likely correlate with local embeddedness, because diverse backgrounds of top managers may increase the sensibility of a subsidiary to various opportunities in the local environments. Corporate entrepreneurial culture may increase the sensibility as well, thus correlated with local embeddedness. Knowledge exploration as a learning strategy increases the motivation to develop relationship with local knowledge, thus correlated with local embeddedness. In-house knowledge resources can provide competent and slack resources, thus increasing the ability of a subsidiary to develop close relationship with local institutions. Similarly, knowledge exploration would be likely correlated with knowledge resources and corporate entrepreneurial culture.

| | Mean | S.D | LSI | CI_A | TMT | ENT | EOI | EOR | COM | LE_T |
|------|--------|-------|----------|---------|---------|----------|---------|----------|----------|---------|
| LSI | 12.413 | 2.050 | | | | | | | | |
| CI_A | 4.788 | 2.013 | 0.035 | | | | | | | |
| TMT | 12.717 | 1.957 | 0.213** | -0.081 | | | | | | |
| ENT | 12.083 | 2.546 | 0.266*** | -0.099 | 0.129 | | | | | |
| EOI | 7.027 | 2.715 | 0.003 | 0.089 | -0.095 | 0.088 | | | | |
| EOR | 6.891 | 2.230 | 0.394*** | 0.058 | 0.178** | 0.253*** | -0.017 | | | |
| COM | 7.194 | 2.901 | -0.034 | 0.137 | -0.145 | 0.171* | 0.220** | 0.064 | | |
| LE_T | 2.217 | 1.754 | 0.245*** | 0.191** | 0.081 | -0.006 | -0.086 | 0.283*** | 0.091 | |
| KO_T | 4.925 | 2.512 | 0.214** | 0.186** | 0.004 | 0.270*** | 0.154* | 0.285*** | 0.270*** | 0.205** |

*** Correlation is significant at the 0.01 level (2-tailed).

** Correlation is significant at the 0.05 level (2-tailed).

* Correlation is significant at the 0.1 level (2-tailed).

Table 6-9 Correlation Of Summated Variables in Sample two

Table 6-10 summarizes the results. Corporate entrepreneurial culture (hypothesis 4) and knowledge exploration (hypothesis 2) have again obtained evidence for their significant influence on localized subsidiary innovation. The path coefficient between local embeddedness and localized subsidiary innovation is significant only at 0.1 level ($P = 0.068$). Thus hypothesis one only obtains partial support. Although top management team heterogeneity and knowledge resources are significantly correlated with localized subsidiary innovation, they become nonsignificant in the model that simultaneously includes other independent variables. The fit indices of Model one are satisfactory. CFI is 0.991, and NFI is 0.972. Both exceed 0.9. RMSEA is 0.057, lower than 0.08. Although the Chi-square value is 184.632 ($P < 0.001$), it has significantly reduced from the value in the measurement model (Chi-square = 320.812, $P < 0.001$). The Chi-square decrease (104.765) is significant at 0.05 level, given the df difference is 74. Thus, the fit of Model one improves significantly from the measurement model and the proposed model.

6.2.3.3 Model two

Model two increases parsimony over Model one by only including the significant variables ($p < 0.10$) from Model one. Thus Model two only includes local embeddedness, corporate entrepreneurial culture, and learning strategy of knowledge exploration as independent variables. I connected all the three independent variables because of the theoretical plausibility. The results appear in Table 6-10. The influences of independent variables are consistent in both models, with increased significance overall Model one. The P value for the path between local embeddedness and localized subsidiary innovation becomes 0.036 in Model two, significant at 0.05 level. The influence of corporate entrepreneurial culture becomes significant at 0.01 level in Model two. Localized subsidiary innovation can affect knowledge outflow significantly in both models, at 0.01 level in the model. The fit indices improve as well. The Chi-square of Model two further drops to 131.868 from 184.632 of Model one. Other fit indices change slightly, still satisfactory. The Chi-square/ df ratio becomes 1.884, CFI 0.987, NFI 0.973, and RMSEA 0.077.

| Hypotheses | Model 1* | | | Model 2** | | |
|--|--------------------------|---------|------------------------|--------------------------|---------|------------------------|
| | Standardized coefficient | P-value | Support for Hypotheses | Standardized coefficient | P-value | Support for Hypotheses |
| H1 Local embeddedness - Localized subsidiary innovations | 0.233 | 0.068 | Yes | 0.259 | 0.036 | Yes |
| H2a Learning strategy/exploration – Localized subsidiary innovations | 0.329 | 0.007 | Yes | 0.325 | 0.007 | Yes |
| H4 Corporate entrepreneurial culture - Localized subsidiary innovations | 0.285 | 0.016 | Yes | 0.313 | 0.007 | Yes |
| H5 Top management team heterogeneity - Localized subsidiary innovations | 0.089 | 0.357 | No | | | |
| H6 Localized subsidiary innovations - Knowledge outflows | 0.241 | 0.012 | Yes | 0.254 | 0.007 | Yes |
| Control variables | | | | | | |
| Knowledge resources | 0.042 | 0.656 | No | | | |

* Chi-square = 184.632 ($P < 0.001$), Chi-square/ df = 1.489, Chi-square change = 136.180 ($P < 0.001$).

Fit indices: CFI 0.991, NFI 0.972, RMSEA 0.057.

** Chi-square = 131.868 ($P < 0.001$), Chi-square/ df = 1.884, Chi-square change = 136.180 ($P > 0.05$).

Fit indices: CFI 0.987, NFI 0.973, RMSEA 0.077.

Table 6-10 Summary Table Of Results: The Parsimonious Models

6.3 Summary and conclusions

This chapter tested the hypotheses proposed in the study. The empirical test involved two samples. One included foreign subsidiaries in U.S. pharmaceutical industry. The other included foreign subsidiaries in U.S. from the top five home countries. In the first sample, I tested the hypotheses with simple correlation analysis. In the second sample, I used multiple-indicator to test the hypotheses. Structural equation modeling (SEM) was the analytical method. Both exploratory and confirmatory factor analysis provided evidence on construct validity in this test. I compared the fit indices, and *P* value of path coefficients across alternative models. Table 6-11 summarizes the support for hypotheses through all the endeavors in this study, including a multiple-case research and survey research in two samples. Model two boasts the best parsimony, thus making the best choice for this study. The multiple-case research, and sample one test both provide confirmation to Model two. Figure 6-2 depicts the model. Detailed discussion of the findings, and the conclusion of this research follows in the next and last chapter of this dissertation.

| Hypotheses | Exploratory case analysis | Sample one (Correlation) | Sample two* | | | | |
|---|---------------------------|--------------------------|-----------------|----------------|-----------|---------|--|
| | | | Correlation | Proposed Model | Model 1 | Model 2 | |
| H1 Local embeddedness – Localized subsidiary innovations | Strong | Yes | Yes | Yes | Yes (0.1) | Yes | |
| H2 Learning strategy/exploration – Localized subsidiary innovations | Weak** | Yes | Yes | Yes | Yes | Yes | |
| H3 Competitive intensity – Localized subsidiary innovations | Strong | No | No | No | | | |
| H4 Corporate entrepreneurial culture - Localized subsidiary innovations | Strong*** | Yes | Yes | Yes | Yes | Yes | |
| H5 Top management team heterogeneity - Localized subsidiary innovations | | Yes (0.1) | Yes | No | No | | |
| H6 Localized subsidiary innovations - Knowledge outflows | | Yes (0.1) | Yes | Yes | Yes | Yes | |
| H7 Localized subsidiary innovations X intra-unit communication - Knowledge outflow | | No (ANOVA) | No (Regression) | | | | |
| Control variables | | | | | | | |
| Knowledge resources | Weak | Yes (0.1) | Yes | No | No | | |
| Size | | No | No | No | | | |
| Internationalization | None | No | No | No | | | |

"Yes" indicates significant relationship at 0.05 level or lower, unless specified with an 0.1 level of significance.

* Unless specified, Structural equation modeling is the analytical method.

** Learning orientation and learning strategy/exploration share similar meanings. I use exploration because it is a well-developed construct in the literature.

*** Local autonomy to create new products is an indicator of high corporate entrepreneurial culture. It uses the latter because of its broad domains.

Table 6-11 Grand Summary Of Support For Hypotheses

Chapter 7 Discussion, Implications And Conclusions

7.1 Introduction

This dissertation has examined the antecedents of localized subsidiary innovation and its performance implications in terms of knowledge outflow. This chapter begins with an overview and discussion of the findings from the previous chapters. My discussion focuses on the possible interpretations of the results, especially the unexpected result. I will also discuss the theoretical contributions of this study together with a comparison with findings in the current literature. This chapter also suggests areas for future research, and discusses the limitations of the study. This chapter concludes with some managerial implications of this research.

7.2 Summary and discussion of findings

This study adopted the behavioral framework (awareness-motivation-capability) of organizational action (Chen, 1996; Lant, Milliken and Batra, 1992; Allison, 1971) to investigate factors at multi-levels that impact subsidiary innovation. The behavioral framework of organizational action suggests that the awareness of local strategic knowledge, the motivation to learn from local environments, and the capability to learn from local environments are the key enablers of a subsidiary to learn from diverse local environments. This study adopts a cross-level approach to suggest the enabling factors from three levels: 1) subsidiary level; 2) context levels, including both local market level and MNC corporate level; and 3) interface levels, including the interface level between subsidiaries and local markets, and the interface level between subsidiaries and MNC corporate. Based on a wide range of theories, this research proposed that at the interface levels, a subsidiary's local embeddedness and its learning strategy influence the awareness of local strategic knowledge by the subsidiary, therefore impacting localized subsidiary innovation. At the context levels, local market competition and corporate entrepreneurial culture affect the motivation of a subsidiary to learn from diverse local environments, thus influencing localized subsidiary innovation. Finally, at the level of a subsidiary, top management team diversity influences the capability of a subsidiary to learn from

local environments, thereby affecting localized subsidiary innovation. In terms of the performance implication of localized subsidiary innovation, this study suggests that the localized subsidiary innovation positively influences knowledge outflow from the subsidiary to the rest of MNC. Moreover, intersubsidiary communication could moderate the relationship between localized subsidiary innovation and knowledge outflow.

The empirical tests in this study provide solid support to most of my theoretical propositions, as summarized in Table 6-9. This study has found that (1) learning strategy at the interface level between parent company and subsidiaries, and (2) corporate entrepreneurial culture at the MNC context level, have critical influence on localized subsidiary innovation. Data from both of the samples in this study provide consistent support regarding the influence of these two constructs on localized subsidiary innovation. Local embeddedness can exert a significant influence on localized subsidiary innovation. The multiple-case research, sample one, and sample two all provide support to the influence of local embeddedness on localized subsidiary innovation. In particular, the parsimonious final model crystallizes the influence of local embeddedness diluted in the model, which includes top management team with an insignificant influence. The performance implication of localized subsidiary innovation has obtained solid support in the models.

The influence of top management team heterogeneity has only obtained support in the correlation test. In other words, top management team heterogeneity can explain localized subsidiary innovation to some degree when other antecedents are excluded from the models. In sample one (i.e., the U.S. pharmaceutical industry), national diversity can predict localized subsidiary innovation to some degree. In sample two, I dropped the national diversity from the model because of its poor loading on the construct. Instead, top management heterogeneity includes diversity in functional expertise, academic background, and organizational tenure. The correlation suggests that top management heterogeneity may predict localized subsidiary innovation to some degree. However, when examined simultaneously with other factors, top management team heterogeneity fails to predict localized subsidiary innovation. This finding does not align with the general understanding of group heterogeneity, which improves broad gathering of information, decision creativity and boldness. The discrepancy may result from the

boundary of top management team in this study. I asked respondents to include all the on-site senior managers who make decisions for a subsidiary. There may be perceptual discrepancy across respondents. There is also a possibility that the corporate influence in MNC may offset the influence of top management team heterogeneity to some degree.

Except for the support from the multiple-case studies, competition intensity does not obtain any support from the survey research in both samples. Cyert and March (1963) admit that their behavioral theory of firm cannot predict innovations. Mansfield (1961) collects data on twelve different innovations in four industries and he does not find support to the hypothesis of innovation in the face of adversity. Nelson and Winter (1982) further discuss the controversy between market competition and innovation. On one hand, Schumpeter (1950) argues that perfect competition is incompatible with innovation. Oligopolistic competition can protect firms from high R&D investment and appropriation of innovations. On the other hand, weak competition may reduce the spur to innovation. I focus on the latter in the addition to knowledge spillover advantage, but find no evidence to support the relationship between competition intensity and localized subsidiary innovation. I measure the competition intensity both by competition initiatives and perception of competition intensity. The lack of evidence may be due to the empirical limitations of this study that lead to the discrepancy between the hypothesis related to local competition and empirical result. Both the perceptual nature and the scale of local competition measure may cause the discrepancy. Current research on competition dynamics has typically focused on developing measures by content analysis (e.g., Ferrier, Smith, and Grimm, 1999; Miller and Chen, 1994). Birkinshaw, Hood and Jonsson (1998) have used a survey instrument to measure the perception of overall competition intensity. This study uses survey instrument to measure perceived competition intensity in terms of both overall intensity and frequency of competition initiatives. I expect that perception of competition intensity may better capture the spur to innovation that competition may produce. Moreover, it may increase the variance in the first sample. However, the scale of the survey instruments does not function as well as I expected. The responses on the frequency of competition_initiatives, such as product introduction and market expansion, cluster around the two scales at the left end (i.e., “Once a year or less”, and “every few months”). I used the natural logarithm to accommodate the high kurtosis ($kurtosis < 7$). It would be beneficial to add a scale on the left, saying “Never.”

Besides the theoretical relationships specified in the hypotheses, the empirical test includes control variables, such as size, knowledge resources, and internationalization. With a single-indicator survey instrument, internationalization and size cannot predict localized subsidiary innovation in this cross-sector and cross-country study. Measured by the number of Ph.D.s and research scientists, knowledge resources in this study have influence on localized subsidiary innovation in the correlation test. However, when examined simultaneously with other factors, the influence of knowledge resources turns insignificant. This results calls for some caution for interpretation, because knowledge resources are highly correlated with learning strategy of knowledge exploration. Nevertheless, knowledge resources only obtain low factor loading on knowledge exploration. Since knowledge resources need to serve as a control variable, I keep it in the structural equation model. The advantage of structural equation modeling is that it allows the specification of correlation among endogenous variables. Thus I specify the correlation between knowledge resources and knowledge exploration. Nevertheless, the strong correlation between knowledge exploration and knowledge resources still raises caveat on the final interpretation of the influence of knowledge resources on localized subsidiary innovation.

Overall, this dissertation has provided strong evidence that a learning strategy of knowledge exploration, corporate entrepreneurial culture, and local embeddedness importantly impact localized subsidiary innovation. Localized subsidiary innovation can in turn contribute to knowledge outflow from the subsidiary to the rest of the MNC.

7.3 Theoretical contributions

This study has developed several theoretical contributions to strategic management, mainly to the literature on MNCs, organizational learning, and innovation.

7.3.1 Contribution to MNC literature

This study has developed a holistic view of subsidiary learning. It integrates multiple topics in international management with a cross-level focus. It specifically integrates three streams of MNC research: knowledge acquisition from local environments, knowledge creation

within MNCs, and knowledge diffusion within MNCs. Werner (2002) suggests twelve topic areas in international management research. He suggests that investigating the missing linkages among these topics can potentially advance the international management research. This study has touched upon eight topic areas by developing a holistic model of subsidiary learning. Institutional learning has found its importance in the empirical test of the holistic model. I elaborate the detailed contributions next.

The major focus of this study is to advance the knowledge-based view of MNCs. Literature concerning knowledge creation and diffusion in MNCs (e.g. Ghoshal and Bartlett, 1988; Gupta and Govindarajan, 2000) has discussed how subsidiaries create and transfer innovations within MNCs but has focused only on the internal factors of MNCs. In their research, knowledge stock and absorptive capacity are assumed as a given, and the factors outside MNCs are not discussed. Conversely, current research in the internationalization of MNC's R&D units (knowledge acquisition) has emphasized the importance of local resources for MNC innovations. How these resources are transformed to become innovations has not been explored. The integrated approach developed and proposed in this research advances the inquiry of research on MNCs through developing the link among these three key streams of research.

Moreover, the "dual" approach of this study contributes to MNC research with empirical findings. Theoretical work in MNC research has grown in recently years (e.g., Ghoshal and Bartlett, 1990; Rosenzweig and Singh, 1991; Birkinshaw and Hood, 1998; Kostova, 1999), whereas empirical work falls short (e.g., Birkinshaw, Hood and Jonsson, 1998). In the area of subsidiary innovation, this study builds on and goes beyond the internal focus of Ghoshal and Bartlett (1988). It takes into account of factors in all the five sublevels (i.e., MNC corporate level, interface level between corporate and subsidiary, subsidiary level, interface level between subsidiary and local environment, and local environment level). The integrated approach presents a more complete picture on the forces impacting subsidiaries' learning from local environments. The resulting parsimonious model further increases the confidence on the strong influence of the remaining antecedents. In comparison, some factors with face validity lose their power in predicting localized subsidiary innovation. For example, top management team heterogeneity is significant in the correlation test, aligning with the innovation literature and

group research. But in the simultaneous testing of all the paths, the influence of top management team heterogeneity becomes insignificant. The remaining factors in the parsimonious model still demonstrate the necessity of a dual approach, since there are both remaining external factor (i.e., local embeddedness), and remaining internal factors (i.e., learning strategy and corporate entrepreneurial culture).

Furthermore, the enclosure of learning strategy, local competition, top management team heterogeneity and the moderation effect of inter-subsiary communication advance the MNC research. Research on internationalization of R&D has applied the idea of knowledge exploration and exploitation (e.g., Kuemmerle, 1999; Patel and Vega, 1999). This research expands the factor to both manufacturing and R&D subsidiaries. The expansion is in line with the typology of subsidiaries suggested by Gupta and Govindarajan (1991). Some subsidiaries are “global innovators”, some are “local innovators”, some are “implementors”, and some others are “integrated players.” In the MNC literature, local competition has not received much attention. Birkinshaw, Hood and Jonsson (1998) find that local competition can decrease the global responsibilities of subsidiaries. This study addresses the debate between market competition and innovation, and finds no correlation between them in the context of MNCs. Even though expatriates in subsidiaries have constituted a research focus in MNC research (e.g., Boyacigiller, 1990; Rosenzweig and Singh, 1991), the research stream of upper echelon has not seen much application in the MNCs literature. Whereas this study built on the upper echelon literature and suggested that top management team heterogeneity could impact localized subsidiary innovation, the results do not support this assertion. The inconsistency may imply that application in the MNC context may provide additional insights on the upper echelon literature.

7.3.2 Contribution to organizational learning and innovation literature

To organizational learning and innovation literature, the contributions lie in the adoption of a “dual” approach, the empirical support to the institutional learning mode, and further development of the understanding on learning strategy. This study adopts a “dual” approach, namely, investigating both external factors and internal factors on organizational learning and innovation. As I have discussed in the literature review, current literature in the two areas has mainly focused on either the influence of internal organizational factors or that of external

environmental factors (see Table 2-4; Table 2-6). Fiol and Lyles (1985) have touched upon both domains by suggesting four contextual factors that may affect the probability of organizational learning. The four factors include (1) internal organizational factors such as corporate culture conducive to learning, (2) strategy that allows flexibility, (3) an organizational structure that allows both innovativeness and (4) new insights. The external factors include the change and stability in the environment. This study develops the contextual model of Fiol and Lyles (1985) in three folds. First, this study splits the internal context to corporate level (MNC) and subsidiary level (subsidiary), given the unique context of MNC. Secondly, this study not only includes the competitive change in the environments, but also takes into account the most recent development in external learning (e.g. Almeida, Dokko, and Rosenkopf, 2003; Dyer and Nobeoka, 2000; Powell, Koput, and Smith-Doerr, 1996; Hamel, 1991). Lastly, the dual model can simultaneously test the influence of each force with improved scrutiny.

This study provides the empirical support to the institutional learning mode and modifies it to the context of MNCs. In this study, institutional learning finds its appeal in the complex multinational context. Learning strategy, corporate entrepreneurial culture, and local embeddedness are the three factors that exert significant influence on localized subsidiary innovation in this study, whereas the influence of knowledge resources and internationalization becomes insignificant. Learning strategy, and corporate entrepreneurial culture both reflect the indoctrination from the parent company. Local embeddedness indicates the teaching from local environments. Instead of standardizing concrete practices, institutional learning focuses on internalization of values. As Miller (1996) predicts, institutional learning takes place at lower level than top managers and middle managers in an organization. In the complex system of MNCs with the corporate headquarters, regional headquarters, and subsidiaries, the correspondent levels in a MNC is corporate headquarters at the top, regional headquarters at the middle, and subsidiaries at the lower level. Scott (1995) and Miller (1996) suggest the importance of indoctrination from top managers. In the MNC context, the indoctrination can come from the parent company. Thus, this study supports the importance of institutional learning mode in subsidiary learning from local environments. Moreover, it modifies the mode according to the MNC context. Even though this study does not test a competing theory, e.g. routine-based learning approach, the findings can still make valid contributions to organizational learning

literature as “the outcome of a theory test is a shift in belief rather than an accept or reject verdict” (Brinberg, Lynch, and Sawyer, 1992: 152).

This study develops the understanding on learning strategy as well. March (1991) elaborates the tradeoff between knowledge exploration and knowledge exploitation because they compete for scarce resources. The tradeoff implies an inverse and orthogonal relationship between knowledge exploration and exploitation. In the empirical studies of overseas R&D establishments, this assumption continues, although the relative importance of this two remain inconsistent (Belderbos, 2001). Wortmann (1990) finds that exploration is rarely a motivation for German MNCs in his sample. Similarly, Patel and Vega (1999) find that knowledge exploitation remains the major motives of overseas R&D activities. However, Florida (1997) finds that the knowledge exploration motive is at least as important as the technology exploitation motive for foreign stand-alone laboratories in the United States. Kuemmerle (1997) classifies 70 out of 156 overseas R&D sites in the pharmaceutical and electronics industries as pursuing the knowledge exploration goal.

In this study, an interesting finding suggests that knowledge exploitation and knowledge exploration may coexist, but they may not exist at the expense of each other. Specifically, 65 percent of respondents in this study agree that one of the major tasks of their subsidiary is to develop market for the products of their parent company in the United States. With such a high percentage of the sample subsidiaries taking knowledge exploitation as a learning strategy, I expect that 35 percent or less of the sample subsidiaries would take knowledge exploration as learning strategy. Surprisingly, 46 percent of them agree that one of the major tasks of their subsidiary is to gain access to new scientific or technological information in the United States. The correlation statistics between these two indicators shows no inverse relationship. The coexistence of exploitation and exploration is implicit in Gupta and Govindarajan (1991) and Bartlett and Ghoshal (1998). Both studies suggest that subsidiaries may apply knowledge from parent companies and simultaneously create new knowledge to transfer back to parent companies. Thus the MNC literature can provide nutrition back to the learning literature.

7.4 Limitations of current research

As with any empirical research, this study is subject to some limitations. The measures of constructs may bear the major limitation of this study. The measures are all survey instruments. The perceived measures may not represent the objective reality (Hambrick and Mason, 1984). The self-reported data hinge on the knowledge of respondents. There may be systematic errors across the constructs due to the bias of respondents, resulting in the single-method bias. Jick (1979) has suggested a triangulation approach to combine qualitative and quantitative methods. Thus, the multiple-case research in this study can serve as a validation to the survey research. I have also tried to integrate secondary data and content analysis to this study in order to provide further validation. The problem is that the unit of analysis is not explicit in the available data and news reports. These data resources typically use the names of the whole MNCs and do not specify the subsidiaries. Since the unit of analysis in this study is subsidiary, I expect that a survey responded specifically by subsidiary managers would be more reliable measures.

The choice of business survey has some inherent limitations. The major challenges of conducting a business survey include low response rate. Some companies have policy against responding to any survey (Cox, Binder, Chinnappa, Christianson, Colledge, and Kott, 1995). I have adopted various ways to increase response rate, including confidentiality and anonymity assurance, monetary incentive, nonmonetary incentive, among others. The response rate of over ten percent is reasonable but not exciting. I conducted analysis to check nonresponse bias. Fortunately, I have not found a significant bias. Nevertheless, the low response rate may still present a potential bias. Another challenge is that companies vary in job designs. It is hard to define the appropriate respondents because of various hierarchical levels and job responsibilities. The target respondents in this study are the presidents and general managers of subsidiaries. It would ensure that respondents are knowledgeable of the overall activities of their subsidiaries. Gatekeepers, however, may challenge the response rate. Calling Human Resources Department may be of help to find the appropriate person for responding the survey and also to avoid the gatekeepers. The small-scale calling for the first sample in this study was not fruitful. Moreover, in business survey research, one cannot ensure that the respondents are the same as the ones

addressed. Identifying the major responsibilities of the respondents may help check the function bias in their answers.

As any other empirical studies, generalizability may present potential limitations in this study. Given the lack of subsidiary lists, and the time and resource constraints, this study could not use a universal population. Instead, it focused on two special populations. One includes subsidiaries of foreign pharmaceutical industry in the U.S., and the other is cross-sectional sample but limited to the subsidiaries of MNCs from the top five home countries. The consistency of results in the two samples can increase the confidence in generalizing the finding to all subsidiaries in the United States. However, it is still questionable whether the findings can apply to other host countries of MNCs. By comparing with the findings of this study with the findings of current literature with similar research topics, the generalization of this study to a universal population is promising. For instance, Binkinsaw, Hood and Jonsson (1998) have conducted a survey research with subsidiaries of MNCs in Canada, Scotland, and Sweden. They find that subsidiary entrepreneurial culture contributes to subsidiary initiatives to some degree. This study tests the entrepreneurial culture at corporate level, and finds its strong influence on localized subsidiary innovation. Ghoshal and Bartlett (1988) conduct a survey research with parent companies of U.S. and European MNCs. They suggest strong influence of inter-subsidiary communication on subsidiary innovations. Because of their measurement design, however, they cannot test it in the single-respondent large-scale survey. In this study, I found the importance of inter-subsidiary communication on knowledge outflow. The influence of local embeddedness can find its confirmation in a field study by Hamel (1991) and in biotechnology industry by Powell, Koput, and Smith-Doerr (1996).

Assumption of linearity may put additional restraints on the findings of this research as well. I test linear relationship between local embeddedness, technology resources, and localized subsidiary innovation. Uzzi (1997) has pointed that overembeddedness could hurt firms. Overembeddedness happens when “all firms in a network are connected through embedded ties” (Uzzi, 1997: 58). Although it less likely happens to a foreign subsidiary, which tends to have difficulties in developing local ties, a test for a curvilinear relationship between local embeddedness and localized subsidiary innovation is still of empirical value. There is a

possibility for a curvilinear relationship between technology resources and localized subsidiary innovation as well. A cross-sectional and longitudinal study of Artz, Norman, and Hatfield (2003) finds a curvilinear relationship between a firm's commitment to R&D and its patents and new product announcements. In future research, a curvilinear test may provide insights to this research.

7.5 Implications for future research

This study has significant implications for future research. As with other studies in this stream, this study focused on manufacturing industries. Further investigation on industry effect is meaningful because each industry has its own characteristics of local responsiveness and global integration. Particularly as service industries grow extensively, it would be significant to investigate the difference between service industries and manufacturing industries in terms of strategic management in MNCs. Given the significant difference in the nature of products or services provided, I expect to see that studies in service industries can provide insights in MNC strategic management and localized subsidiary innovation. In particular, I expect to see that localized subsidiary innovation in service industries may bear more importance than in manufacturing industries, because of the high requirement on local responsiveness in service industries. A related future research direction is to include a typology of international strategies into the model proposed in this study.

Future research can also investigate the role on localized subsidiary innovation that regional headquarters can play. Some MNCs set up regional headquarters, whereas others not. Given the wide variety among MNCs, I have not included the role of regional headquarters in this study. However, some subsidiaries may assume the responsibility to the U.S. market, whereas others may assume that to international markets as well. Some assume the responsibility to the complete value chain of parent companies, whereas others only a fraction of the value chain. To increase the generalizability, I did not focus on a certain type of subsidiaries. In future research, it would be interesting to investigate the roles on localized subsidiary innovation played

by various types of subsidiaries. Moreover, the knowledge inflow from parent companies or sister subsidiaries may also play a role in localized subsidiary innovation.

A more fine-grained analysis of localized subsidiary innovation and knowledge outflow can also serve as a direction for future research. I have not differentiated technology and practice in this study. I used a general term, “new ideas” to measure localized subsidiary innovation. This measure captures the potential for successful innovation implementation, but not the same as innovation implementation. On one hand, it can avoid the positive bias pervading the study of innovation (Kimberly, 1981). Although innovation refers to new ideas by definition, new ideas have to be useful in order to be innovations. Otherwise, the new ideas can be mistakes. The usefulness of new ideas can only become clear after successful innovation implementation. Moreover, only a very few proposed new ideas receive serious consideration and development effort. Thus, to reduce the confounding of innovation implementation in this study, I chose to use the general term “new ideas” to measure innovations. However, most innovations involve both technical innovations (e.g., new technologies, products, and services) and administrative innovations (e.g., new procedures, policies, and organizational forms) (Van de Ven, 1986). Daft and Becker (1978) have emphasized keeping technical and administrative innovations distinct. Although I have made a distinction between technical and administrative in knowledge outflow, the two types of knowledge are lumped together in the factor analysis in this study. Nevertheless, applying the distinction would produce insights in future research. Similarly, the distinction between “vertical” from “lateral” inter-subsidiary communication and knowledge outflow may also present a future research opportunity.

The search for an important factor inside subsidiary organizations in this model presents an important future research. In this research, none of top management team heterogeneity, technology resources, and subsidiary size bears significant influence on localized subsidiary innovation. Although it fits well to institutional theory and I have searched for significant factors that may apply to subsidiaries from innovation literature, there may still be an important variable inside subsidiary organizations that influences localized subsidiary innovation. The importance of a local market to a MNC and other strategic roles of a subsidiary may present future research potentials.

Lastly, although this research assumes the independence of antecedents of localized subsidiary innovation, interaction among those antecedents is still a possibility. For instance, learning strategy may influence the staffing of subsidiaries' top management team, and top management team heterogeneity may interact with learning strategy to influence localized subsidiary innovation. Therefore, some interesting future research could include the following research questions. What are the joint effects of the factors on localized subsidiary innovation? For example, will the influence of local embeddedness be more significant when competition intensity at the local market is high? There are also a number of questions related to the nature of valuable local knowledge that subsidiaries should learn in order to create localized subsidiary innovation. For example, how does a specific type of local knowledge affect the model? Local knowledge could also be related to functional areas of a firm (e.g., R & D, manufacturing, marketing, or management). Valuable local knowledge could also assume different types such as product-related, process-related, and administration-related. Moreover, will it make a difference if valuable local knowledge creates a challenge to an existing practice of subsidiaries? Future research endeavors in these questions can further our understanding of the process of leveraging valuable local knowledge to achieve competitive advantage by MNCs.

7.6 Managerial implications

The research question regarding localized learning is of significant practical relevance. The ability to innovate and to exploit those innovations globally has become essential for the survival and success of MNCs (Cheng and Bolon, 1993). A key asset of MNCs is the diversity of environments in which they operate (Ghoshal, 1987: 431). In order to learn from valuable local knowledge, MNCs have started decentralizing their R & D units. These units increasingly become involved in product development rather than adaptation (Pearce, 1999). This research attempts to explain why some subsidiaries learn more from diverse local environments than others. It could be used to derive recommendations for developing the ability of subsidiaries to create innovation by learning from valuable local knowledge. For example, subsidiaries can develop local embeddedness by interacting with local customers, suppliers, or research

institutions more frequently. This research also emphasizes the critical role of subsidiaries' learning strategies in developing localized subsidiary innovation.

MNC corporate entrepreneurial culture plays an important role in localized learning. Managers need to design appropriate control systems to develop corporate entrepreneurial culture. Corporate entrepreneurial culture can be achieved by culture-based controls such as socialization (Ouchi, 1980). Socialization between MNC headquarters and subsidiaries can develop both normative integration and entrepreneurial spirit for subsidiaries. For example, the R & D units of MNCs that served as an international creator can use socialization extensively as a control mechanism (Nobel and Birkinshaw, 1998). Control systems can also be based on finance, output, or behavior. The outflow of knowledge from subsidiaries can be encouraged through appropriate control methods. For instance, the incentives can be based on the performance of a cluster of subsidiaries in order to encourage knowledge outflow (Gupta and Govindarajan, 1991). Corporate entrepreneurial culture can be developed through a bonus relative to salary in order to facilitate risk-taking actions (Gupta and Govindarajan, 1991). After MNCs implement corresponding control systems to develop a shared culture that is favorable to change and learning, the possibility of localized subsidiary innovation can increase tremendously.

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APPENDIX

**A SURVEY OF FOREIGN PHARMACEUTICAL
COMPANIES IN THE UNITED STATES**

This survey is designed to understand how foreign subsidiaries can learn from local markets in the United States, and contribute their knowledge to the Headquarter and other subsidiaries. You will find ten questions on the following five pages. If you wish to comment on any questions or qualify your answers, please feel free to use the space in the margins. Your comments will be appreciated.

Thank you very much for your help.



Department of Management
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INSTRUCTIONS

Purpose Of Survey

The survival and success of multinational corporations (MNCs) increasingly depend on their ability to innovate and to exploit those innovations globally. It is particularly true in the pharmaceutical industry. The purpose of this research is to explore the best practices for subsidiaries to innovate. Your response will be of great importance.

How To Complete This Survey

It takes about 15 minutes to complete this questionnaire. Please kindly answer all questions as completely and honestly as possible.

This questionnaire can be answered quickly by checking the answers or filling in the blanks which best describe your observations, beliefs, and attitudes about your site.

You are free not to answer any questions that you choose.

Anonymity and Confidentiality

This questionnaire is anonymous. There is nothing on it to identify you. Moreover, only the primary investigator will have access to the completed survey, and it will be kept confidential. Furthermore, only aggregate findings will be reported, thus no individually identifiable data will be reported.

Please mail back both your completed survey and the Informed Consent Form in the enclosed addressed envelope. We need the Informed Consent Form to be returned so that we can remind only those who do not answer.

Compensation

In appreciation for your participation, you can attain a summary of results, a copy of final research report, and also a list of current research in Innovation Management, if you indicate your interest at the end of this questionnaire.

If you have any questions about this survey, please call Carolyn Mu at 540-231-4676, or email (smu@vt.edu).

Thank you very much for your help!

GLOSSARY

- Site:** An operational unit controlled by a multinational company. Interchangeable with subsidiary and establishment. Unless specified, all questions on this questionnaire are about your site.
- Parent company:** The foreign company that owns your site.
- Nonequity alliances:** A cooperative relationship in which there are no stock and/or ownership exchanges between partners in the alliances.
- Joint ventures:** A cooperative relationship in which there are stock and/or ownership exchanges between partners in the ventures.
- Top managers:** The senior managers in your site who make decisions for your site.

Q_1 What are the most important, second most important, and third most important sources of new ideas for your site? (Please put appropriate number in each box)

| | |
|---|--|
| <div style="display: flex; flex-direction: column; justify-content: space-between; padding: 2px;"> MOST IMPORTANT </div> | <ol style="list-style-type: none"> 1 Our customers in the United States 2 Our competitors in the United States 3 Universities or research Institutions in the United States |
| <div style="display: flex; flex-direction: column; justify-content: space-between; padding: 2px;"> SECOND MOST IMPORTANT </div> | <ol style="list-style-type: none"> 4 Biotechnology companies in the United States 5 Our suppliers in the United States 6 Our employees in our site |
| <div style="display: flex; flex-direction: column; justify-content: space-between; padding: 2px;"> THIRD MOST IMPORTANT </div> | <ol style="list-style-type: none"> 7 Our parent company 8 Other sites of our parent company 9 Others (Please specify) _____ |

Q_2 Which of the following best describes the type of relationship between your site and other companies (or institutions) in the United States? (Please check all the appropriate boxes)

| | <u>Our customers</u> | <u>Our suppliers</u> | <u>Biotechnology companies</u> | <u>Universities or research institutions</u> |
|---|--------------------------|--------------------------|--------------------------------|--|
| 1 Sales or purchasing | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Marketing agreement for at least one year | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Technical assistance agreement(s) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 Licensing agreement(s) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 Nonequity alliance(s) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 Joint venture(s) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 Other (Please specify) _____ | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Q_3 How frequently does your site contact the following companies (or institutions) overall in the United States? (Please check the appropriate boxes, one for each column)

| | <u>Our customers</u> | <u>Our suppliers</u> | <u>Biotechnology companies</u> | <u>Universities or research institutions</u> |
|----------------------------------|--------------------------|--------------------------|--------------------------------|--|
| 1 Once a year or less | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Every few months. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Once a month | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 Every few weeks. | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 Once a week | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 Several times a week | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 Daily | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Q_4 To what extent do you agree with each of the following statements? (Please check the appropriate boxes, one for each row)

| A | <u>Strongly Disagree</u> | <u>Mildly Disagree</u> | <u>Neither Agree Nor Disagree</u> | <u>Mildly Agree</u> | <u>Strongly Agree</u> |
|---|--------------------------|--------------------------|-----------------------------------|--------------------------|--------------------------|
| 1 It is not important for our site to have new ideas . . . | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Our site has many new ideas | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Our site has adopted many new ideas from the United States | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 Our site has adopted many new ideas from our parent company | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 Our site has created many new ideas | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 The new ideas in our site are very beneficial to our performance | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 The revenues from new products created in our site accounts for a significant portion of the total revenues of our site | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| B “One of the major tasks of our site is _____.” | <u>Strongly Disagree</u> | <u>Mildly Disagree</u> | <u>Neither Agree Nor Disagree</u> | <u>Mildly Agree</u> | <u>Strongly Agree</u> |
| 1 To develop market for the products of our parent company in the United States | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 To customize the products of our parent company for the U.S. market | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 To provide products or service to other sites of our parent company | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 To gain access to new scientific or technological information in the United States | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 To gain access to well-trained human resources in the United States | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 To develop new products that our parent company does NOT currently have | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 Others (Please specify) _____ | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| C “Top managers in our site _____.” | <u>Strongly Disagree</u> | <u>Mildly Disagree</u> | <u>Neither Agree Nor Disagree</u> | <u>Mildly Agree</u> | <u>Strongly Agree</u> |
| 1 Have different nationality | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Have different functional expertise | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Have different level of education | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 Have different academic background | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 Have been at current management positions for different years | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 Are very different in their ages | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Q_5 To what extent do you agree with each of the following statements? (Please check)

| A About your site | <u>Strongly Disagree</u> | <u>Mildly Disagree</u> | <u>Neither Agree Nor Disagree</u> | <u>Mildly Agree</u> | <u>Strongly Agree</u> |
|---|------------------------------|----------------------------|---------------------------------------|--------------------------|---------------------------|
| 1 People at our site are enthusiastic about pursuing the vision of our parent company | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Our site shares the same vision with other sites of our parent company | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 For us, the objectives of our site are more important than the objectives of our parent company | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 The compensation of top managers at our site are linked to their contribution to the global performance of our parent company | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 People at our site visit our parent company frequently | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 People at our site visit other sites of our parent company frequently | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| B About your parent company | <u>Strongly Disagree</u> | <u>Mildly Disagree</u> | <u>Neither Agree Nor Disagree</u> | <u>Mildly Agree</u> | <u>Strongly Agree</u> |
| 1 Our parent company strives for new business opportunities worldwide | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Our parent company encourages us to look for new business opportunities in the United States | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Our parent company encourages us to try out new ideas | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 In our parent company, individual risk-takers are awarded if their ideas lead to success | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 In our parent company, individual risk-takers are awarded even if their ideas have NOT led to success | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| C About some other issues | <u>Strongly Disagree</u> | <u>Mildly Disagree</u> | <u>Neither Agree Nor Disagree</u> | <u>Mildly Agree</u> | <u>Strongly Agree</u> |
| 1 The products of our site are very important for our parent company | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Our parent company relies on our site for sales | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Our parent company relies on our site for new product ideas | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 Our site relies on our parent company or other sites of our parent company for major inputs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 Competition in our U.S. market is very intense | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 There are few competitors in our U.S. market | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Q_6 How frequently do you think that overall your major competitors in the U.S. market have initiated the following competitive actions? (Please check, one for each row)

| | Once a year or <u>less</u> | Every few <u>months</u> | Once a <u>month</u> | Every few <u>weeks</u> | Once a week or <u>more</u> |
|---|----------------------------------|-------------------------------|--------------------------|------------------------------|----------------------------------|
| 1 They introduced new products | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 They initiated promotional activities | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 They expanded their U.S. markets | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 They changed their prices | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 They shifted their product-line focus | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 They built new sites in the U.S | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 They made mergers or acquisitions | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8 They formed alliances | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9 Other (Please specify) _____ | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Q_7 How frequently has your site provided the following knowledge and skills to your parent company and other sites of your parent company? (Please check)

A To your parent company

| | Once a year or <u>less</u> | Every few <u>months</u> | Once a <u>month</u> | Every few <u>weeks</u> | Once a week or <u>more</u> |
|---|----------------------------------|-------------------------------|--------------------------|------------------------------|----------------------------------|
| 1 Marketing or distribution know-how | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Product technology or designs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Process technology or designs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 Purchasing know-how | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 Packaging design or technology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 Administrative systems or practices | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 Other (Please specify) _____ | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

B To other sites of your parent company

| | Once a year or <u>less</u> | Every few <u>months</u> | Once a <u>month</u> | Every few <u>weeks</u> | Once a <u>week</u> |
|---|----------------------------------|-------------------------------|--------------------------|------------------------------|--------------------------|
| 1 Marketing or distribution know-how | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2 Product technology or designs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3 Process technology or designs | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4 Purchasing know-how | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5 Packaging design or technology | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6 Administrative systems or practices | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7 Other (Please specify) _____ | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Q_8 A. Please name the locations of three other sites of your parent company with which your site has the closest relationship. How frequently has your site contacted each of them? (Please fill the locations in the blanks, and check the appropriate boxes)

| Our site contacts | Every few months or <u>less</u> | Once a <u>month</u> | Every few <u>weeks</u> | Once a <u>week</u> | Every few days <u>or more</u> |
|-------------------|---------------------------------------|--------------------------|------------------------------|--------------------------|-------------------------------------|
| Site a (_____) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Site b (_____) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Site c (_____) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

B. How frequently has the above three sites contacted each other to exchange new ideas? (Please check the appropriate boxes. If you do not know, please just ignore the correspondent item).

| | Every few months or <u>less</u> | Once a <u>month</u> | Every few <u>weeks</u> | Once a <u>week</u> | Every few days <u>or more</u> |
|-------------------------------------|---------------------------------------|--------------------------|------------------------------|--------------------------|-------------------------------------|
| 1. Site a contacts Site b | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. Site a contacts Site c | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. Site b contacts Site c | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

Q_9 Finally, the following questions are about your site and your parent company for statistical purposes (Please fill in the blank, unless specified)

1. Our site _____ . (Please check)
- is the North American Headquarters of our parent company
 - is the U.S. Headquarters of our parent company
 - includes both a manufacturing unit and a R&D unit
 - is one of the manufacturing units of our parent company
 - is one of the R&D units of our parent company
 - Other (Please specify) _____

2. Our site started from _____. (Please check)
- an acquired U.S. firm
 - a completely new site
 - a joint venture
 - an alliance
 - other (Please specify) _____

3. Our site began operation in the year of _____ .

4. There are approximately _____ employees in our site, among which roughly _____ have Ph.D. or are research scientists.

5. Our parent company sells products in approximately _____ countries worldwide.

6. Our parent company manufactures products in approximately _____ countries worldwide.

Is there anything else you would like to tell us about how your site has learned from the United States? If so, please use this space for that purpose. Also, any comments you wish to make that you think may help us in future efforts to understand how foreign subsidiaries can be better managed would be greatly appreciated, either here, or in an email (smu@vt.edu), or by a phone call to Carolyn Mu at 540-231-4676.

I greatly appreciate your contribution to this survey!

Please put the completed survey and the Informed Consent Form
in the enclosed addressed envelope, or mail them to:

Carolyn Mu
Department of Management (0233)
Pamplin College of Business
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

Please put an "X" on the following blank(s) if applicable

_____ Yes, I would like to have a summary of results.

_____ Yes, I would like to have a copy of final research
report.

_____ Yes, I would like to have a list of current
research in Innovation Management.

_____ Yes, I would like to further discuss this research.

VITA

Shaohua (Carolyn) Mu

July 2003

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Education

Ph.D. of Management (Strategic Management), 2003
Pamplin College of Business
Virginia Polytechnic Institute and State University

Master of Engineering (Industrial & Management Engineering), 1995
School of Business Administration
Wuhan Institute of Technology, China

Bachelor of Engineering (Industrial & Management Engineering), 1992
School of Business Administration
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Academic Employment

1998 - Present Graduate student assistant
Department of Management
Pamplin College of Business
Virginia Polytechnic Institute and State University, Blacksburg, VA
Responsibilities: Instructor; academic research

1995 - 1998 Assistant Research Fellow
Department of International Economics
Institute of World Economy & Politics
Chinese Academy of Social Sciences, Beijing, P.R.China
Responsibilities: Academic research

Publications

Mu, S., and Gnyawali, D. (Forthcoming). "Developing synergistic knowledge in student groups". *Journal of Higher Education*.

Mu, S. & Gnyawali, D. 2000. "Synergistic Knowledge Development in Cross-Major Student Groups: An Empirical Examination." *Best Paper Proceedings of the Academy of Management*, Pages: C1-C6. This paper won the "Best Paper In Management Education" award.

Mu, S., and Kang, R. (1997) "Comparative analysis on the Outward Direct Investment of Asian 'Four Dragons'." *Journal of World Economics and International Politics*. No. 11: 41-45. (In Chinese).

Presentations

Mu, S., and Gnyawali, D. "Inter-Subsidiary Tie Formation: Administrative Manipulation of the HQ or Voluntary Choice of Subsidiaries?" 2003 Annual Conference of the Academy of Management in Seattle, WA.

Mu, S. "Subsidiary Innovation: An Integrated Approach on Subsidiaries Learning from Local Knowledge." 2002 Annual Conference of the Academy of Management in Denver.

Mu, S., and Hatfield, D. "An Intra-Industry Analysis of Geographic Clustering Behavior: Do Industry Characteristics Matter?" 2002 Annual Conference of the Academy of Management in Denver.

Mu, S., and Gnyawali, D. "Synergistic Knowledge Development in Cross-Major Student Groups: An Empirical Examination." 2000 Annual Conference of the Academy of Management in Toronto, Canada.

Mu, S., and Hatfield, D. "The Prevalence of the Silicon Valley Phenomena: An intra-industry analysis of geographic clustering behavior." 2000 Annual International Conference of the Strategic Management Society in Vancouver, Canada.