2004

The impact of innovation capabilities on firm performance: an empirical study on industrial firms in China's transitional economy

Jing Zhang
University of Wollongong

Recommended Citation
http://ro.uow.edu.au/theses/2031
NOTE
This online version of the thesis may have different page formatting and pagination from the paper copy held in the University of Wollongong Library.

UNIVERSITY OF WOLLONGONG

COPYRIGHT WARNING

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site. You are reminded of the following:

Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.
THE IMPACT OF INNOVATION CAPABILITIES ON FIRM PERFORMANCE: AN EMPIRICAL STUDY ON INDUSTRIAL FIRMS IN CHINA’S TRANSITIONAL ECONOMY

A thesis submitted in fulfillment of the requirements for the award of the degree

Doctor of Philosophy

from

University of Wollongong

by

Jing Zhang

Department of Management
School of Management, Marketing and Employment Relations
Faculty of Commerce

2004
I, Jing ZHANG, declare that this thesis, submitted in fulfillment of the requirements for the award of Doctor of Philosophy, in the Department of Management, School of Management, Marketing and Employment Relations, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Jing ZHANG

February 16, 2004
THE IMPACT OF INNOVATION CAPABILITIES ON FIRM PERFORMANCE: AN EMPIRICAL STUDY ON INDUSTRIAL FIRMS IN CHINA’S TRANSITIONAL ECONOMY

ABSTRACT

During the past two decades of economic reform in China, market processes have given rise to new imperatives for industrial firms. These firms must now rely far more on internal innovation capabilities and resources in pursuit of efficiency-based performance. These firms can no longer assume that their previous resources and capabilities such as capabilities to produce more existing products will provide them with competitive advantage. This thesis is concerned with the way that Chinese industrial firms are responding to this new environment. The focus of this study is on the impact of internal innovation capabilities on firm performance.

The resource-based view of the firm (RBV) and the chain-link model of innovation provide the theoretical building blocks for the analysis.

The main stream of research in strategic management literature has generally concentrated on examining firm internal specific resources and capabilities in enhancing firm performance. The resource-based view of the firm (RBV) has provided a theoretical focus for much of this work. This perspective suggests that firm internal idiosyncratic capabilities and resources with valuable, rare, inimitable and imperfectly substitutable characteristics are the primary determinants of firm performance (Barney, 1991). On the other hand, in the area of innovation research, the chain-link model of innovation conceptualizes innovation as an interactive process of market opportunities and firm knowledge base and capabilities (Kline and Rosenberg, 1986; OECD, 1997). These resources and capabilities maintain intrinsic characteristics such as specificity, valuableness, and inimitability, and thereby result in competitive advantage and superior performance.

In this thesis, the RBV is integrated with the chain-link model of innovation to provide a theoretical framework for understanding the impact of innovation capabilities on firm performance among a large sample of Chinese industrial firms. Although the RBV approach has been one of the most popular frameworks for understanding the determinants of firm performance and the importance of innovation has been widely recognized, there is little empirical evidence to explain the nature of the relationship between innovation capabilities and firm performance and how this is mediated, especially in a transition economy. This thesis seeks to inform that understanding by drawing together the RBV approach and the dynamic process of innovation revealed through the chain-link model.

The empirical base for this study is provided by data collected through China’s largest official technological innovation survey of industrial firms carried across six important
industrial regions in 1996. A sample of 3843 Chinese industrial firms in Beijing, Liaoning, Harbin City, Shanghai, Jiangsu and Guangdong province offered the opportunity for this thesis to investigate the relationship between innovation capabilities and firm performance. This unique dataset provides comparable data across these regions and different type of firms.

The general finding from this study is that innovation capabilities carry significant implications for enhancing firm performance. However, the analysis also reveals the complexity of this relationship. Innovation capabilities have both independent and interactive impacts on firm performance. Moreover, the impact of innovation capabilities is moderated by several environmental and organizational factors.

Innovation capabilities in this study are delineated in a multidimensional form: R&D capability; absorptive capability of external technology resources; product development capability; process innovative capability; manufacturing capability; and marketing capability. Firm performance is measured in terms of financial, market and innovation performance. The analysis exposes how the impact of the individual dimensions of innovation capabilities varies according to different performance objectives. R&D capability is an important contributor to financial, market and innovation performance. Absorptive capability is positively related to market performance, but negatively related to innovation performance. Product development capability and process innovative capability are positively associated with market and innovation performance, but have no direct association with financial performance. Manufacturing capability and marketing capability have a relatively weak relationship with firm performance. The interaction of R&D capability and marketing capability demonstrates a monotonically positive effect on innovation performance, but a non-monotonic negative relationship with financial performance. Furthermore, innovation capabilities affect firm performance under different environments influenced by experiences of regional development, innovation policy support, industry type and ownership. These findings also support the argument developed in this thesis that it is the interaction between innovation capabilities in specific environmental contexts rather than the separate capabilities themselves that is more important for driving firm performance.

Overall, this study provides evidence to support the theoretical assumptions of the RBV and confirms the potential of the RBV to provide an appropriate analytical framework for investigating the relationship between innovation capabilities and firm performance in a transitional economy. These findings carry implications for how managers and policy makers can best promote innovation capabilities to assist Chinese industrial firms enhance their performance in transforming economic environments.

**Key words:** the resource-based view of the firm; the chain link model of innovation; innovation capabilities; firm performance; strategic management; transitional economies
ACKNOWLEDGMENTS

I would like to express my appreciation and gratitude to all those who, in various ways, have contributed to the realization of this challenging thesis.

It has been my privilege and good fortune to have Prof. Tim Turpin as my supervisor, mentor, and good friend. I would like to express my sincere appreciation and deepest gratitude to Prof. Tim for his intellectual inspiration, enthusiastic guidance, endless encouragement and continuous support throughout the research. Prof. Tim has set an excellent model for my lifelong emulation through his extraordinary professionalism and admirable personality. He has always been a refreshing spring of thoughts. His insights into the strategic management and technological innovation have provided me with the impetus to make more clear understanding on theoretical issues of this study, and sharpened my research skills. More importantly, Prof. Tim has always been encouraging me to be innovative, and giving me unlimited freedom to work the way I liked on topics that I enjoyed. I especially appreciate his patience and effort in checking countless revisions of the thesis. His reassuring and valuable comments on each chapter enhanced my confidence and accelerated my efforts. Moreover, his realistic views as to the essence of a good thesis have been taken into account. I am also grateful for his help and tolerance in numerous situations even unrelated to my study.

I am also extremely grateful to my second supervisor Dr. Peter Massingham for his professional and efficient guidance, especially for his important inputs in the last stage of the completion of the thesis. Dr. Peter's expertise has strengthened my understanding of the perspectives of industry organization economics and the resource-based view of the firm. His comments on all aspects of the study have been much appreciated.

Special gratitude is also owed to my good friend Associate Prof. Sam Garrett-Jones from the Department of Management for his friendship, expertise and encouragement, especially for his valuable comments on my thesis proposal and his kind aid in many occasions.

I would like to thank Dr. Winter Nie, from the American Graduate School of International Management in Thunderbird, and Dr. Yanni Yan, from the City University of Hong Kong for their friendship and helpful advices and discussions on this research. Gratitude is extended to Dr. Guanghua Wan from the University of Sydney for his encouragement and useful suggestions on a relevant paper of this research, which is under review. I also wish to thank Dr. Fei Guo from Macquarie University for her helpful comments on the technical part of this study during my presentation of thesis proposal.

I am thankful to all the people and colleagues at the Department of Management and CAPSTRANS who have helped me in various ways during my study. Appreciations also go to
my former colleagues at the National Research Centre for Science and Technology for Development (NRCSTD) in Beijing and the City University of Hong Kong, as well as my good friends from Tsinghua University, Zejiang University and the Development Research Centre of State Council of China for their friendly help in obtaining relevant Chinese reference papers.

I would also like to thank one of the important friends in my life, Associate Prof. Robyn Iredale from the Faculty of Science for her friendship and love. She offered me emotional support by teaching me how to manage and balance my study and family and giving me the positive attitude towards life.

Special thanks are also extended to my good friends Mr. Matt Ngui from the Department of Management and his wife Mrs Robyn Ngui for their sincere care and help in many aspects, as well as most of their friendship during my study.

There have also been several friends in Australia who gave me their friendship and moral support: Dr. Jie Ding, Dr. Zemin Wu, Miss Anny Cao, Mr. Nathan Cen, as well as Mr. and Mrs Smith.

Last but not the least, I express my deepest gratitude to the most important people in my life, starting with my parents, my husband, my younger sister and brother and my children for giving me love and care throughout my life.

I express my sincere love and appreciation to my mother Junlan Wang and my father Dejun Zhang. They have raised me and given me everything necessary including their sacrifices made for me to succeed in my life. I owe debt of their sacrifices I shall never be able to repay.

My heartiest appreciation goes to my dear husband Dr. Jin E. Zhang for his great love, understanding, encouragement and support over these years that kept me a step closer towards my goal. He is always there for me to honor me in success, strengthen me in challenge, and relief me in sadness, even he is also under a pressure of research and teaching at the Hong Kong University of Science and Technology.

I extend my sincere appreciation to my younger sister and brother for their moral support and love throughout my Ph.D. study, although they are also working on their own subjects as the postgraduate students in Australia and in U.K at the same time.

I also appreciate very much having such wonderful musical background from my LOVELY infant son Patrick during my home working hours.

Without all above these, I could not have accomplished what I have done. THANK YOU!
## TABLE OF CONTENTS

*Thesis Certification* ................................................................................................................. i

*Abstract* ........................................................................................................................................ ii

*Acknowledgements* ..................................................................................................................... iv

*Table of Contents* ....................................................................................................................... vi

*List of Figures* ........................................................................................................................... vii

*List of Tables* ........................................................................................................................... viii

*Abbreviations* ................................................................................................................................ xi

## PART ONE

### CONCEPTUAL DEVELOPMENT AND RESEARCH FRAMEWORK

#### CHAPTER ONE: INTRODUCTION......................................................................................... 1

1.1 Research Background .............................................................................................................. 4

1.1.1 Recognizing the Significance of China's 'Transition' Economy ........................................... 4

1.1.2 Adopting a Firm-level Perspective of Innovation in Transitional Economies .................. 5

1.1.3 Incorporating the Resource-based View of the Firm ......................................................... 7

1.2 Research Objectives and Specific Research Questions ....................................................... 11

1.3 Justification for the Present Study ......................................................................................... 12

1.4 Definitions, Concepts and Hypotheses .................................................................................. 16

1.4.1 Definitions and Concepts of Firm Performance and Innovation Capabilities ................. 16

1.4.2 Hypotheses about the Impact of Innovation Capabilities on Firm Performance .............. 18

1.5 Methodology .......................................................................................................................... 20

1.6 Main Results and Conclusions ............................................................................................. 22

1.7 Outline of the Thesis .............................................................................................................. 25

1.8 Chapter Summary .................................................................................................................... 26

#### CHAPTER TWO: THE DETERMINANTS OF FIRM PERFORMANCE: A REVIEW ON THEORETICAL PERSPECTIVES AND CONCEPTUAL DEFINITIONS ................................................................................................................. 28

2.1 Determining Firm Performance ............................................................................................. 28

2.2 Measuring Firm Performance ............................................................................................... 35

2.3 Defining Innovation Capabilities at Firm Level .................................................................. 41

2.3.1 Dynamic Capabilities ........................................................................................................ 42

2.3.2 Technological Capabilities ............................................................................................... 42

2.3.3 Innovation Capabilities ..................................................................................................... 45

2.3.4 Other Capabilities .............................................................................................................. 52

2.4 Chapter Summary .................................................................................................................... 55

#### CHAPTER THREE: THE IMPACT OF INNOVATION ON FIRM PERFORMANCE: AN REVIEW OF EMPIRICAL STUDIES ................................................................................................................. 59

3.1 Innovativeness-Performance Stream ..................................................................................... 61

3.2 Innovation Strategy-Performance Stream ............................................................................ 62

3.3 Innovation Capability/Resource-Performance Stream ......................................................... 64

3.3.1 Input-oriented innovation capabilities and firm performance ........................................ 66

3.3.2 Output-oriented innovation capabilities and firm performance ....................................... 70

3.3.3 Complementarity and Interactions of Capabilities/resources and Firm Performance ....... 73
### 3.4 Characterizing Innovation Activities in Chinese Industrial Firms

3.5 Chapter Summary

---

**CHAPTER FOUR: THE DEVELOPMENT OF RESEARCH FRAMEWORK**

4.1 Definitions of Innovation and Firm Internal Innovation Capabilities

4.2 Research framework

4.3 Dimensions of Innovation Capabilities in Chinese Firms

- 4.3.1 Input-oriented Innovation Capabilities
- 4.3.2 Output-oriented Innovation Capabilities

4.4 Dimensions of Firm Performance in Chinese Firms

4.5 Chapter summary

---

**CHAPTER FIVE: THE IMPACT OF INNOVATION CAPABILITIES ON FIRM PERFORMANCE AMONG CHINESE FIRMS - THE DEVELOPMENT OF HYPOTHESES**

5.1 The Independent Impact of Innovation Capabilities on Firm Performance

- 5.1.1 R&D capability and Firm Performance
- 5.1.2 Absorptive Capability of External Technology Resources and Firm Performance
- 5.1.3 Product Development Capability, Process Innovative Capability and Firm Performance
- 5.1.4 Manufacturing Capability and Firm Performance
- 5.1.5 Marketing Capability and Firm Performance

5.2 The Interactive Impact of Innovation Capabilities on Firm Performance

5.3 The Moderated Impact of Innovation Capabilities on Firm Performance

- 5.3.1 Regional Development and the Impact of Innovation Capabilities
- 5.3.2 Innovation Policy Support and the Impact of Innovation Capabilities
- 5.3.3 Industry Type and the Impact of Innovation Capabilities
- 5.3.4 Firm Ownership and the Impact of Innovation Capabilities

5.4 Chapter Summary

---

**PART TWO
EMPIRICAL ANALYSES, DISCUSSION AND CONCLUSIONS**

**CHAPTER SIX: RESEARCH METHODOLOGY AND ANALYTICAL FRAMEWORK**

6.1 The Introduction of the Technological Innovation Survey

- 6.1.1 Sample Selection of the Survey
- 6.1.2 Questionnaire Design for the Innovation Survey
- 6.1.3 Data Collection

6.2 Data and Sampling for this Study

6.3 Hypotheses Testing Model and Techniques

- 6.3.1 Hypotheses Testing Model
- 6.3.2 Hypotheses Testing Techniques

6.4 Variable Operationalizations

- 6.4.1 Dependent Variables - Firm Performance
- 6.4.2 Independent Variables - Innovation Capabilities
- 6.4.3 Environmental and Organizational Variables
- 6.4.4 Control Variables

6.5 Reliability and Validity Assessment
6.6 Chapter Summary

CHAPTER SEVEN: REVEALING THE COMPLEX IMPACT OF INNOVATION CAPABILITIES – THE RESULTS OF DATA ANALYSES

7.1 Main Effects of Innovation Capabilities on Firm Performance (Hypotheses 1 through to 6)

7.1.1 Main Effects of Innovation Capabilities on Firm Performance

7.1.2 The Effects of Control variables

7.2 The Interactive Effect of R&D Capability and Marketing Capability on Firm Performance (Hypothesis 7)

7.3 Moderating Effects of Environmental and Organizational Factors on the Relationship between Innovation Capabilities and Firm Performance (Hypotheses 8 through to 31)

7.3.1 Regional Development

7.3.2 Innovation Policy Support

7.3.3 Industry Type

7.3.4 Ownership: SOEs, non-SOEs and IJVs

7.4 Chapter Summary

CHAPTER EIGHT: DISCUSSION AND CONCLUSIONS

8.1 The Complex Impact of Innovation Capabilities among Chinese Firms

8.1.1 The Different Impact of Individual Innovation Capability Dimensions on Firm Performance

8.1.2 The Interaction between R&D Capability and Marketing Capability

8.1.3 The Influence of Regional Development on the Relationship between Innovation Capabilities and Firm Performance

8.1.4 The Influence of Innovation Policy Support on the Relationship between Innovation Capabilities and Firm Performance

8.1.5 The Influence of Industry Type on the Relationship between Innovation Capabilities and Firm Performance

8.1.6 The Difference of Innovation Capability-Performance Relationship in Different Ownership Firms

8.2 Contributions and Theoretical Implications

8.2.1 The Implication of the RBV in Transition Economies

8.2.2 Unpacking Innovation Capabilities

8.2.3 Interactions between Innovation Capabilities

8.2.4 The Role of Environmental and Organizational Factors

8.2.5 Methodological Implications

8.3 Managerial and Policy Implications

8.3.1 Managerial Implications

8.3.2 Policy implications

8.4 Limitations and Future Research Directions

8.5 Conclusions

REFERENCES

Appendix A Questionnaire of the Technological Innovation Survey

Appendix B OECD’s Classifications of Manufacturing Industries (ISIC Revision 2)
LIST OF FIGURES

1.1 Research Methodology Flowchart of the Thesis ............................................. 27

4.1 Research Framework ......................................................................................... 91

4.2 R&D Expenditures in China's Large and Medium-sized Industrial Enterprises (1991-1997) ................................................................. 97

5.1 R&D Expenditures in Selected Countries by Performing Sectors .................. 128

6.1 The Location of the Six Surveyed Provinces and Cities .......................... 141
LIST OF TABLES

2.1 Examples of Quantitative Measures of Firm Performance Used in Pervious Studies ---39
2.2 Matrix of Technological Capabilities (Lall, 1994: 268) -------------------------------44
2.3 Examples of Definitions of Firm-level Capabilities-------------------------------------- 57
3.1 Examples of Empirical Studies on the Impact of Innovation on Firm Performance ---- 84
5.1 Summary of Hypotheses---------------------------------------------------------------136
6.1 Analysis of the Technological Innovation Questionnaire Returns------------------------ 146
6.2 Distribution of the Sample Firms-------------------------------------------------------148
6.3 Profile of Sample Firms---------------------------------------------------------------149
6.4 Regional Per Capita GDP (1979-1998)-----------------------------------------------------159
6.5 Operationalizations and Measurement of Variables----------------------------------------163
6.6 Cronbach Alpha Levels of Relevant Construct Measures in High and Low Development Regions -----------------------------------------166
7.1 Descriptive Statistics and Correlations for all Dependent, Independent and Control Variables----------------------------------------170
7.2 Collinearity Statistics for Control Variables, External and Internal Environmental Variables, and Innovation Capability Variables ----------------------------------------172
7.3 Results of Regression Analyses for Firm Performance: Main and Interactive Effects of Innovation Capabilities ----------------------------------------174
7.4 Results of Regression Analyses for Firm Performance: Moderating Effects of Regional Development, Innovation Policy Support and Industrial Type------------------------181
7.5 Split Sample Regression for Small and Medium-Sized SOEs, non-SOEs and IJVs----------194
7.6 Summaries of Hypotheses Testing--------------------------------------------------------201
8.1 Technology Trade in Domestic Technology Markets and High-Tech Product Exports ------------------------214
8.2 Distribution of R&D Expenditures in Six Surveyed Provinces and Cities------------------ 218
8.3 Distribution of R&D Personnel in Six Surveyed Provinces and Cities----------------------218
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AISF</td>
<td>Annual Industrial Statistics Form</td>
</tr>
<tr>
<td>ABTCAPA</td>
<td>Absorptive capability of external technology resources</td>
</tr>
<tr>
<td>CSIC</td>
<td>China Standard Industrial Classification</td>
</tr>
<tr>
<td>FAGE</td>
<td>Firm age</td>
</tr>
<tr>
<td>FINPFM</td>
<td>Financial performance</td>
</tr>
<tr>
<td>FSIZE</td>
<td>Firm size</td>
</tr>
<tr>
<td>FSTRUK</td>
<td>Financial structure</td>
</tr>
<tr>
<td>IJVs</td>
<td>International joint ventures</td>
</tr>
<tr>
<td>INDSTYPE</td>
<td>Industry type</td>
</tr>
<tr>
<td>INNPFM</td>
<td>Innovation performance</td>
</tr>
<tr>
<td>INNPSPT</td>
<td>Innovation policy support</td>
</tr>
<tr>
<td>IO</td>
<td>Industrial organization economics</td>
</tr>
<tr>
<td>MKTCAPA</td>
<td>Marketing capability</td>
</tr>
<tr>
<td>MKTPFM</td>
<td>Market performance</td>
</tr>
<tr>
<td>MNFCAPA</td>
<td>Manufacturing capability</td>
</tr>
<tr>
<td>NBS</td>
<td>National Bureau of Statistics of China</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OWNSHIP</td>
<td>Ownership</td>
</tr>
<tr>
<td>RDCAPA</td>
<td>R&amp;D capability</td>
</tr>
<tr>
<td>PRCCAPA</td>
<td>Process innovative capability</td>
</tr>
<tr>
<td>PRDCAPA</td>
<td>Product development capability</td>
</tr>
<tr>
<td>PSSCALE</td>
<td>Production scale</td>
</tr>
<tr>
<td>RBV</td>
<td>The resource-based view of the firm</td>
</tr>
<tr>
<td>REGDEV</td>
<td>Regional development</td>
</tr>
<tr>
<td>ROS</td>
<td>Return on sales</td>
</tr>
<tr>
<td>SCP</td>
<td>Structure-conduct-performance</td>
</tr>
<tr>
<td>SOEs</td>
<td>State-owned enterprises</td>
</tr>
<tr>
<td>VIF</td>
<td>Variance inflation factor</td>
</tr>
<tr>
<td>WTO</td>
<td>World Trade Organization</td>
</tr>
</tbody>
</table>
PART ONE

CONCEPTUAL DEVELOPMENT AND RESEARCH FRAMEWORK
CHAPTER ONE
INTRODUCTION

The ability to innovate is essential to a firm's survival and superior performance in today's competitive markets. The present study is concerned with the relationship between innovation capabilities and firm performance from the perspectives of the resource-based view of the firm and the chain-link model of innovation. It does this by studying the impact of firm internal specific innovation capabilities in terms of R&D capability, absorptive capability of external technology resources, product development capability, process innovative capability, manufacturing capability and marketing capability on firm financial, market and innovation performance in Chinese industrial firms in China's transitional economy.

Schumpeter's (1934) fundamental work on innovation introduced the idea of innovation as the central driven-force to a nation's economic growth. However, how important is innovation for an individual firm? According to Schumpeter's (1934) original formulation, entrepreneurship is emphasized as the key motive force in creating innovations, which are responsible for most economic growth (Galunic and Rodan, 1998; Sundbo, 1998). Entrepreneurship includes a firm's radical innovations and risk taking, which are important for the firm to survive (Covin and Slevin, 1991; Miller, 1983; Zahra, 1996). Therefore, at the micro level, innovation is one of the most essential ways for the development and growth of individual firms (Dougherty and Hardy, 1996; Hitt, Hoskisson, Johnson and Moesel, 1996) and thus in turn, for economic growth and national competitiveness. More importantly, Schumpeter's innovation theory offered answers to the question about why firms might obtain high profits from their innovation activities. Innovation tends to produce technological monopoly in products, processes or services at the point of introduction to the market and then leads to high profits of the firm (Roberts, 1999).

Following Schumpeter's seminal work on innovation theory, rich theoretical and empirical research based on industrial firms in western economies has provided evidence to show that innovation has become generally crucial to the firms' competitive advantage and
superior performance. How does the innovation take place in a firm? Modern innovation theories also offer some ideas. For example, the chain-link model conceptualizes innovation as a complex interactive process between market opportunities as well as the firm’s knowledge base and *capabilities* (Kline and Rosenberg, 1986; OECD, 1997). This process begins with potential market, invention and product design, prototyping and pre-testing, redesign and production, and effective marketing (Kline and Rosenberg, 1986). Thus, successful innovation is based on ‘strong’ and ‘varied’ knowledge and capabilities, which are combined by various internal and external sources (Zahra and Nielsen, 2002).

Moreover, the resource-based view of the firm (RBV) implies that the firm’s internal *idiosyncratic capabilities* and *resources* drive firm sustained competitive advantage and superior performance (Barney, 1991; Penrose, 1959; Peteraf, 1993; Wernerfelt, 1984). Based on the RBV, recent literature on the sources of firm performance focuses on various firm *internal rare, valuable, inimitable and non-substitutable capabilities* and *resources* as the most valuable resources that provide superior performance and sustainable competitive advantage (Barney, 1991). Among these capabilities, explaining the role of innovation capabilities is one of the key empirical issues in the field of strategic management (Schroeder, Bates and Junttila, 2002).

Innovation is particularly important for Chinese firms during China’s transitional economy. Since the opening of Chinese markets and especially since the entry to the WTO, Chinese firms can no longer assume that their traditional domestic market environments, such as lack of demands of customers on new products, will provide them with advantage to survive. They have to face international competition directly in both international and domestic markets, and have to follow some common market principles. In any advanced market, the competition is innovation-based competition (Teece, Pisano and Shuen, 1997). The pressure to produce new products leads to a greater emphasis on technological innovation among Chinese firms. Although innovation activities in Chinese firms might be at a relatively low level of technology development, the technological innovation survey in Chinese industrial firms conducted in 1996 found a larger percentage of innovative firms (91%) who claimed that they carried out
technological innovation activities compared to some innovation surveys in market economies.

For example, the results of the UK Innovation Survey conducted in 2001 show that 47 percent of enterprises in the UK were innovation active in the three-year period 1998-2000. The growing enthusiasm for innovation among Chinese firms therefore provides a rich opportunity to study the role of firm internal capabilities related to innovation process on firm competitive advantage and superior performance.

However, despite the wide confirmation of the importance of innovation, we still, however, do not know much about how firms, especially the firms in transitional economies, conduct innovation activities and develop capabilities and resources successfully in pursuit of their superior performance (Helfat, 2000). Consequently, despite the emphasis on internal capabilities, researchers have not systematically defined innovation capabilities. It is also not clear from the literature how and what innovation capabilities contribute to different types of firm performance. This also ties into an important current debate within strategic management about the parameterization of resource value (Barney, 2001a; Priem and Butler, 2001). In order to apply the resource-based view of the firm to innovation management, managers must be able to evaluate their resources and capabilities and build strategies on this basis. It is the interest in addressing these gaps in the literature that motivates the present study. Specifically, this study, based on data from 3843 Chinese industrial firms in six provinces and cities Beijing, Liaoning, Harbin City, Shanghai, Jiangsu and Guangdong province, explores the extent to which and how internal innovation capabilities in Chinese industrial firms influence firm performance. The argument developed in this study is that innovation capabilities needed by different stages of the innovation process have implications for the valuable resources of Chinese firms to achieve and sustain superior performance. Furthermore, the impact of particular innovation capabilities on firm performance is influenced by specific environmental and organizational factors such as regional development, innovation policy support, industry type and ownership of firm. This is because of the unique characteristics of China’s transitional economy.
1.1 Research Background

Studying the impact of firm internal innovation capabilities on firm performance in Chinese industrial firms is important from at least three considerations: the significance of China’s transitional economy in global production; firm-level perspective of innovation in a transitional economy; and the perspective of the resource-based view of the firm. This is because the characteristics of China’s transitional economy offer an opportunity to apply the resource-based view of the firm to the studies of firm level innovation in transitional economies.

1.1.1 Recognizing the Significance of China’s ‘Transition’ Economy

Recognizing the importance of China’s economic system in transition is the first consideration. During the last two decades, China has been the largest and one of the fastest growing emerging economies in the world, with market growth as well as investments in and from western countries. In 1978, China began an economic reform process that evolved into economic transition from a central planned economic system to a market-driven system. The ultimate goal of the transition has been to build a market economy that can deliver long-term growth in economics while shedding the former central planned system. One of the important characteristics of economic development in market economies is that innovation plays a central role in supporting their economic growth. Given the close link between innovation and a nation’s economic system, following economic reform, China has taken a number of reforms in science and technology and innovation systems. Promoting technological innovation has received top priority in Chinese government policies in driving the move to a market-driven economy.

What does the reform mean for Chinese firms in an environment, where industrial production is encouraged to expose both ends (sourcing and marketing) to global market forces? The opening of Chinese markets has made Chinese firms face the global market competition directly. On the one hand, Chinese firms get more opportunities to sell their goods on western markets. On the other hand, new competitors from market economies enter home markets. These new players have exploited new conditions, which have raised higher standards for
market success such as innovation-based competition (Teece, Pisano and Shuen, 1997). It has given rise to a new economic context within which a Chinese firm has to introduce or develop new technology and new products rather than simply produce more of existing products in order to improve its performance (White 2000). The Chinese government has promoted this new approach to enterprise reform by introducing various policy incentives including investment, taxation, financial support, technology transfer assistance, scientific awards, and human resource policies to strengthen technological competencies and competitiveness in industries and to stimulate firms’ innovation activities to develop and improve their innovation capabilities. The emphasis on the role of innovation provides Chinese firms with positive innovation environments. As a result, Chinese firms are increasingly pursuing innovation as a critical way of achieving their superior performance. They are pressed by the environmental imperative to understand innovation capabilities and resources in order to achieve efficiency-based performance rather than scale-based performance (White and Liu, 1998). This imperative is particularly strong during the process of economic transition.

Researchers empirically investigating innovation in Chinese firms have typically anchored their work in traditional innovation theories, which generally concern such as innovation activities or process (Porter and Jin, 1988; Simon and Rehn, 1987); innovation management (Xu, Chen and Guo, 1998); and innovation policies (Baark, 2001, Turpin and Liu, 2001). There has been far less research in China to empirically link internal innovation capabilities and resources to firm performance. Consistent with general objectives of economic and innovation reforms, examining the impact of internal innovation capabilities on firm performance can lead to further understanding of the importance of innovation and how innovation capabilities can be developed and deployed in Chinese firms to create new products, and in turn, lead to superior performance.

1.1.2 Adopting a Firm-level Perspective of Innovation in Transitional Economies

A research emphasis on innovation at the firm level is not new in market economies. Following Schumpeter’s (1934) fundamental work on innovation theory, a large body of
research has undertaken a continuous examination of innovation, especially in the form of new or improved products and processes. Innovation has become crucial to a firm’s competitive advantage and high performance (Franko, 1989; Roberts, 1999; Terwiesch, Loch and Niederkofler, 1998).

However, as OECD experts (1997) point out, an understanding of the innovation process and its impact is still deficient. Moreover, the empirical evidence on the importance of innovation in firms in transitional economies is typically sparse. This is because innovation was not seen as a source of advantage for host country firms in transitional economies because innovation especially radical innovation is most commonly created in mature markets such as United States, Japan, and Germany. Mature markets foster innovation due to demanding customers, intense competition, accessible capital, high levels of entrepreneurship, and qualified staff. Research in the Western economies have typically considered low cost leadership as the main source of competitive advantage for host country firms operating in transitional economies such as China (e.g., Camuffo, 2003; Lardy, 1992). This has been based on perceptions that China has scale economies due to low cost human resources and a large domestic market. However, these resources are also available to Western firms entering China and, therefore, are not a source of sustainable competitive advantage. Chinese firms has recognized that they must change the way they compete and can no longer rely on relationships and market awareness for sustainable advantage. Competition is forcing them to innovate. There is, therefore, a need for empirical studies to adopt a firm level perspective of innovation in China. The study sheds light on the question as to whether the development of innovation capabilities in Chinese firms is a sensible response to these competitive pressures.

On the other hand, the globalization of economic development has driven much research in market economies to explain the characteristics of innovation in firms operating in developing economies, especially the firms operating in newly industrializing countries and transitional economies. Some firms in transitional economies are becoming major international competitors, especially in their domestic markets. However, since the innovation theories were
developed on the basis of analyses of industrial sectors in developed countries (Sundbo, 1998), it leaves open the question of whether their insights can be transferred to very different situations such as in China. Few studies have especially explored the characteristics of innovation, or relationships between innovation capabilities and performance at firm level in transitional economies. More importantly, western market principles and theoretical perspectives of innovation systems are not necessarily applicable to or suitable for analyzing transitional economies because of different economic systems, mechanisms and market environments. Studying the influence of innovation capabilities on firm performance in a transitional economy like China can provide a deeper understanding of the difference of the development and impact of innovation capabilities between transitional economies and their fully market-driven counterparts.

1.1.3 Incorporating the Resource-based View of the Firm

The third reason of studying the impact of innovation capabilities on firm performance in Chinese firms comes from the growing body of literature on the resource-based view of the firm.

Strategy researchers have been trying to understand and explain why some firms are consistently achieving relatively high performance levels over time. Previous research in this area emphasized the different structural characteristics of industries as the primary determinant of performance differentials between industries based on *industrial organization (IO)* economics perspective (Bain, 1968; Mason, 1939) and its derivative *industry structure framework* (Porter, 1980).

Recent strategic management research has turned to analyzing the firm itself to explain performance differentials from emphasizing the difference of industry structures (Eisenhardt and Martin, 2000; Helfat, 2000), because of 'the inability of the industrial organization tradition to provide a rigorous explanation for intra-industry heterogeneity in performance' (Hawawini, Subramanian and Verdin, 2003: 2). For example, the *organization environment* perspective suggests that intra-industry factors and conditions faced by firms within an industry lead to performance differences among firms (Hansen and Wernerfelt, 1989; Nelson, 1991). More
importantly, extant strategic management research hypothesizes that firms obtain competitive advantages and sustainable performance via the use of firm-specific capabilities and resources (Barney, 1991; McEvily and Zaheer, 1999; Nelson, 1991; Teece, Pisano and Shuen, 1997; Thomas and Weigelt, 2000) based on the resource-based view of the firm (RBV).

The RBV has been insightful in explaining how a firm's "idiosyncratic capabilities and resources" result in firm sustained competitive advantage and superior performance (Barney, 1986, 1991; Peteraf, 1993; Wernerfelt, 1984 and 1995). Specifically, the RBV emphasizes a firm's "valuable, rare, hard to imitate and non-substitutable" capabilities and resources as important determinants of firm competitive advantage and superior performance (Barney, 1991). The RBV perspective clearly points out the different sources of firm competitive advantage and superior performance internal specific capabilities and resources from other perspectives (Makhija, 2003; Roqueber, Phillips and Westfall, 1996) such as industrial organization economics (Bain, 1968; Mason, 1939) and industry structure framework (Porter, 1980), which focuses on external structures of industries and markets.

Practically, the RBV logic can help firm managers 'more completely understand the kinds of resources that can generate sustained strategic advantages' (Barney, 2001a: 49). This assists firm managers to 'identify...the most critical resources controlled by the firm...and to nurture and maintain these resources' (Barney, 2001a: 49). In other words, the RBV perspective provides firm managers with a helpful decision path. When a firm seeks to achieve its superior performance, firm managers can firstly evaluate their most valuable resources and capabilities; secondly, decide whether the firm should acquire these resources and capabilities from strategic factor markets or develop them internally; and thirdly, protect this investment by maintaining their unique value creating properties.

More importantly, the RBV perspective is consistent with firm-level innovation theories and dynamic capabilities approach (Mahoney and Pandian, 1992; Williamson, 1991):

'Schumpeterian competition may be translated into the resource-based framework by considering the firm’s 'new combinations of resources' (Penrose, 1959: 85) as a means of achieving the goal of sustained competitive advantage (Ghemawat, 1986)' (Mahoney and Pandian, 1992: 369).
'One approach is to integrate the resource-based view with the organizational economics and dynamic capabilities approach (Teece, Pisano and Shuen, 1990), in which heterogeneity is explained as an outcome of a disequilibrium process of Schumpeterian competition (Iwai, 1984)...' (Mahoney and Pandian, 1992: 374).

'The leading efficiency approaches to business strategy are the resource-based and the dynamic capabilities approach ... Plainly, they deal with core issues. Possibly they will be joined' (Williamson, 1991: 76).

According to innovation theories, a firm is considered as the developer of resources and the purpose of a firm pursuing innovation is to search out and develop novel capabilities and resources or 'new ways of using existing resources', as the foundation for superior performance (Galunic and Rodan, 1998: 1193; Penrose, 1959; Schumpeter, 1934). As mentioned above, Mahoney and Pandian (1992) therefore point out that the RBV approach could be integrated with the perspective of dynamic process of innovation. The process of innovation relies on interactions of these novel capabilities and resources. In other words, innovation is a renewal of tangible or intangible capabilities and resources in a firm (Sundbo, 1998) to exploit new products and technologies, which are distinctive and valuable resources that cannot be easily reproduced by competitors. Therefore, innovation capabilities and resources are one of the major idiosyncratic sources of firm performance.

Although, the RBV has attracted considerable attention in the literature, researchers still know relatively little about how firms successfully use their capabilities and resources to achieve expected performance (Helfat, 2000). This is especially the case with firm-level innovation capabilities (Sen and Egelhoff, 2000). It may be particularly attributable to the complexity and variability of innovation process, as well as the 'parameterization' or the 'exogenous determination' of capability and resource value (Barney, 2001a; Priem and Butler, 2001) and the difficulty in defining and measuring valuable capabilities and resources (Yeoh and Roth, 1999). Examining the impact of innovation capabilities on firm performance in Chinese industrial firms would add more empirical evidence on the efficiency of firm-specific capabilities to firm performance. This study shows that research on the relationship between innovation capabilities and firm performance in Chinese firm can benefit greatly from firms' specific experience to show how innovation might proceed by firms' assembling various
capabilities and knowledge bases. Furthermore, the value and the effectiveness of particular resources and capabilities on firm performance are different when they are applied in different market contexts (Barney, 2001a). Examining the impact of innovation capabilities in Chinese firms can help to understand how different the value of innovation capabilities is in Chinese firms from firms in market economies, and what are the particularly valuable innovation capabilities in the context of China's transitional economy.

The above discussion highlights the importance of considering innovation capabilities as the important sources of superior performance among Chinese industrial firms. In summary, despite the wide recognition of the importance of innovation capabilities, the impact of innovation capabilities on firm performance has not been well documented empirically in the literature, given the lack of authorized definition and measurement of innovation capabilities. In particular, limited empirical research can be found to explain how innovation capabilities relate to firm performance in a transitional economy. Given the general paucity of comprehensive empirical research on innovation capabilities, there is a need for more empirical evidence to inform debates and findings on the impact of innovation capabilities on firm performance.

Based on these considerations, the present study introduces two guiding firm-level theories: the resource-based view of the firm and the chain-link model of innovation to develop a research framework for identifying the nature and characteristics of innovation capabilities and their impact on firm performance among Chinese industrial firms. This is because both the resource-based view of the firm and chain-link model of innovation perspective focus on the significant role of firm capabilities and resources related to innovation as the determinants of firm performance. They therefore provide this study with an appropriate theoretical standpoint on which to understand the impact of innovation at the firm level. This study seeks to combine the resource-based view of the firm with the chain-link model of innovation through an empirical analysis on the relationship between different innovation capabilities related to different stages of innovation process and firm performance. It will provide empirical evidence
on Mahoney and Pandian's (1992) theoretical discussion on the integration of the resource-based framework and innovation perspective.

It should be noted that the level of innovation within Chinese firms might be low compared to those at the leading age of innovation. Western firms entering China will have superior innovation compared with local firms. For this reason, it is important to understand that this thesis does not argue that Chinese firms compete based on having world's best practice or leading edge innovation. Rather, it examines the contribution of innovation to performance in the context of China.

1.2 Research Objectives and Specific Research Questions

The primary goal of this study is to draw on new empirical evidence to test theories of capability-performance linkage at the firm level by examining whether innovation capabilities affect firm financial, market and innovation performance in a transitional economy China. The empirical data was drawn from a sample of over 3000 Chinese industrial firms in six different provinces and cities. This allows the present study to explore the role played by different innovation capabilities in enabling Chinese industrial firms to achieve superior performance across a wide range of locations and industrial settings.

There are three specific objectives of the study. First, this study seeks to elucidate firm-level innovation capabilities accumulated or developed by Chinese industrial firms by setting out major considerations for measuring firm-level innovation capabilities. Second, based upon the resource-based view of the firm, this study aims to examine not only the independent impact of an individual innovation capability but also the interactive effects of different innovation capabilities on firm performance. This is because the chain-link model of innovation suggests that innovation is an interactive process characterized by interactions between various capabilities and market opportunities (Kline and Rosenberg, 1986). Finally, this study aims to identify the moderating effects of several environmental resources or organizational factors characterized by economies in transition on the relationship between innovation capabilities and firm performance.
With these objectives, this study seeks to address some of the limitations and gaps in the literature mentioned in section 1.1 by posing four major research questions. First, what are the main internal capabilities that should be considered as the major dimensions of innovation capabilities in Chinese industrial firms? Second, do different innovation capability dimensions play different roles in helping the firm achieve superior performance in different aspects such as financial, market and innovation performance? Third, is the interaction between innovation capabilities more effective to firm performance than individual capabilities in Chinese industrial firms? Fourth, to what extent do specific environmental and organizational factors such as regional development, innovation policy environment, industry type and firm ownership influence the relationship between innovation capabilities and firm performance?

These questions provide the central focus of this study. The task is therefore to show whether different internal innovation capabilities take on a significant importance to firm performance, rather than how these innovation capabilities are built. With such a focus, the empirical analyses presented in subsequent chapters lead to the argument that innovation capabilities are multidimensional that a particular innovation capability contributes to different firm performance objectives in different ways, meanwhile, the impact of innovation capabilities is moderated by specific environmental and organizational circumstances in Chinese industrial firms.

1.3 Justification for the Present Study

Innovation is a concept that deals with a broad spectrum of a firm's technological, economics and managerial behaviors. Although, the innovation and strategic management literature are rich in empirical studies, there are limited data on the innovation capability-performance relationship. In order to explain the impact of firm specific innovation capabilities on firm performance, the present study departs from previous research in the literature in several ways.

First, the present study extends previous research in the literature by examining multiple dimensions of innovation capabilities necessary for different stages of innovation process rather
than consider one type of innovation capabilities. Previous research in this area has selectively focused on one or a few particular dimensions of capabilities related to innovation such as R&D capability (Ettlie, 1998; McGee, Dowling and Megginson, 1995), new product development (Calantone, Vickery and Droge, 1995; Roberts, 1999) and market-driven capability (Baker and Sinkula, 1999; Mishra, Kim and Lee, 1996), but ignoring others. Examining different capabilities embodied in various subsystems of innovation processes simultaneously is an important and little addressed issue. Based on the chain-link model of innovation (Kline and Rosenberg, 1986; OECD, 1997), which emphasizes the interaction of knowledge and capabilities during innovation process, this study extends this line of research by suggesting a set of innovation capabilities including both input and output measures of innovation to clarify the notion of a firm's innovation capabilities. The perspective of input-oriented and output-oriented capabilities is drawn from the method of input-output analysis of innovation activities in the innovation literature (Debresson, 1996). Previous studies assume that input-oriented capabilities such as R&D capability and output-oriented capabilities such as product innovation capability play different roles in enhancing firm performance. The input-oriented and output-oriented perspectives permit a measurement of innovation capabilities while explicitly linking different capabilities (Dutta, Narasimhan and Rajiv, 1999).

Second, in some cases, either input-oriented or output-oriented capabilities may not be association with performance as a single asset (Moorman and Slotegraaf, 1999). The determinants of firm performance can be more attributed to the interactions of input-oriented and output-oriented innovation capabilities. Only a few studies have explored the interactions between input-oriented and output-oriented innovation capabilities when they are contributing to firm performance, especially the interaction of R&D and marketing-oriented resources in high-tech industries (Dutta, Narasimhan and Rajiv, 1999; Moorman and Slotegraaf, 1999). The current study extends this line of research by explicating not only the independent impact of input-oriented or output-oriented capabilities, but also the effect of interactions of input-oriented
and output-oriented capabilities in terms of the interaction of R&D capability and marketing capability.

Third, the present study with an emphasis on firm internal innovation capabilities is one of the first studies to test the resource-based view of the firm in Chinese industrial firms during China's transitional economy. Most previous studies focus on the relationship between capabilities and firm performance in market economies, while the current study emphasizes this kind of relationship in the context of a transitional economy. Transforming economic system from a central planned toward a market-driven system in a transitional economy provides tremendous market opportunities for both domestic and foreign firms. During this transformation, all firms face the market environmental turbulence and institutional deterrence (Luo, 2002) featured by incomplete market system. They do have the different organizational behavior in order to adapt specific market environments and achieve superior performance, compared with the firms in a complete market system. Therefore, as mentioned previously, western market principles are not fully applied to transitional economies. The present study suggests that examining the impact of innovation capabilities on firm performance in China's transitional economy, which is the largest emerging economy and fastest growing market in the world, cannot be isolated from its specific market environments and organizational factors.

Fourth, this study seeks to overcome several methodological limitations. For example, the present study offers multidimensional measures of innovation capabilities and firm performance. For innovation capability measures, much of previous research relies on either objective methods such as the use of R&D intensity in terms of the percentage of R&D expenditures to total sales as a R&D capability measure, or subject methods based upon the perspectives of firm managers. To some extent, the effects of capabilities are influenced by special objective indicators. For example, R&D intensity can be measured by the percentage of R&D expenditure to total sales, or R&D expenditure per employee. Meanwhile, private perspectives often differ from those of the other managers. Thus, only using objective or subjective method may raise questions about common methods variance and other method biases (Moorman and Sloteegraaf,
This study measures innovation capabilities by integrating both objective and subjective methods.

On the other hand, a great deal of the literature on firm performance suggests that firm performance is a complex multidimensional construct (Chakravarty, 1986; Damanpour and Evan, 1984; Slater and Olson, 2000). However, only limited empirical studies have examined the relationship between capabilities and multiple dimensions of firm performance. Much of the research examines the relationship between capabilities and one particular firm performance dimension such as financial performance or market performance. In order to obtain relatively comprehensive information of firm performance and the impact of innovation capabilities, the present study therefore measures firm performance by three most relevant dimensions: financial, market and innovation performance.

Moreover, the data used in this study were drawn from a large firm level technological innovation survey in Mainland China conducted in 1996. The sample used in this study included over 3000 industrial firms. The sample size is large enough to analyze the effects of as much as possible capability terms and provide more comprehensive information on the relationship between innovation capabilities and firm performance. Some of previous studies related to Chinese firms are limited by the relevant small sample size, which may raise some statistical problems about power and generalizability (Atuahene-Gima and Evangelista, 2000).

This study uses the sample of firms from about 600 industrial sectors defined by 4-digit CSICs (China Standard Industrial Classification) rather than from only one or a few sectors as its empirical setting. It will examine innovation capabilities not only in mature or traditional industries but also in high-technology industries in which technological innovation plays dominant roles in maintaining and strengthening competitive advantage of a firm. Much empirical research suggests that industrial structure and environments have the significant influence on the relationship between capabilities and performance. Sometimes, the restriction of the sample to a single industrial context limits verification whether the major findings based in one industry are generalizable to other industries (Ahuja and Katila, 2001). The cross-
industry analysis in this study provides the possibility to analyze and compare the differences of innovation capability effects in different industries.

Finally, the present study carries practical implications for managers and policy makers. This study provides an empirical understanding of what innovation capabilities exist in Chinese industrial firms and whether they contribute to firm performance effectively. For those foreign firms that attempt to develop China’s markets, this study provides some information and evidence for understanding how firms sustain their competitive advantage and achieve performance through firm internal innovation capabilities in a transitional economy. On the other hand, this study may facilitate the policy makers to better understand what innovation capabilities are necessary for Chinese industrial firms to achieve their superior performance under the moderation of administrative and market mechanisms. It helps them make more effective policies to stimulate firms’ innovation activities and capability development.

1.4 Definitions, Concepts and Hypotheses

The primary purpose of this study is to examine firm internal specific innovation capabilities and their impact on firm performance in Chinese industrial firms. Based on the literature review presented in Chapter Two, this study draws upon the resource-based view of firm (Wernerfelt, 1984 and 1995), relevant innovation models (OECD, 1992; OECE, 1997; Schumpeter, 1934; Sundbo, 1998), and capability perspectives (Christensen, 1995; Teece, Pisano and Shuen, 1997) to develop definitions and measures of firm-level innovation capabilities and firm performance. Based on these definitions and measures, the hypotheses are developed to examine the relationship between innovation capabilities and firm performance.

1.4.1 Definitions and Concepts of Firm Performance and Innovation Capabilities

There are three key concepts used in this study: firm performance, innovation, and firm internal innovation capabilities.
Firm Performance

Firm performance provides information about the current well-being of a firm (Montgomery and Thomas, 1988). However, the literature suggests that clear-cut definitions of firm performance are almost impossible because of its complexity and multidimensional (Damanpour and Evan, 1984). This study focuses on the dimensions and measures of firm performance rather than exact definitions. Firm performance is commonly regarded as a multidimensional construct (Damanpour and Evan, 1984; Kaplan and Norton, 1996). There is no commonly accepted set of performance variables or models (Biggadike, 1976; Damanpour and Evan, 1984; McGee, Dowling and Megginson, 1995), and it is measured by different dimensions according to different research objectives (Hofer, 1983). The present study focuses on the relationship between innovation capabilities and performance in industrial firms. Therefore, this study considers three dimensions of firm performance: financial performance, market performance and innovation performance, which are highly associated with innovation effectiveness and frequently discussed in the literature. Each dimension of firm performance is further assessed by multiple indicators. For example, financial performance and innovation performance measures focus on quantitative indicators such as return on sales and the intensity of new products, while market performance measures are based on qualitative indicators such as the extent of market growth or market share.

Innovation

Innovation is difficult to define because it is a complex process that covers a wide spectrum of technological and economic behaviors as well as organizational management. Since this study focuses on the case of Chinese industrial firms, the concept of innovation used in the present study emphasizes technological innovation. The concept of technological innovation used in this study follows OECD’s (1997) definition of technological innovation in which technological innovation are generally defined as technologically new, and technologically improved products or processes (OECD, 1997).
Similarly, the literature review suggests that there is no authoritative definition for firm-level innovation capabilities. The aim of this study is not to present all capabilities that relate to various aspects of innovation, but instead to test the importance of a set of capabilities that closely relate to a firm’s technological innovation. Based on the literature review, the present study defines firm internal innovation capabilities as the combination of a firm’s abilities to integrate and build resources to develop new products and processes, improve existing products and processes, and bring new products to the markets in order to provide an advantage towards achieving superior performance.

1.4.2 Hypotheses about the Impact of Innovation Capabilities on Firm Performance

The preceding discussion suggests that the impact of innovation capabilities on firm performance should be examined from three aspects.

First, the resource-based view of firm literature suggests that a firm’s internal idiosyncratic capabilities define superior performance. A large body of research in the literature has examined the impact of selected capabilities related to innovation on firm performance (Gatignon and Xuereb, 1997; Jaworski and Kohli, 1993; Lee, C., Lee, K. and Pennings, 2001), such as R&D capability (Ettlie, 1998; Patterson, 1998; Pegels and Thirumurthy, 1996), absorptive capability (Ahuja and Katila, 2001; Jones, Lanctot JR. and Teegen, 2000), new product development (Calantone, Vickery and Droge, 1995; Loof and Heshmati, 2002), and marketing capability (Baker and Sinkula, 1999; Zhao, Droge and Stank, 2001). The present study draws from the literature to propose multiple dimensions of innovation capabilities including six types of capabilities, which are generally involved in technological innovation process: (1) R&D capability; (2) absorptive capability of external technology resources; (3) product development capability; (4) process innovative capability; (5) manufacturing capability; and (6) marketing capability. Based upon this set of innovation capabilities, the first group of hypotheses here predicts the significant impact of each innovation capability dimension on each performance dimension. These hypotheses are helpful in answering the questions about the
crucial innovation capabilities in Chinese firms and which innovation capabilities stand out in shaping performance among Chinese industrial firms.

Second, the chain-link model of innovation suggests that innovation is an interactive process. This process is conceptualized as the interrelatedness between various innovation capabilities, the existing knowledge base and market opportunities. In particular, the interaction between R&D and marketing is centrally important (Kline and Rosenberg, 1986; OECD, 1997). The resource-based view of the firm also directs attention to the interaction and complementarity between R&D and marketing capabilities, and suggests that this interaction will lead to a stronger impact on firm performance than a single capability (Dutta, Narasimhan and Rajiv, 1999; Moorman and Slotergraaf, 1999). These arguments lead to the second group of hypotheses predicting the interactive effect of innovation capabilities on firm performance. This set of hypotheses proposes that the interaction between R&D capability and marketing capability is more effective on firm performance.

The third aspect for examining the impact of innovation capabilities is from the recognition that innovation capabilities are only one of a firm’s assets that influence firm performance. In contrast with the resource-based view of the firm, some perspectives flowing from industrial organization economics (Bain, 1968; Mason, 1939; Porter, 1980) and the market-based view of the firm (Makhija, 2003) suggest that industrial structures and market environmental factors also have a significant impact on firm performance. Moreover, some previous empirical studies also provide evidence of moderating effects of these external structural and environmental factors such as organizational structure, munificence of environment and social capital (Irwin, Hiffman and Gerger, 1998; Lee, C., Lee, K. and Pennings, 2001) on the relationship between internal capabilities and firm performance. This could be particularly pertinent for a transitional economy, because it is characterized by a nature of transferring processes and market mechanisms. Thus, some special environmental and organizational factors such as regional variation, policy environments, and economic ownership significantly influence firm innovation and performance. Therefore, the third aspect provides a
A group of hypotheses. These hypotheses propose that the relationship between innovation capabilities and firm performance is moderated by several environmental and organizational factors. These factors include regional development, innovation policy support, industry type and firm ownership. This set of hypotheses serves to explain the relationship between innovation capabilities and firm performance and the extent to which the relationship is moderated by these specific environmental and organizational factors.

This section briefly introduced the key concepts of innovation capabilities and firm performance, as well as three groups of working hypotheses to be tested in this study. The definitions of related concepts and the development of the hypotheses are presented in more details in Chapter Four and Chapter Five.

1.5 Methodology

Data selection

The selection of research sample is motivated by the objective of being able to generalize the findings of the study. The present study aims at examining the impact of firm internal innovation capabilities on firm performance. It focuses on the idiosyncratic and valuable nature of unconventional innovation capabilities, and the moderating influence of some special external environmental and organizational factors in a transitional economy. To examine relevant notions, the sample used in this study came from a dataset produced by the Technological Innovation Survey in industrial firms within six provinces and cities in China including Beijing, Liaoning, Harbin City, Shanghai, Jiangsu and Guangdong province. Based on a random sampling method, the survey was conducted through mailing a questionnaire in 1996. 4196 of 10100 industrial firms (41.5%) responded the questionnaire. This study will show that industrial firms are still the leading factor in China’s transitional economy, and they provide useful and available measures of internal innovation at the firm level (Hitt, Hoskisson, Johnson and Moesel, 1996) that offer a possibility for testing the resource-based view of the firm.
Introduction

Data distribution

In this study, 3843 innovating firms were included as the final usable samples. Among these firms, 2131 firms located in high economic development regions characterized by high annual growth rate of per capita GDP, while 1712 firms located in low economic development regions. The sample also covered 809 firms in high technology-intensive industries, 1631 in medium-high technology-intensive industries, 559 in medium-low technology-intensive industries, 361 in low technology-intensive industries and 484 in extremely less technology intensive industries. If look at the ownership, 1854 firms were state-owned enterprises (SOEs), 1385 firms were domestic non-SOEs, and 604 firms were international joint ventures (IJVs). The distribution and profile of sample firms will be further discussed in Chapter Six.

Data analysis methods

Multivariate data analysis methods are used through this thesis. The first step of data preparation focuses on adjusting the variables to reflect innovation capabilities and firm performance. Reliability and validity are assessed by using factor analyses.

Multiple regression models with explanatory variables of innovation capabilities and performance consistent with the resource-based view of the firm are developed to test the relevant hypotheses. Multiple regression analysis is a general statistical technique widely used in the literature to analyze the relationship between a single dependent variable and several independent variables (Hair, JR., Anderson, Tatham and Black, 1998). These models are based upon the assumption that each performance dimension is a linear function of innovation capabilities, environmental and organizational factors, and relevant control variables.

A flow chart depicting the various methodological steps in this thesis is shown in Figure 1.1 on page 27. First, the relevant literature related to the determinants of firm performance, firm performance, innovation capabilities, and the relationship between innovation and firm performance are reviewed in Chapter Two and Chapter Three. Second, a research framework is built up and relevant hypotheses are developed based upon the resource-based view of the firm and the chain-link model of innovation in Chapter Four and Chapter Five. Third, empirical data
are selected. Fourth, a pilot test and relevant statistical analyses are conducted. Fifth, innovation capability dimensions and firm performance dimensions are employed. Sixth, relevant factor analyses along with reliability and validity testing are carried out. Chapter Six, Research Methodology, will present the details of data selection, operationalizations of variables and analytical methods. Finally, the main effects of innovation capabilities and the interactive effects of innovation capabilities, as well as the moderating effects of environmental and organizational factors are tested by using multiple regression analysis in Chapter Seven.

1.6 Main Results and Conclusions

The data analyses produce two general results. First, the study leads to the development of an analytical framework that integrates firm-level innovation theories and the resource-based view of the firm (RBV). This provides the theoretical underpinnings to examine the impact of what are defined here as firm inwardly idiosyncratic innovation capabilities on firm performance in China's transitional economy. The results suggest that for Chinese industrial firms operating in a significant economic transforming environment, the RBV is also an appropriate analytical way of explaining the sources of firm performance. Second, the empirical findings indicate that in the period of China's economic transition, innovation capabilities in terms of R&D capability, absorptive capability of external technology resources, product development capability, process innovative capability, manufacturing capability and marketing capability play significant and distinctive roles in achieving firm financial, market and innovation performance in Chinese industrial firms. Moreover, the impact of innovation capabilities on firm performance is also influenced by different environmental and organizational conditions characterized by a transitional economy in which innovation capabilities are applied. These findings also support the argument developed in this thesis that the interactions between innovation capabilities as well as the interactions between innovation capabilities and other specific environment factors are more important than separate capabilities themselves in enhancing firm performance. Within this general set of findings, the study reveals ten specific observations.
First, R&D capability is a key determinant of firm performance. Whatever performance objective that firms focus on, strengthening internal R&D capability such as the development of R&D financial and human resources is a clearly strategic priority for Chinese industrial firms to achieve superior performance.

Second, absorptive capability of external technology can help the firm draw on new or existing technologies and products needed for short-term market performance. However, the reliance on external technology might hinder the firm’s internal independent development of new products, because external technology resources may not yield tacit knowledge and firm-specific innovation.

Third, product development capability and process innovative capability may be capable of propelling a firm into an advanced position of innovation and market. However, Chinese firms need to further exert themselves in aligning product and process innovation and transforming innovation outcomes into profit-making (financial performance) resources.

Fourth, manufacturing capability in terms of the improvement of manufacturing methods and technologies through advanced technology and equipment introduction is less likely to be effective on improving firm performance. This is due to the limited value derived from introduced technologies and the lack of alignment and fitness between introduced technologies and firms’ production demands and conditions. How to integrate introduced technologies and equipment with effective manufacturing capability development should be a strategic issue for Chinese firms.

Fifth, marketing capability in terms of the breadth of market network development may provide a firm with the potential to obtain more market information to successfully produce new products. However, it is necessary but not sufficient to lead to superior financial performance. This is because broader development of marketing network enlarges innovation cost. This can have a tendency to reduce short-term financial performance.

Sixth, the interaction of R&D capability and marketing capability has a positive impact on innovation performance but has a non-monotonic negative relationship with financial
performance. This result indicates that internal technology development based on great market information would lead to successful new product development. Therefore, the development of marketing capability should be involved from the beginning of innovation. On the other hand, a major feature of this observation is that Chinese firms are likely to orient their internal R&D activities to lower competitive and less R&D-intensive markets such as local markets rather than international markets to achieve superior financial performance. This is because of the lack of internal R&D resources and weak risk-taking abilities in Chinese firms.

Seventh, this study reveals the influence of regional development variation. In regions with higher economic development and more competitive environments, firms pay more attention to R&D capability and product development capability than to other innovation capabilities in order to enhance firm performance. In contrast, in lower development regions, firms emphasize more on absorptive capability of external technology and process innovative capability, which are likely to be associated with less complex technology (Lall, 1994) to improve firm performance. This is due to the lack of internal technology development and relatively rich external technology resources in these regions in China.

Eighth, the study reveals some specific policy implications. For Chinese industrial firms undergoing significant change, innovation policy support is important for a firm to build its innovation capabilities and link them to firm performance. However, Chinese firms may not win sufficient government resources through existing innovation policies because of the weak ability of firm internal technology development and a relatively low qualification of policy implications.

Ninth, innovation capabilities have a significant impact on firm performance in both high technology-intensive and low technology-intensive industries. For example, improving R&D input provides potential for improving financial performance in medium technology-intensive industries. However, R&D capability could not lead to expected financial performance in high technology-intensive industries because of a longer lag to obtain financial return on R&D and the lack of complementary resources in Chinese firms. Product development capability is the
most important determinant of firm performance among firms in high technology-intensive industries. It is therefore important for firms in high technology-intensive industries to consistently improve product development capability with the objective of creating radical new products. Absorptive capability and process innovative capability are more effective on enhancing firm performance among firms in low technology intensive industries.

Tenth, the findings throw some new lights on innovation processes in firms with different ownership. International joint ventures (IJVs), for example, tend to conduct less R&D outside their home base. Instead, they pay more attention to absorptive capability and product development capability in order to achieve market performance in local markets. In contrast, domestic firms including state-owned enterprises (SOEs) and non-SOEs are more likely to use process innovative capability as an appropriate asset to achieve market performance. In general, innovation capabilities seem to be not as important as expected in driving innovation performance in entrepreneurial firms like non-SOEs and IJVs in China.

1.7 Outline of the Thesis

In order to examine the impact of firm internal specific innovation capabilities on firm performance in Chinese industrial firms, especially address research questions mentioned in section 1.2, this study is organized into two parts. The first part is concerned with the conceptual development and the establishment of research framework. It includes Chapter One through to Chapter Five. Chapter One provides an overview of the study, including research background; research objectives; research questions; justification of research; key concepts and hypotheses; research methodology and main findings of data analyses. Chapter Two reviews the literature on theoretical perspectives of the determinants of firm performance underlying the present study with a particular focus on the resource-based view of the firm, as well as on innovation capability concepts and firm performance dimensions. Chapter Three presents the literature review on empirical research concerned with the relationship between innovation and firm performance with an emphasis on the causal relationship between firm strategy, innovativeness, resources, capabilities, activities, and performance. After reviewing relevant theories and empirical studies, Chapter Four proposes a
research framework and details relevant definitions and dimensions of innovation capabilities as well as firm performance. Drawing on the firm-level innovation theories and the resource-based view of the firm, Chapter Five further advances research hypotheses on the impact of innovation capabilities on firm performance.

The second part of the study is focused on methodology, empirical testing of hypotheses, as well as the discussion and conclusions of this study. It includes Chapter Six through to Chapter Eight. Chapter Six describes research methodology in details including the introduction of the technological innovation survey, data selection, variable operationalizations, and the empirical model specifications of data analyses employed in this study. Next, Chapter Seven presents a study that empirically tests relevant hypotheses by using multiple regression models. Finally, Chapter Eight discusses the key findings of data analyses; highlights conclusions of the findings and their theoretical and managerial implications; addresses the limitations of the present study; and outlines future research directions.

1.8 Chapter Summary

This chapter presented the foundation for this study. The introduction of research background suggested that the present study is timely and meaningful. The primary objective of this study is to provide the empirical evidence on how firm internal idiosyncratic innovation capabilities contribute to firm performance in a transitional economy, and how the relationship between innovation capabilities and firm performance is moderated by several environmental and organizational factors. The current study differs from previous research in the literature in several theoretical and methodological ways. The key concepts focus on innovation capabilities and firm financial, market and innovation performance. Specific hypotheses are built up in three groups relating the independent impact of innovation capabilities, the interactive impact of innovation capabilities, and the moderating effect of environmental and organizational factors on the relationship between innovation capabilities and firm performance. Finally, the outline of the thesis makes the present study proceed with a detailed analysis of research.
Figure 1.1 Research Methodology Flowchart of the Thesis

- Literature Review
  - Perspectives on the determinants of firm performance
  - Firm performance
  - Innovation capabilities
  - Impact of innovation on firm performance

- Research framework and hypotheses

- Data selection

- Pilot test

- Statistical analysis

- Measures of firm-level innovation capabilities

- Measures of firm performance

- Factor analyses

- Reliability and Validity

- Relationship and effect analysis: multiple regression analyses
Understanding the determinants of firm performance is a key research area in strategic management. A large number of studies have examined the importance of various firm, industry, and market factors. In the past two decades, the main stream of research in the strategic management literature has shifted empirical studies to examining the significant impact of firm internal specific capabilities and resources on firm performance based on the resource-based view of the firm (RBV) (Helfat, 2000). The RBV proposed a new and standard conceptual framework for understanding firm internal idiosyncratic capabilities and resources as the primary determinants of the heterogeneity of intra-industry firm performance (Hoopes, Madsen and Walker, 2003).

This chapter explores the theoretical literature on the determinants of firm performance, as well as the key concepts, definitions and measures of firm performance and firm-level capabilities as the first step in deriving research framework. This chapter is organized into four sections. The first section discusses theoretical perspectives on the determinants of firm performance, especially the RBV perspective. The purpose of this review is to examine how the determinants of firm performance are currently conceptualized in the literature. The second section presents a review on the definitions and measures of firm performance. The third section then presents the literature review on the definitions and measures of firm-level capabilities related to innovation. These definitions and measures are necessary in advance to identify the differences in firm performance in terms of different innovation capabilities. The last section presents a chapter summary.

2.1 Determining Firm Performance

Why do some firms consistently achieve better performance than others? Understanding the determinants of firm performance differentials has been subject of a central issue and interest to both researchers and practitioners in the area of strategic management (Hawawini,
Subramanian and Verdin, 2003). The previous literature on the determinants and sources of firm performance has accumulated in at least three streams. The first stream, industrial organization economics perspective, explores the factors among industries. The second stream, organizational environment perspective, discusses intra-industry factors. The third stream, the resource-based view of the firm, focuses on firm internal specific resources and capabilities. After a brief review on the first two perspectives, this section typically focuses on the resource-based view of the firm, since it is the most germane to the present study.

**Industrial Organization Economics Perspective**

There has been a huge volume of research in the strategic management literature that has sought to identify the determinants of firm performance. Early research was based upon the perspective of industrial organization (IO) economics, which provided a useful theoretical basis of understanding the determinants of firm performance from external factors. The IO economics perspective provided the structure-conduct-performance (SCP) paradigm (Bain, 1968; Mason, 1939), and its derivative industry structure framework (Porter, 1980). These two models were further defined as Bain-Porter framework (Bain, 1968; Porter, 1980 and 1985) in the literature. The Bain-Porter framework suggests that the firm's external environments such as structures of industries and markets in which the firm operates are key determinants of performance differentials.

Porter (1980) especially discusses the influence of firm strategies such as positioning strategies on raising industry profitability, which is the interaction of five factors: power of suppliers; power of buyers; substitutes; potential entrants; and rivalry. He also defines the strategic objective of a firm as to 'position itself in an industry where it can best defend itself against competitive forces, or at least influence them in its favor' (1980:4). Porter’s more recent work (1991, 1996) focuses on the importance of activities or configuration of activities in determining effective strategy, and more specifically, on having unique activities as a way of resisting the destructive push towards the ‘productivity frontier’ promoted by the desire for operational effectiveness.
Other researchers also discussed the important determinants of firm performance based on the SCP framework. Hansen and Wernerfelt (1989), for example, summarized the major determinants of firm performance as three aspects: (1) characteristics of the industry in which the firm competes; (2) the firm’s position relative to its competitors; and (3) the quality or quantity of the firm’s resources. Specifically, the characteristics of structures of industries or markets can be described such as the number of firms and firm size within an industry, the degree of product differentiation, concentration of suppliers and customers, and barriers to entry.

Empirical research in this stream examined the impact of market structure and industry structural variables on firm performance under the premise that firms do differ in their response to different market and industry structures and environments, in firm performance that results. However, the perspective of IO economics could not provide a rigorous answer to the question about why the performance is still different between firms within an industry when they are in the same industry or market environment (Hawawini, Subramanian, and Verdin, 2003). Moreover, it gave less attention to the dynamic environment (Nelson and Winter, 1982).

Structural characteristics also offer an explanation for Chinese firms’ success. Chinese firms may have better inter-firm relationships or Guanxi, particularly compared with Western firms (Ahlstrom and Bruton, 2001). This may lead to brand awareness, market image and other relationship benefits that will create a sustainable industry position for Chinese firms. However, this is often seen as the only advantage for host country firms in transitional economies, if the human resources cost factor is discounted.

Organizational Environment/Climate Perspective

To explain the intra-industry performance heterogeneity, management researchers have also investigated the determinants of firm performance within a specific industry. This research stream advances the concept of organizational environment/climate, which leads to the difference of organizational behavior within an industrial sector, to account for firm performance variation. This research framework could also be considered as a derivative of IO.
It has produced the argument that intra-industry organizational environment/climate and its associated organizational exchange behavior is the primary source of firm performance (Hansen and Wernerfelt, 1989; Scott, 1992). Despite empirical research that has attempted to capture the performance implications of aspects of organizational environments such as strategic group membership, human resources, decision-making, and organizational strategy, no overall synthesis of concepts and conclusive evidence have emerged from this research stream. The lack of explicit concepts and conclusive evidence lead to less contribution of the organization environment perspective than it can have.

The Resource-Based View of the Firm

Given the weakness to the industrial organization economics perspective and organizational environment approach to generate conclusive evidence on organization performance, empirical studies in the strategic management literature have shifted to examining firm internal resource-based factors (Rouse and Daellenbach, 1999). Following the path-breaking paper by Wernerfelt (1984), the resources-based view of the firm (RBV) has gained considerable currency. The RBV emphasizes the importance of firm specific resources and capabilities, especially resources and capabilities that reside within firms, in explaining differences in firm performance (Barney, 1991; Penrose, 1959; Peteraf, 1993; Wernerfelt, 1984). The popularity of the RBV appears to lie in the premise that firms can control their unique resources and capabilities better than they can control their industry (Rumelt, 1984). Further, today’s markets are highly dynamic and hence market positioning led to, at best, a temporary competitive advantage. The central argument of the RBV is that firm internal idiosyncratic resources and capabilities rather than external factors such as industry and market structures are the primary determinants of firm performance. In particular, the RBV perceives that each firm is a unique bundle of its internal idiosyncratic resources and capabilities (Amit and Schoemaker, 1993; Eisenhardt and Martin, 2000; Grant, 1996; Mahoney and Pandian, 1992; Wernerfelt, 1984).
The notion of ‘idiosyncratic’ is important, as the RBV suggests that only those internal tangible or intangible resources and capabilities, which are valuable, hard to imitate, scarce, and imperfectly substitutable, may lead to superior performance (Barney, 1986, 1991, 2001b; Dierickx and Cool, 1989; Dyer and Singh, 1998; Peteraf, 1993; Reed and Dellippi, 1990; Rumelt, 1984). In other words, a firm can obtain superior performance when it is implementing its valuable resources and capabilities, which are not simultaneously owned or being imitated by other firms (Barney, 1991; Combs and Ketchen JR, 1999; Irwin, Hoffman and Lamont, 1998; Schroeder, Bates and Junttila, 2002). Value and inimitability are the two most important and central characteristics of the RBV (Hoopes, Madsen and Walker, 2003).

However, it is difficult to evaluate the value of capabilities and resources because the determination of the value of capabilities and resources is exogenous (Barney, 2001a; Priem and Butler, 2001). Barney (2001a) defends the RBV by arguing that recent literature (e.g., Barney and Hansen, 1994; Brush and Artz, 1999; Hunt, 1997; McWilliams and Smart, 1995; Miller and Shamsie, 1996) has begun work addressing the value of resources and capabilities with theoretical tools that specify market conditions under which different resources will and will not be valuable. Barney accepts the importance of parameterizing the value variable so that managers may estimate resource value when making strategic decisions about accessing or developing resources. This study aims to contribute to this important discussion by providing a framework enabling managers in Chinese firms may better understand how their firm’s innovation capabilities and resources can generate superior performance.

The distinction between resources and capabilities is also important. In his 1984 paper, Wernefelt suggests that ‘... a firm’s resources at a given time could be defined as those tangible and intangible assets, which are tied semi-permanently to the firm’ (Wernefelt, 1984:173). According to this definition, resources refer to the ‘factors’ which lead to productive activities and valuable services that a firm uses to achieve its objectives (Christensen, 1995; Dutta, Narasimhan and Rajiv, 1999). Resources can be either given exogenously or created within the firm, and they may refer to tangible assets (i.e. equipment) or intangible assets (i.e. knowledge,
human resources). In contrast, capabilities have to emerge from the accumulation and combination of these resources within a firm (Brush and Artz, 1999; Christensen, 1995; Peteraf, 1993; Prahalad and Hamel 1990; Wernerfelt, 1984). Capabilities aim at deploying different resources to affect a desired result (Amit and Schoemaker, 1993; Dutta, Narasimhan and Rajiv, 1999; Grant 1996; Prahalad and Hamel, 1990; Verona, 1999). Hoopes, Madsen and Walker (2003) comment Makadok’s (2001) work on the distinction of a resource and a capability as the clearest one. Makadok (2001) suggests that a capability must be ‘embedded in the organization and its processes,’ and ‘can not easily be transferred from one organization to another without also transferring ownership of the organization itself...’ (2001: 388). In other words, a firm’s capabilities can not exist alone after the firm is dissolved. In contrast, a firm’s resources can be transferred and traded (Hoopes, Madsen and Walker, 2003).

On the other hand, the concepts of resources and capabilities are consistent with each other. As Makadok points out, ‘a ‘capability’ is defined as a special type of resource – specifically, an organizationally embedded nontransferable firm – specific resource whose purpose is to improve the productivity of the other resources possessed by the firm’ (2001:389). For a firm that wants to enjoy superior performance, it has to be able to possess superior and specific capabilities arising from the complex interaction of resources. Some researchers, such as Barney (1991), Combs and Ketchen JR. (1999), Dutta, Narasimhan and Rajiv (1999), use the term resources or capabilities broadly to refer to both resources and capabilities.

Although the RBV emphasizes the importance of firm internal specific capabilities and resources, a specific capability depends on both within-firm decision-making and external factors because they affect the accumulation and value of firms’ capabilities and resources (Combs and Ketchen JR., 1999; Oliver, 1997). For example, manufacturing capability is valuable in industrial sectors but it may not be suitable in service industries. Given this discussion, the present study seeks to determine those innovation capabilities that are most critical for different stages of innovation process and firm performance among Chinese industrial firms.
As mentioned in Chapter one, the RBV perspective has the implications in explaining the importance of innovation capabilities. Theoretically, innovation capabilities are one of the resources used in a firm since resources can be defined as ‘all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness’ (Barney, 1991: 101). In industrial firms, innovation typically focuses on the technological novelty of products and processes, and it is an interaction between market opportunities and the firm’s knowledge base and capabilities (Kline and Rosenberg, 1986; OECD, 1997). These capabilities for innovation exhibit a high degree of ‘tacitness, complexity and firm-specificity’ (Dutta, Narasimhan and Rajiv, 1999). It implies that innovation provides one route to a firm’s unique success that by nature innovation provides outputs that are valuable, rare, imperfectly substitutable, and not easily to be imitated by other firms during a short period. Based on this definition, a firm’s capabilities to innovate could be adequately characterized in terms of the combination of technological resources, and could be considered as one of the firm’s internal specific capabilities that contribute to superior performance. Moreover, as Mahoney and Pandian (1992) summarized, Schumpeterian innovation ‘may be translated into the resource-based framework by considering the firm’s ‘new combinations of resources’ (Penrose, 1959: 85)’ (1992: 369). The theoretical discussion leads to the conclusion that innovation capabilities should be the important determinants of industrial firms’ performance.

Based on the RBV, innovation researchers have empirically examined several types of capabilities related to innovation that can serve as the important determinants of firm performance. For example, the research by Lee and his colleagues (2001) indicates that technological capabilities are important determinants of start-up firms’ performance, since ‘the capabilities comprise patents protected by law, technological knowledge, and production skill that are valuable and difficult to imitate by competitors’ (Lee, et al., 2001: 618). Dutta, Narasimhan and Rajiv (1999) argue that a high technology firm with R&D capability will enjoy
superior performance in the market because an important characteristic of R&D is a significant learning-by-doing effect, which make it difficult for competitors to imitate and replicate.

In summary, this section reviewed three theoretical perspectives regarding the determinants of firm performance. The industrial organization economics model, organization environment/climate perspective and the resource-based view of the firm emphasize the range of determinants of firm performance. The shift in perspectives over time from industrial organization economics, to organization environment/climate, to the resource-based view of the firm reflects a shift in focus: firstly on industry factors, secondly on firm external factors within an industry, and more recently on firm internal factors. In fact, the resource-based view of the firm has been receiving considerable attention in strategic management research. It provides a useful and standard framework for explaining the heterogeneity of firm performance and sustainable competitive advantages based on firm internal specific resources and capabilities (Hoopes, Madsen and Walker, 2003). More importantly, the resource-based view of the firm is consistent with and complementary to IO perspective in both theoretical and methodological areas (Mahoney and Pandian, 1992).

The literature that has emerged from the resource-based view of the firm also suggests that innovation capabilities, the subject of this study, are the important determinants of firm performance in industrial firms, because of their characteristics of firm-specificity, complexity, as well as imperfect imitation and substitutability. Therefore, the present study draws on the resource-based view of the firm as the theoretical model to examine the impact of innovation capabilities on firm performance in Chinese industrial firms.

The use of performance measurement is an important characteristic of research in strategic management (Havavini, Subramanian and Verdin, 2003). The next section provides a review of concepts and research approaches for measuring firm performance.

2.2 Measuring Firm Performance

Organizational performance has been a core analytical concept in the strategic management literature (Venkatraman and Ramanujam, 1986). Performance provides
information about the current well-being of a firm, its ability to react to unforeseen opportunities in the environment, to meet its maturing financial obligations, and the firm's basic position with respect to its creditors (Montgomery and Thomas, 1988). Given the importance of organizational performance, it is necessary to establish robust and replicable conceptual definitions and measures. The literature offers a variety of descriptions and perspectives of firm performance. *Economic perspectives,* for example, treat organizational performance such as profitability as the ultimate goal of all organizations (Damanpour, Szabat and Evan, 1989).

From the *strategic management perspective,* performance reflects an achievement of different strategic goals (Miller, 1988), where performance implications are implicitly or explicitly underscored in examining a variety of content and process issues of strategy (Venkatraman and Ramanujam, 1986). On the other hand, from a *systems perspective,* performance is the ability of a firm to cope with all four systemic processes: inputs, outputs, transformations, and feedback effects, relative to its goal-seeking behavior (Damanpour and Evan, 1984; Evan, 1976). Given the different perspectives, there are consequently no common terminology and definitions for performance, although the volume of research on this topic is increasing.

The present study aims at examining the impact of internal innovation capabilities on firm performance in Chinese industrial firms. In view of the complexity of performance definition, the literature review on performance focuses on the measurement of firm performance and provides a foundation on which this study will be based.

Performance measurement is one of the most important issues and critical challenges facing researchers and firm managers (Ittner and Larcker, 1998; Simerly and Li, 2000). Consistent with the variety of performance definition, the strategic management literature also suggests that firm performance is a 'complex multidimensional construct', which varies with one's vantage and method of measurement (Cameron and Whetten, 1983; Chakravarthy, 1986; Damanpour and Evan, 1984; Kaplan and Norton, 1996; Montgomery and Thomas, 1988; Slater and Olson, 2000; Walker and Ruekert, 1987a). Moreover, the common recognition of firm performance measurement is that there is no commonly accepted set of performance variables.
or models (Biggadike, 1976; Damanpour and Evan, 1984; McGee, Dowling and Megginson, 1995; Simerly and Li, 2000). Hofer (1983) points out that '... it seems clear that different fields of study will and should use different measures of performance because of the differences in their research questions’ (p. 44).

However, research on firm performance has traditionally relied on some firm performance measures. For example, according to the measurement method, they are divided into financial measures and non-financial measures. From a statistical view, firm performance measures include qualitative and quantitative indicators.

**Financial Measures vs Non-financial Measures**

As far as the approach to measuring firm performance is concerned, Venkatraman and Ramanujam, 1986 summarizes two kinds of measures, which have dominated performance measurement in the literature: (1) financial measures and (2) non-financial (operational) measures.

**Financial measures** focus on the use of simple economic or accounting-based indicators to reflect the achievement or fulfillment of economic goals of the firm. The frequently used indicators in the literature include profitability, sales growth, return on investment, return on sales, return on assets, return on stock, etc. Financial measures are the dominant approach used in the empirical strategic management research (Irwin, Hoffman and Geiger, 1998; Venkatraman and Ramanujam, 1986).

Although firms have traditionally relied on financial measures (Ittner and Larcker, 1998), there is a general consensus in the literature that a broader measurement of performance is required that includes indicators of non-financial performance, since firms generally seek multiple goals in addition to financial goals.

**Non-financial measures** examine a variety of strategy content and the extent to which the firm strategies achieve. Non-financial/accounting measures are ‘forward looking’ indicators that provide information about ‘future’ performance (e.g., Ittner and Larcker, 1998). Empirical studies examining non-financial performance in the strategic management literature have
focused on several aspects of performance measurement such as *market/customer-based performance measure*, *technology/innovation-based performance measure* and *internal firm operation as outcome indicators*.

Market performance measures emphasize factors such as market share, customer satisfaction and market goals achievement (Banker, Lee, Potter and Srinivasan, 1996; Delaney and Huselid, 1996; Slater and Olson, 2000). Among the market performance measures, market share, to some extent, is assumed to be a determinant of profitability, and it focuses on economic outcomes (Buzzell, Gale and Sultan, 1975; Delaney and Huselid, 1996; Venkatraman and Ramanujam, 1986).

A large body of empirical research in the literature has addressed the issue of technology/innovation performance. Technology/innovation performance measures are used to evaluate technology development and innovation effectiveness of a firm. Specifically, innovation performance can be measured in terms of innovation outcomes such as new product development success at both project and firm level (Atuahene-Gima, 1995; Barczak, 1995; Cooper, 1999; Gatignon and Xuereb, 1997; Kahn, 1996), and patents (Ahuja and Katila, 2001).

**Quantitative Indicators vs Qualitative Indicators**

From the view of statistical method, two kinds of indicators can be found to measure firm performance in the economics and strategic management literature: *quantitative (or objective)* and *qualitative (or subjective)* indicators.

For *quantitative (objective)* indicators, frequently used variables in the literature include economic-based variables, such as sales growth, profitability, asset growth, market share; and accounting-based variables, such as return on sales, return on assets, return on investment, etc. Table 2.1 presents some examples of quantitative measures of performance at firm level adopted in recent studies.

For *qualitative (subjective)* methods, there are various evaluation criteria based on different research issues and purposes. Nicholson, Rees and Brooks-Rooney (1990), for example, use four criteria to examine firm performance in the UK wool textiles industry: (1)
financial viability; (2) market security; (3) capacity to withstand change; and (4) ability to attract and retain staff. Moreover, a popular qualitative method is to use measures of subjective ranking of effectiveness obtained through questionnaires or interviews (Gopalakrshnan, 2000). In this approach, respondents are asked to evaluate the performance of their firms based on specific questions or factors on a Point-Likert scale (usually 5, 7, 9 or 11-point-likert scale). Higher scores reflect the higher performance. For example, Delaney and Huselid (1996) evaluate firm performance by asking the question 'how would you compare the firm's performance over the past 3 years that do the same kind of work' at important issues such as product quality, customer satisfaction, and new product development. Homburg, Krophmer and Workman JR. (1999) introduce perceptual measures of performance related to effectiveness and efficiency. Relevant questions solicit responses from items such as: adapting your marketing strategy adequately to changes in competitors' marketing strategies; achieving customer satisfaction; earning profits; and so on.

Table 2.1 Examples of Quantitative Measures of Firm Performance Used in Pervious Studies

<table>
<thead>
<tr>
<th>Studies</th>
<th>Industry or firms</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Lee, K. Lee and Pennings (2001)</td>
<td>1012 technology-based ventures in South Korea</td>
<td>Sales growth (E)</td>
</tr>
<tr>
<td>Lu and Beamish (2001)</td>
<td>164 SMEs in Japan</td>
<td>Return on assets (A); Return on sales (A)</td>
</tr>
<tr>
<td>Simerly and Li (2000)</td>
<td>700 large U.S firms</td>
<td>Return on assets (A); Return on investments (A)</td>
</tr>
<tr>
<td>Thomsen and Pedersen (2000)</td>
<td>2610 largest European companies</td>
<td>Market-to-book value of equity (E); Return on assets (A); Sales growth (E)</td>
</tr>
<tr>
<td>Pan and Chi (1999)</td>
<td>1066 foreign manufacturing enterprises in China</td>
<td>Level of profitability (E)</td>
</tr>
<tr>
<td>Hitt, Hoskission and Kim (1997)</td>
<td>295 manufacturing firms</td>
<td>Return on assets (A); Return on sales (A); Return on equity (A)</td>
</tr>
<tr>
<td>Davidson III, Worrell and Fox (1996)</td>
<td>51 U.S. firms</td>
<td>Profit margin (net income divided by net sales revenue) (E); abnormal stock returns (A)</td>
</tr>
<tr>
<td>Lawless and Anderson (1996)</td>
<td>U.S. microcomputer industry</td>
<td>Market share (E)</td>
</tr>
<tr>
<td>McGee, Dowling and Megginson (1995)</td>
<td>210 firms in communication equipment and electronic components, office and computing machines, and professional and scientific instruments sectors in U.S.A</td>
<td>Average sales growth (E)</td>
</tr>
<tr>
<td>Cowley (1988)</td>
<td>828 companies in U.S. A</td>
<td>Return on sales (A); Return of total capital (A)</td>
</tr>
</tbody>
</table>

E: economic-based indicators
A: accounting-based indicators
However, as many researchers have pointed out that each variable or method of performance measurement has strengths and weaknesses (Damanpour and Evan, 1984; McGee, Dowling and Megginson, 1995; Lee, Lee and Pennings, 2001). For example, on the one hand, financial measures of performance commonly used in the strategic management literature provide researchers with information about the current well-being of a firm, but they are not relevant to firm strategy level (Slater and Olson, 2000). Moreover, to some extent, financial measures are influenced by firm-specific financial reports and they are too aggregated to reflect firm managerial actions (Ittner and Larcker, 1998; Jayaraman, Khorana, Nelling and Covin, 2000). On the other hand, it seems that non-financial measures of performance are more appropriate than financial ones because they focus more on specific strategy issues such as firm internal operations, learning and growth. However, compared with financial measures, non-financial measures depend upon the specification of questions or items. Different focuses on questions and items about a performance measure may lead to different results.

To compensate for the weaknesses in each measure, many researchers suggest multiple financial and non-financial performance measures, as well as using a combination of quantitative and qualitative methods for firm performance evaluations (Damanpour and Evan, 1984; Ittner and Larcker, 1998; Venkatraman and Ramanujam, 1986). Jones, Lanctot and Teegen (2000), for instance, measure firm performance through three dimensions: finance-related (financial measure), product- and market-related measures (non-financial measure) in their study on the relationship between firm performance and technology acquisition.

In sum, this section addresses the question of how to measure firm performance by reviewing the distinctions and uses of firm performance measurement. The conclusion is that while firm performance measurement is a critical issue in the literature, no single measure may fully explicate all aspects of firm performance. The large body of research in the literature suggests that firm performance measures should be appropriate for the specific research question being posed. In some cases, multiple dimensions should be adopted.
In order to better understand firm performance, firm performance measures should consider financial as well as non-financial measures, as Venkatraman and Ramanujam's framework of measurement of firm performance in strategy research has suggested. Their framework provides a useful classificatory scheme for measuring firm performance using financial and non-financial measures.

Based on the literature review of firm performance measurement, and due to the purpose of the research, the present study considers both financial and non-financial measures of firm performance, and focuses on three aspects of performance: financial; market; and innovation performance. The multidimensional measures of performance adopted in this study include both objective and subjective criteria. The present study is concerned with the relationship between innovation capabilities and these three aspects of firm performance described above.

Innovation capabilities are firm level capabilities, but can be one of many forms of capabilities. The following section will discuss the relevant definitions and measures of firm-level capabilities.

2.3 Defining Innovation Capabilities at Firm Level

The review of the RBV literature found many abstract conceptualizations of capabilities and resources, which have a potential to contribute to firm competitive advantage and superior performance (Oliver, 1997). These conceptualizations include such as: strategic assets (Amit and Schoemaker, 1993); reputation, buyer-supplier relationships, tacit knowledge, R&D expertise, and technological capabilities (Barney, 1991; Mahoney and Pandian, 1992; Schoemaker and Amit, 1994); 'idiosyncratic physical, human, and intangible resources' (Mahoney and Pandian, 1992); trade contracts, efficient procedures, access to capital (Wernerfelt, 1984); information technology (Mata, Fuerst and Barney, 1995); strategic planning (Powell, 1992a); organizational alignment (Powell, 1992b); human resource management (Flood, Smith & Derfus, 1996); trust (Barney and Hansen, 1994); organizational culture (Oliver, 1997); and top management skills (Castanias and Helfat, 1991).
However, in the innovation and strategic management literature, there is little evidence of research that has clearly defined innovation capabilities. One possible reason is that innovation covers a broad spectrum of technological, economic, and managerial behaviors in a firm. Thus, similar to firm performance, no single concept of innovation capability may fully reflect all aspects of innovation. Several concepts and terms frequently discussed in the literature such as dynamic capability, technological capability, absorptive capability, R&D capability, new product development capability, marketing capability, combinative capability, innovative capability, seem to all relate to the concept of innovation capabilities. This section reviews some of these related capabilities.

2.3.1 Dynamic Capabilities

Teece and Pisano (1994) develop the *dynamic capability approach* to confront the question as to how firms achieve and sustain competitive advantage. They define dynamic capabilities as 'the subset of the capabilities which allow the firm to create new products and processes and respond to changing market circumstances' (Teece and Pisano 1994: 541). Dynamic capabilities emphasize the capacity to renew competence (Teece, Pisano and Shuen, 1997), as well as 'to integrate, reconfigure, gain and release resources – to match and even create market change.' (Eisenhardt and Martin, 2000: 1107). As Teece, Pisano and Shuen (1997) point out, the dynamic capability approach is closely related to innovation-based competition based on Schumpeterian innovation theory. In particular, dynamic capabilities reflect a firm's ability to find and solve new problems as well as 'achieve new and innovative forms of competitive advantage' (Teece et al., 1997: 516). Moreover, the dynamic capability approach emphasizes not only the capabilities but also the mechanisms through which firms accumulate these capabilities (Deeds, DeCarolis and Coombs, 1999). There has been extensive empirical research associated with dynamic capabilities. For instance, Helfat (1997) has carried out an empirical investigation of dynamic capability accumulation by describing the changing conditions of R&D capabilities in the U.S. petroleum industry. Eisenhardt and Martin (2000) argue that dynamic capabilities are a set of specific and identifiable processes such as product
development, strategic decision-making and alliancing. These studies on dynamic capabilities emphasize a firm's ability to achieve new and innovative forms and the links between capabilities and changing environments, such as market dynamism.

2.3.2 Technological Capabilities

In the resource-based view of the firm, technological capabilities are regarded as the fundamental determinant of sustainable competitive advantage (Lee, et al., 2001). Especially for innovation performance, technological capabilities are the most important driven-force (Verona, 1999). The literature reveals that many empirical studies regarding technological capabilities have been carried out and that have been a variety of ways to define and classify technological capabilities.

For example, Fransman (1984) suggests a six-classification of technological capabilities. In his classification, technological capabilities are defined as a firm's ability to: (1) search for available technological alternatives and select the appropriate ones; (2) dominate the selected technologies, and efficiently use them for transforming inputs into outputs; (3) adapt technologies to specific conditions of production and local demand; (4) achieve subsequent improvements through incremental innovations; (5) institutionalize R&D activities; and (6) carry out basic research activities.

Lall (1994) proposes a matrix to categorize firm-level technological capabilities (Table 2.2). In the row of the matrix, technological capabilities are classified into basic, intermediate and advanced capability defined by degree of complexity or difficulty of technology. Basic capabilities arise from experience-based activities, intermediate capabilities are accumulated by search-based experience activities such as adoptive activities of technology, and in turn, advance capabilities are developed through research-based efforts such as innovative activities. In addition to the degree of complexity or difficulty, the columns of the matrix present three categories of technological capabilities: investment capability; production capability; and, linkage capability regarding their technical functions in facilitating particular activities. Among these, linkage capabilities refer to 'skills needed to transmit information, skills and technology
to, and receive them from, component or raw material suppliers, subcontractors, consultants, service firms, and technology institutions' (Lall, 1994: 269).

### Table 2.2 Matrix of Technological Capabilities (Lall, 1994: 268)

<table>
<thead>
<tr>
<th>Degree of Complexity</th>
<th>Pre-investment</th>
<th>Project execution</th>
<th>Process engineering</th>
<th>Product engineering</th>
<th>Industrial engineering</th>
<th>Linkages within economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>Simple, routine (Experienc e-based)</td>
<td>Prefeasibility studies; site selection; scheduling of investment</td>
<td>Civil construction; ancillary services; equipment erection; commissioning</td>
<td>Debugging; balancing; quality control preventive maintenance; assimilation of process technology</td>
<td>Assimilation of product design; minor adaptation to market needs</td>
<td>Work flow; scheduling; time-motion studies; inventory control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Local procurement of goods and services; information exchange with suppliers</td>
</tr>
<tr>
<td></td>
<td>Adaptive, duplicative (Search-based)</td>
<td>Search for technology source; negotiation of contracts; bargaining suitable terms; info. systems</td>
<td>Equipment procurement; detailed engineering; training and recruitment of skilled personnel</td>
<td>Equipment stretching; process adaptation and cost saving; licensing new technology</td>
<td>Product quality improvement; licensing and assimilating new imported product technology</td>
<td>Monitoring productivity; improved coordination</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Technology transfer of local suppliers; coordinated design; S&amp;T links</td>
</tr>
<tr>
<td></td>
<td>Innovative, risky (Research-based)</td>
<td>Basic process design; equipment design and supply</td>
<td>In-house process innovation; basic research</td>
<td>In-house product innovation; basic research</td>
<td></td>
<td>Turnkey capability; cooperative R&amp;D; licensing own technology to others</td>
</tr>
</tbody>
</table>

Based on Lall's (1994) classification of technological capabilities, some researchers categorize technological capabilities into *operational capabilities* and *innovation capabilities* (e.g., Lall, 2000; Costa, 2001). Operational capabilities refer to learning capability as well as skills and knowledge required for using technologies. They are associated with basic and intermediate capabilities. In turn, innovation capabilities refer to the ability to develop new technology and to understand the principles of technology. Innovation capabilities are related to advanced capabilities, and then they are taken as a proxy for more complex capabilities (Costa, 2001).
However, the notion of innovation capabilities used in the present study is different from the above classification. Innovation capabilities refer to not only ‘advanced’ capabilities but also ‘basic’ and ‘intermediate’ capabilities. This is because ‘advanced’ capabilities are based on ‘basic’ and ‘intermediate’ capabilities. On the other hand, ‘basic’ or ‘intermediate’ capabilities can be research-based capabilities. For example, a firm’s absorptive capability, which is classified into ‘intermediate’ capability category in Lall’s (1994) matrix, has very close relationship with R&D, which is regarded as an advanced capability. A firm’s absorptive process does not simply bring outside technologies into the firm. It emphasizes the acquisition and absorption of adequate and suitable resources and technologies. This absorption of adequate technologies is associated with a firm’s previous R&D and technology stocks (Cohen and Levinthal, 1990). Therefore, to some extent, the boundaries among ‘basic’, ‘intermediate’ and ‘advanced’ capabilities are not distinguishable.

Other similar approaches to defining technological capabilities can be found in the literature. For example, Dollinger (1995) suggests that technological capabilities comprise technological knowledge, know-how generated by R&D and other technology-specific intellectual capital. Verona (1999) summarizes previous empirical studies on technological capabilities to propose that technological capabilities should include R&D (scientific expertise), manufacturing (process innovation), design and technological complementarities.

From these studies, the usual definition of technological capabilities concentrates on skills, knowledge and experience required by firms to choose, assimilate, adapt, modify and improve existing technologies as well as to develop new technologies (Albaladejo and Romijn, 2000). They are directly or indirectly related to innovation. The definitions and classifications of technological capabilities are helpful for giving more precision to the definition of innovation capabilities discussed in this study.

2.3.3 Innovation Capabilities

Innovation has been cited as one of the critical resources and capabilities that affect firm sustainable competitive advantage and superior performance. Yet, despite widespread
agreement about their benefits, innovation capabilities are still poorly understood and the
definition remains inexplicit. Although a few empirical studies discussed the definitions and
categories of firm-level innovation capabilities as a whole, no authoritative definition of
innovation capabilities has emerged so far.

Christensen (1995), however, has provided helpful analytical categories of innovation
capability. For example, he proposes a framework for analyzing four categories of technological
innovation assets: scientific research assets; process innovative assets; product innovative
application assets; and aesthetic design assets. The author uses the term ‘asset’ to signify both
innovation resources and innovation capabilities, and argues that innovation requires specific
combinations of different innovation asset types to make it successful. In this regard, scientific
research assets refer to the stock of scientific knowledge and new research. They include pure
scientific research and applied scientific research, which ‘comprises the processing and
exploiting of existing scientific knowledge for specific technical tasks within the innovation
process’ (Christensen, 1995: 731). Process innovative assets refer to capabilities not only
related to technological process innovation but also to organizational and managerial innovation
such as quality control and management structure. Product innovative application assets imply
capabilities and resources required to conducting product development activities. Aesthetic
design assets reflect market trends in taste and fashion. They involve interaction with marketing
and focus not only on integrated industrial design approach but also on style, fashion and artistic
expression.

Following Christensen’s framework, Sen and Egelhoff (2000) discuss the nature of
innovative capabilities reported by product innovative capabilities and process innovative
capabilities and examine the relationship between innovation capabilities and technical alliance
in the semiconductor industry. They propose that product innovative capabilities include
incremental and radical product R&D capability, while process innovative capabilities include
incremental and radical process R&D capability.
Neely and Hii (1998) point out that *innovative capability* is often cited in the literature although its definition is implicit. Based on their literature review, the authors consider innovative capacities as a firm's potential to generate innovative outputs. They further define innovative capability in detail as 'the internal potential of a firm to generate new ideas, identify new market and technological opportunities, and implement innovations by leveraging resources and capabilities' (Neely and Hii, 1998: 7). According to their perspective, innovative capacity is built on four interrelated dimensions: *culture; resources; competence; and networking*.

Albaladejo and Romijn (2000) regard innovation capability as a crucial type of technological capability. Consistent with their technological capability definition, they define innovation capability as the ability to improve and modify existing technologies and to develop or create new technologies. The authors also suggest that innovation capabilities are enhanced through internal and external sources. Internal sources include internal learning, investments in formal R&D, informal experimentation, processes and organization, in-house staff training and so on. External sources refer to suppliers, customers, public institutions and industry associations. The authors argue that the purpose of interaction with these sources is to gather information about technologies and markets as well as to obtain other complementarities such as external staff training and consulting services.

While the above discussion concerns the overall definition of innovation capabilities, many researchers emphasize instead several particular measures of capabilities associated with innovation. The review indicates that innovation process is a complex process and needs to integrate various capabilities. However, it is impossible and not necessary to capture all characteristics of innovation process to provide an overall definition of innovation capabilities. This study follows this approach to review several capabilities related to innovation. This is because the present study aims at examining the relationship between innovation capabilities and firm performance rather than provide a conceptual definition of innovation capability.
The chain-link model suggests that innovation process is an interaction of capabilities needed by different sub-processes: the creation of new knowledge and new ideas; invention; product analytical design; pre-testing; detailed design; production; as well as the distribution and marketing (Kline and Rosenberg, 1986; OECD, 1997). Several firm level capabilities discussed in the literature are associated with these sub-processes of innovation such as R&D capability, absorptive capability, product development and process innovation capability, manufacturing capability and marketing capability.

**R&D Capability**

R&D capability is often regarded as a proxy for innovation (Hitt, Hoskisson and Kim, 1997). A large number of empirical studies have confirmed that R&D capability, especially R&D investment capability such as R&D intensity in terms of R&D expenditure as a percentage of total sales is significantly associated with innovation and firm performance (Ballot, Fakhfakh and Taymaz, 2001; Baysinger and Hoskisson, 1989; Ettlie, 1998; Franko, 1989; Hitt and Hoskisson, 1988; Ito and Pucik, 1993; Patterson, 1998; Pisano, 1990; Zif and McCarthy, 1997).

In conceptualizing R&D capability, Pisano (1990) suggests that R&D capabilities are critical determinants of ability in a firm to develop and exploit technological know-how. Relying on March's (1991) notions of exploration and exploitation, Lukas and Bell (2000) define R&D capability as the ability of idea generation (exploration) and product extension (exploitation). In details, exploration refers to searching and experimenting for new knowledge, while exploitation refers to capitalizing on existing knowledge.

On the other hand, although not all R&D would lead to successful innovation and superior performance especially short-term performance because of its nature of high-risk, R&D increases a firm's stock of knowledge and technologies (Cohen and Levinthal, 1990). To a large extent, sustained innovation and long-term performance are based on a firm's effective accumulation and exploration of knowledge and technologies. Thus, R&D capability is a useful proxy of innovation and firm performance.
Absorptive Capability

Drawing from previous studies of the role of outside knowledge on innovation (e.g., Brock, 1975; Mansfield, 1968; Von Hippel, 1988; Westney and Sakakibara, 1986), Cohen and Levinthal (1989, 1990) develop the absorptive capacity theory and point out that absorptive capacity which is related to exploitation of external knowledge is a critical component of innovation capabilities. They define absorptive capacity as a firm’s ability ‘to recognize the value of new information, assimilate it, and apply it to commercial ends’ (Cohen and Levinthal, 1990: 128). They argue that absorptive capability of the firm is largely associated with prior related knowledge and is determined by the stock of prior knowledge such as investment in R&D. They further emphasize the importance of R&D in ‘creating a capability to assimilate and exploit new knowledge’ (1990: 148). By using R&D spending, they find the empirical support that R&D investment is a proxy for a firm’s willingness to invest in absorptive capacity.

Based on Cohen and Levinthal’s theory of absorptive capacity, some researchers have also explored some specific determinants of absorptive capability in their particular empirical studies. For example, Lane and Lubatkin (1998) distinguish ‘student’ and ‘teacher’ firms in their empirical research on alliances. They propose that a student firm’s absorptive capability depends on ‘the specific type of new knowledge offered by the teacher firm; the similarity between the student and the teacher firm’s compensation practices and organizational structures and the student firm’s familiarity with the teacher firm’s set of organizational problems’ (1998: 462). Similarly, Lane, Salk and Lyles (2001) suggest that an international joint venture’s (IJV) absorptive capability should include the ability to understand external knowledge (such as trust between IJV’s parents), the ability to assimilate external knowledge (such as IJV flexibility and adaptability), and the ability to apply external knowledge (such as IJV’s business strategy).

More importantly, the above discussion shows that the purpose of assimilating or applying external knowledge and technology is to enhance and complement a firm’s internal technology accumulation. Therefore, absorptive capability has an implication in enlarging innovation stocks through obtaining new valuable information and technology.
Product Development Capability and Process Innovative Capability

Product development capability and process innovative capability are two of the important capabilities in a firm. However, a number of papers discussing the importance of product development and process innovation in the literature refer to product and process innovation themselves, but ignore the capabilities underlying them (Sen and Egelhoff, 2000). Only a few studies give a relatively precise definition to the concept of product development capability and process innovative capability. For instance, Moorman and Slotegraaf (1999) highlight the product technology (development) capability as ‘a firm’s technological ability to formulate and develop new products and related processes’ (1999: 240). Subramaniam and Venkatraman (2001) use the concept of transnational new product development capability to define new product development as the ability to consistently and successfully introduce new products in the markets. Christensen (1995) suggests that process innovative assets refer to capabilities for both ‘hardware’ process innovation and some organizational and managerial assets involved in the development of production system. Sen and Egelhoff (2000) distinguish incremental process innovative capability from radical process innovative capability. They highlight radical process innovative capability as the ability of developing new manufacturing equipment and processes that provide the firm with fundamentally technologies that are at the forefront of the next generation of process technology. While incremental process innovative capability refers to the ability of improving existing manufacturing and process technology and equipment.

Although these previous studies provide a general description for product and process innovation capability, to some extent, they are a one-sided view. For example, Moorman and Slotegraaf’s (1999) definition just emphasized technological ability during the new product development, but did not consider the effectiveness of product development. Subramaniam and Venkatraman’s (2001) definition focused on the market success of new products, but took little account of the main factors lead to successful product development including new products and technologically improved products.
Even the conceptual shortcomings, product development and process innovative capability are important measures of innovation capabilities. This is because the above discussion indicates that they are particularly important to two of Schumpeter's innovation categories new and improved products and processes. In other words, product development and process innovation capability change and strengthen the firm's technology assets (OECD, 1997), and directly lead to the success of technological innovation.

*Manufacturing Capability*

Manufacturing capability is an area of growing concern in the literature. Some researchers have suggested several definitions of manufacturing capability. For example, manufacturing capability in terms of basic dimensions such as cost efficiency, high quality, fast and reliable delivery, and process flexibility is an ability of a firm's production system (Hayes and Wheelwright, 1984; Hill, 1994; Krajewski and Ritzman, 1996; Safizadeh, Pitezman and Mallick, 2000). The major theme of manufacturing capability is the manufacturers' choice of emphasis among key tasks that span a wide range of attributes such as improvement, innovation, integration, acuity, control, agility and responsiveness of production (Swink and Hegarty, 1998). These studies defined manufacturing capability based on the characteristics of general manufacturing processes, but ignored its role on product and process innovation.

In fact, manufacturing capability associated with product and process innovation is an important intangible innovation asset in a firm. It is distinct from the notion of other manufacturing competence. Strong manufacturing capability leads to successful outcomes especially in the redesign and production stage of innovation process. From this standpoint, manufacturing capability is an important dimension of innovation capabilities.

*Marketing Capability*

In both strategic management and marketing literature, increasing interest can be observed in efforts to understand the nature of marketing capability. Marketing capability is considered as the superior ability to identify customers' needs and to understand the factors that influence customers' choice behavior (Dutta, Narasimhan and Rajiv, 1999). For example,
Moorman and Slotegraaf (1999) focus on the capabilities related to product development. They suggest that product-marketing capability refers to the ability to develop and maintain relationships with customers. Based on the literature review of prior empirical studies, Fahy and his colleagues (2000) categorize marketing capabilities into three types: market orientation; the time horizon of firm strategic decisions; and positioning capabilities. Market orientation is the subject of renewed attention in the literature (e.g., Atuahene-Gima, 1996; Han, Kim and Srivastava, 1998; Jaworski and Kohli, 1993; Kohli and Jaworski, 1990). Market orientation broadly refers to the ability to diagnose and respond to customer needs (Hunt and Morgan, 1995) in order to deliver superior value to customers (Slater and Narver, 1994). It consists of three behavioral components: customer orientation; competitor orientation; and inter-functional coordination (Narver and Slater, 1990). The time horizon of a firm’s decision making is an essential aspect of its marketing management culture reflecting its values and beliefs and impacting on the marketing decisions (Fahy, et al., 2000). Positioning capabilities refer to the ability to build a defensible market position, and most popular, capabilities relate to the ability to differentiate on the basis of quality or price of products and services (Porter, 1986).

These studies focus on the relationship with customers, and emphasize the role of marketing factors in understanding customer requirements. Although not all marketing activities are associated with innovation activities and the above studies take little account of innovation-related factors, marketing capability is a part of innovation when its purpose is to implement technologically new or improved products and processes (OECD, 1997). On the other hand, the chain-link model of innovation also indicates that marketing capability and its interaction with capabilities needed by R&D stages are key determinants of the innovation success. Therefore, innovation-related marketing capability especially required to understanding customer requirements and preferences to new products is a useful dimension of innovation capabilities.

2.3.4 Other Capabilities

Besides the concepts of capabilities discussed above, some other capabilities related to innovation are also discussed in the literature. For example, based on previous studies on the
concept of firm capabilities, Leonard-Barton (1992) points out that capabilities are considered *core* if they differentiate a company strategically. From the resources-based view of the firm, he defines the *core capabilities* as a knowledge set that distinguishes and provides a competitive advantage. The content of knowledge set is embodied in employee’s knowledge and skills, technical systems, managerial systems, as well as the values and norms. Nelson (1991) suggests that core capabilities can be linked to a set of skills and search routines developed within firms. Meyer and Utterback (1993) propose that in a product family, core capabilities have four basic dimensions: product technology; understanding of customer needs as reflected by products sold; distribution; and manufacturing. Duysters and Hagedoorn (1996) claim that core capabilities of firm are expected to depend largely on R&D-oriented skill and routines, since technological innovation is an important phenomenon in industries. Similarly, Helfat and Raubitschek (2000) define core knowledge (capability) as scientific or technological that ‘is at the heart of, and forms the foundation for a product or service’ (2000: 963). Prahalad and Hamel (1990) use core competence to describe the core capabilities as ‘the collecting learning in the organization, especially how to coordinate diverse production skill and integrate multiple streams of technologies... the communication, involvement, and a deep commitment to working across organizational boundaries’ (1990: 82).

Following Amit and Schoemaker’s (1993) capability definition, McEvily and Zaheer (1999) define *competitive capabilities* as a firm’s capacity to deploy resources and use organizational processes to achieve a strategic objective. Competitive capabilities focus on the exchange of information, as well as combinations and interactions among the firm’s various resources.

Kogut and Zander (1992) introduce the concept of *combinative capabilities* to describe the processes of getting access to knowledge resources, learning new skills and generating new applications from existing knowledge based on a dynamic perspective. They view the combinative capabilities as the ability to generate new applications from exiting knowledge.
Henderson and Cockburn (1994) give the definition of architectural competence to describe the organizational capacities by which firms require and develop new competencies, such as the control of systems and the culture or dominant values of the organization.

Heterogeneous capability related to innovation can be defined as the ability to introduce new products or technologies into market; it reflects the diversity of technologies that firms possess (Barney, 1991; Sakakibara, 1997).

In brief, this section reviews the definitions of capabilities related to innovation. Table 2.3 on page 57 shows some examples of the capability definitions. Although some of definitions may only be a description of capabilities rather than a conceptual definition, the common characteristic of these definitions/descriptions is that they all emphasize the capabilities required to introduce and create new knowledge and technology in various firm's activities, link with and adapt to environments and circumstances, as well as achieve products, processes and services success in the markets. The current study draws on these concepts to generally define innovation capabilities, and tries to give more prominence and robustness to the overriding concept of innovation capabilities.

The literature review also suggests that innovation is variously defined to fit particular requirements of studies (Damanpour and Evan, 1984). This conceptual characteristic leads to having no extant and common well-articulated dimensions of innovation capabilities in the literature. One reason is that innovation is a broad and complex spectrum (e.g., OECD, 1997). Another reason is that innovation capabilities are also a dynamic concept (e.g., Teece, Pisano and Shuen, 1990), and they are influenced by various firm resources and environments. To some extent, it is difficult to capture and identify precise observable proxies of innovation capabilities. For example, it is difficult to assert that innovation investment or innovation outcome as a proxy of innovation capabilities is better than one another.

Given the difficulty of defining innovation capabilities discussed above, and to sharpen the focus for the present study, the dimensions rather than definitions of innovation capabilities are especially emphasized in this study. More importantly, it is evident that innovation
capabilities are a multidimensional construct, and a unidimensional definition of innovation capabilities may be oversimplifying the construct. This kind of multidimensional analysis is more likely to be useful to understand the characteristics of innovation capabilities required by different stages of innovation process as a whole. Some aspects of innovation capabilities related to different stages of innovation process such as R&D capability, absorptive capability, product development capability, process innovation capability, manufacturing capability and marketing capability are treated separately. This is consistent with most empirical studies reported in the literature.

2.4 Chapter Summary

This chapter discussed several theoretical perspectives on the determinants of firm performance, as well as the key concepts and measures of firm performance and capabilities in the innovation and strategic management literature that are related to the current study.

Section 2.1 discussed three main research perspectives on the determinants of firm performance emerged in the literature: industrial organization economics (IO), organization environment/climate and the resource-based view of the firm (RBV). In particular, the RBV provides a theoretical underpinning and fundamental framework in explaining the differences in firms’ performance in terms of the differences in internal capabilities and resources. The central argument of the RBV is that firm internal idiosyncratic capabilities and resources, which are valuable, scarce, imperfectly substitutable and hard to imitate, define firm durable performance. In the RBV, innovation capabilities are view as the critical determinants of firm performance. The current study will introduce the resource-based view of the firm as a guiding theory.

The literature review in section 2.2 suggested that firm performance is a multi-dimensional concept. Firm performance measures should be based on specific research objectives and questions. In general, there are two kinds of measures of firm performance: financial and non-financial measures; and two methods can be used: quantitative (objective) and qualitative (subjective) measures. In consistence with the purpose of the research, the present study would focus on the measurement of firm performance rather than performance definition,
and would prefer to multiple dimensions of performance including financial, market and innovation performance by using both quantitative and qualitative indicators.

Section 2.3 presented a review of firm-level capabilities related to innovation. The literature did not provide an authoritative definition for innovation capabilities. There are several concepts of capabilities that relate to innovation capabilities such as dynamic capability, technological capability, absorptive capability, R&D capability, product development capability, marketing capability, etc. The definitions of these capabilities emphasize the introduction and creation of new knowledge and technology, but no single concept may reflect all aspects of innovation. The current study will discuss some aspects of innovation capabilities required by different stages of innovation process such as R&D capability, absorptive capability, product development and process innovative capability, manufacturing and market capability.

After reviewing the theoretical perspectives, the next chapter will provide a brief view of some empirical studies on the relationship between innovation and firm performance.
Table 2.3 Examples of Definitions of Firm-level Capabilities

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Concepts</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elsenhardt and Martin (2000)</td>
<td>Dynamic capability</td>
<td>Dynamic capabilities are defined as the firm’s processes that use resources—specifically the processes to integrate, reconfigure, gain and release resources—to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die (2000:1107).</td>
</tr>
<tr>
<td>Teece and Pisano (1994); Helfat (1997)</td>
<td>Dynamic capability</td>
<td>Dynamic capabilities are the subset of the competencies/capabilities, which allow the firm to create new products and processes and respond to changing market circumstances (Teece and Pisano, 1994: 541).</td>
</tr>
<tr>
<td>Teece, Pisano and Shuen (1997)</td>
<td>Dynamic capability</td>
<td>Dynamic capabilities are the firm’s ability to integrate, build, and reconfigure internal and external competence to address rapidly changing environments (1997: 516).</td>
</tr>
<tr>
<td>Lall (1994)</td>
<td>Technological capability</td>
<td>Technological capabilities are the skills needed to transmit information, skills and technology to, and receive them from, component or raw material suppliers, subcontractors, consultants, service firms, and technology institutions (1994: 269).</td>
</tr>
<tr>
<td>Albaladejo and Romijn (2000)</td>
<td>Innovation capability</td>
<td>Innovation capability refers to the ability to make major improvements and modifications to existing technologies, and to create new technologies (2000: 5)</td>
</tr>
<tr>
<td>Neely and Hii (1998)</td>
<td>Innovative capacity</td>
<td>Innovative capacity is the internal potential of a firm to generate new ideas, identify new market and technological opportunities, and implement innovations by leveraging resources and capabilities (1998:7).</td>
</tr>
<tr>
<td>Lukas and Bell (2000)</td>
<td>R&amp;D capability</td>
<td>R&amp;D capability relates to the creative processes of discovering new product (exploration capability), and the extension of existing products (exploitation capability) (2000: 567).</td>
</tr>
<tr>
<td>Cohen and Levinthal (1990)</td>
<td>Absorptive capacity</td>
<td>Absorptive capacity is an ability to recognize the value of new information, assimilate it, and apply it to commercial ends (1990:128)</td>
</tr>
<tr>
<td>Lane and Lubatkin (1998)</td>
<td>Absorptive capability</td>
<td>Absorptive capability is a firm’s ability to value, assimilate, and apply new knowledge from a learning alliance partner, depends upon: (1) the specific type of new knowledge offered by the partner; (2) the similarity between the firms’ compensation practices and organizational structures; and (3) the learning firm’s familiarity with the partner’s set of organizational problems (1998:462).</td>
</tr>
<tr>
<td>Subramaniam and Venkatraman (2001)</td>
<td>Transnational new product development capability</td>
<td>Transnational new product development capability is defined as the ability to consistently and successfully introduce new products simultaneously in multiple country markets (2001: 361).</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Concepts</td>
<td>Definitions</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Safizadeh, Prtzman and Mallick (2000)</td>
<td>Manufacturing capabilities</td>
<td>By manufacturing capabilities, we mean a productions system’s ability to compete on basic dimensions such as quality, cost, flexibility and time (2000: 111).</td>
</tr>
<tr>
<td>Moorman and Slotegraaf (1999)</td>
<td>Product marketing capability</td>
<td>Product marketing capability refers to a firm’s ability to develop and maintain relationships with customers, including both end users and channel members (1999: 240).</td>
</tr>
<tr>
<td>Helfat and Raubitschek (2000)</td>
<td>Core knowledge</td>
<td>Core knowledge is knowledge – often scientific or technological – that is at the heart of, and forms the foundation for, a product or service (2000: 963).</td>
</tr>
<tr>
<td>Leonard-Barton (1992)</td>
<td>Core capability</td>
<td>Core capability is the knowledge set that distinguishes and provides a competitive advantage (1992: 113).</td>
</tr>
<tr>
<td>Prahalad and Hamel (1990)</td>
<td>Core competence</td>
<td>Core competence is communication, involvement, and a deep commitment to working across organizational boundaries (1990: 82).</td>
</tr>
<tr>
<td>Amit and Schoemaker (1993); McEvily and Zaheer (1999)</td>
<td>Competitive capability</td>
<td>Competitive capabilities are defined as a firm’s capacity to deploy resources, usually in combination, using organizational processes to effect a desired end (1999: 1133).</td>
</tr>
<tr>
<td>Kogut and Zander (1992)</td>
<td>Combinative capabilities</td>
<td>Combinative capabilities are defined as the intersection of the capability of the firm to exploit its knowledge and the unexplored potential of the technology (1992: 391).</td>
</tr>
<tr>
<td>Henderson and Cockburn (1994)</td>
<td>Architectural competence</td>
<td>The architectural competence of an organization allows it to make use of its component competencies: integrate them together in new and flexible ways and to develop new architectural and component competencies, as they are required.</td>
</tr>
<tr>
<td>Barney (1991)</td>
<td>Heterogeneous capability</td>
<td>Heterogeneous capabilities related to innovation is the ability to give a firm an advantage in bringing certain types of products or new technologies to market.</td>
</tr>
<tr>
<td>Sakakibara (1997)</td>
<td>Capability heterogeneity</td>
<td>Capability heterogeneity is defined as the diversity of technological capabilities that firms possess (1997: 147).</td>
</tr>
</tbody>
</table>
Innovation capabilities and resources are one of the important idiosyncratic assets among firms. In order to further build on the foundation of the present study, this chapter reviews empirical findings concerning relationships between innovation, especially innovation capabilities and firm performance.

The innovation-performance relationship literature is vast ranging from broad-brush explorations to in-depth case studies across many types of firms. Innovation researchers have tended to examine the relationship between innovation and performance in terms of different concepts, frameworks and theories from various disciplines such as product diversification, management heterogeneity, market orientation, industrial diversification, and strategic management (Damanpour and Evan, 1984; Han, Kim and Srivastava, 1998; Miles, Snow and Shparfman, 1993; Palich, Cardinal and Miller, 2000; Pegels, Song and Yang, 2000). Even though some conflict exists among these studies and most studies only addressed one or a few aspects of innovation such as the adoption of technology or innovations (Irwin, Hoffinan and Geiger, 1998), type of innovation (Damanpour, Szabat and Evan, 1989), technological acquisitions (Ahuja and Katila, 2001), R&D investment (Ito and Pucik, 1993), and innovativeness (Han, Kim and Srivastava, 1998; Lawless and Anderson, 1996), a lot of findings of theoretical and empirical studies indicate that a significant relationship exist between innovation and performance (Armour and Teece, 1978; Damanpour and Evan, 1984; Han, Kim, Srivastava, 1998; Kamien and Schwartz, 1988; Mansfield, 1968).

More importantly, the empirical research findings confirm that innovation is one of the critical and positive determinants of firm performance. For example, Nicholson and Brooks-Rooney (1990) suggest that firms can benefit from generating a climate of innovation, in which new ideas are encouraged. Lawless and Anderson (1996) find that firm performance is affected by its position on new technology relative to others, those ahead on innovation will perform
better. Neely and Hii (1998) point out that innovation enhances business performance because innovation increases firm competitiveness and transforms a firm’s internal capabilities making it more adaptive to change.

However, it should be noted that the innovation and strategic management literature indicate a general lack of empirical studies on the relationship between innovation capabilities/resources and firm performance, especially in transitional economies. Only a few have especially discussed the nature of innovation capabilities as a whole, and empirically explored the relationship between innovation capabilities and performance. Defining capabilities necessary for innovation that contributes to superior performance is a new and important but less addressed issue in the literature.

The starting point for this study is the observation that the firm level innovation-performance research in the literature has followed three streams: innovativeness-performance; innovation strategy-performance; and, innovation capability/resource-performance. Research within each stream centers on particular aspects of innovation and deals with the particular phenomenon of innovation-performance relationship, although there are overlaps in focus across these research streams. For example, all streams investigate how differences of product innovation affect performance. In this chapter, the literature review unpacks some differences between these streams, and outlines how their key concepts and empirical findings can contribute to the research framework developed in this study.

This chapter is divided into five sections. A review of empirical studies in innovativeness-performance stream is provided in the first section. The second section reviews the empirical research in innovation strategy-performance stream. The third section focuses on the review of empirical studies in innovation capability/resource-performance stream. The fourth section discusses the characteristics of transitional economies in particular and reviews relevant research on innovation in Chinese industrial firms. The final section provides a summary of the discussions through the whole chapter.
3.1 Innovativeness-Performance Stream

Innovativeness occurs when an organization implements new ideas, products, processes or services (Hult and Kitchen JR., 2001). Innovativeness is an enduring organizational trait (Subramanian and Nilakanta, 1996), and is conceived to encompass the generation, development implementation, and R&D activities resulting in new ideas, products and processes (Damanpour, 1991; Lee, Lee and Pennings, 2001; Lumpkin and Dess, 1996). It reflects the organizational tendency towards innovation. Innovativeness is a multidimensional construct. The measures of innovativeness is traditionally based on innovation adoption such as the number of innovation adopted by a firm (Damanpour, 1991; DeCanio, Dibble and Amir-Atefi, 2000; Han, Kim and Srivastava, 1998; Irwin, Hoffman and Geiger, 1998), time of innovation adoption (Subramanian and Nilakanta, 1996), change of innovation adoptions (Damanpour and Evan, 1984), and speed of innovation adoption (Gopalakrishnan, 2000). Some researchers employ other indicators to measure innovativeness. For example, Song and Parry (1999) define innovativeness as the level of a product’s newness to the firm. Stuart (2000) uses the sum of patent citations as a measure of innovativeness. Lee and his colleagues (2001) measure innovativeness by two indices: the number of R&D employees and the number of products/services that created a new market niche. Danneels and Kleinschmidt (2001) employ market and technological familiarity, marketing and technological fit and new marketing activities as the measures of innovativeness.

The innovativeness-performance stream, which is referred to as a sub-stream of ‘innovation variance research’ (Subramanian and Nilakanta, 1996), focuses on examining the relationship between innovativeness and performance. Although relatively few studies have explored the impact of innovativeness on performance (Damanpour and Evan, 1984), the empirical research in this stream generally provides evidence that innovativeness is significantly associated with firm performance. For example, Lawless and Anderson (1996) draw the data on the U.S. microcomputer industry to examine the relationship between speed of innovation adoption and firm performance. Their findings suggest that the faster innovation is adopted the
higher firm performance. Han, Kim and Srivastava (1998) in their study find that technical innovations have a positive and direct impact on performance. In another recent study, Hult and Ketchen JR. (2001) claim that innovativeness is a very important factor in developing market positional advantage (market performance) of the multinational corporations.

Some researchers also investigate the indirect relationship between innovativeness and performance. For instance, the empirical findings of Han, Kim and Srivastava’s study provide some evidence that ‘market orientation facilitates an organization’s innovativeness, which, in turn, positively influences performance’ (1998: 40). Song and Xie (2000) suggest that product innovativeness has positive moderating impact on the relationship between cross-functional integration and performance in technical activities in Japanese firms rather than in the U.S. firms.

The empirical findings in some studies, however, are equivocal. For example, Damanpour and Evan (1984) find that the different levels of innovativeness between firms did not lead to differences in performance. Subramanian and Nilakanata (1996) suggest the different dimension of innovativeness affects different aspects of organizational performance. The number of technical innovation adoptions positively influence return on assets but has no association with deposit share, while time of technical innovation adoptions is related to deposit share rather than return on assets. Gopalakrishnan (2000) finds that innovation speed promotes the objective financial performance, but it has little effect on perceived performance. Danneels and Kleinschmidt’s (2001) findings show that innovativeness, in terms of marketing and technological resources, has significant relationship with product performance. However, when familiarity with market and technology is used as a measure of innovativeness, innovativeness does not have a significant relation with product performance.

3.2 Innovation Strategy-Performance Stream

In the strategic management literature, strategy is viewed as discrete phenomenon that ‘firms (1) reflect on their market and the basis of their existence; (2) do so with an eye to the future; and (3) come up with some ideas on how they should act to survive’ (Sundbo, 1998: 23).
Innovation strategy is one of the most important strategies in a firm. A successful innovation strategy should ensure the successful deployment of a firm's technological capabilities and resources to achieve the firm's goal (Zahra and Covin, 1993). In particular, it should contribute to sustainable competitive advantage and superior performance.

A firm's innovation strategy is a dynamic and uncertainty concept (e.g. Lynn and Akgun, 1998). There are many different categories of innovation strategy. Firms may change from one strategy to another in different development stages or environments, and they may follow different strategies in different industries. Lynn and Akgun (1998), for example, summarize innovation strategy into six categories: (1) process-based strategy; (2) speed-based strategy; (3) learning-based strategy; (4) market-based strategy; (5) technology-based strategy; and (6) quantitative-based strategy. Each strategy focuses on a particular component of innovation especially new product development effort. Based on firms' innovative behavior, Dziura (2001) suggests that a firm has a range of alternative innovation strategies. These strategies include (1) 'offensive' innovation strategy, (2) 'defensive' innovation strategy, (3) 'dependent' innovation strategy, (4) 'imitative' innovation strategy, (5) 'traditional' innovation strategy, and (6) 'opportunist' innovation strategy.

Extant empirical studies in strategic management and innovation literature have been examining firm-level innovation strategy-performance relationships. Some studies investigate the innovation strategy-performance relationships by excluding roles played by other factors such as environments. Cooper (Cooper, 1984; Cooper, 1985; Cooper, 1986; Cooper, 1987) has consistently argued that product innovation strategy has a significant influence on firm performance. He demonstrates a positive link between firm performance and product innovation strategy dimensions such as technological sophistication, product customers, marketing orientation, and market synergy according to a study in Canadian firms (Cooper, 1985). Mezias and Glynn (1993) find that innovation strategies may not always lead to superior performance; they may have both positive and negative effects on firm performance. Pegels and Thirumurthy (1996) focus on the role of R&D efforts to investigate the impact of technology strategy on firm
performance. They define technology strategy as ‘the approaches that firms use to translate R&D efforts into advances in their respective product and process technologies’ (1996: 246). The results indicate that innovation strategy has a positive impact on firm performance. Llerena and Oltra (2000) investigate innovation strategies in both cumulative and non-cumulative firms. They suggest that an increase in the diversity of innovation strategies lead to an increase in the efficiency of industrial dynamics.

Another line of innovation strategy-performance relationship research focuses on the moderated effects of innovation strategies on firm performance. Hill and Snell (1988), for example, find that the relationship between governance variables such as stock concentration and firm performance is moderated by firm innovation strategy reported by R&D investment and diversification of innovation in large firms. McGee, Dowling and Megginson (1995) demonstrate that the impact of R&D cooperative arrangements on performance is greater in new ventures when firms emphasize technical differentiation strategy. Li and Atuahene-Gima (2001a) examine the contingent relationship between product innovation strategy and performance in China’s new technology ventures. Their results suggest that institutional support and environmental turbulence enhance the effects of product innovation strategy on firm performance. Schroeder, Bates and Junntila (2002) focus on manufacturing strategy and the relationship with manufacturing performance. They define manufacturing strategy as capabilities and resources based on the resource-based view of the firm and demonstrate that these ‘manufacturing resources and capabilities have the potential for creating a performance advantage’ (2002: 113). Kessler and Bierly (2002) assert that relationships between innovative strategy and project performance vary with level and source of uncertainty, with the finding that innovation speed leads to performance in more predictable contexts.

3.3 Innovation Capability/Resource-Performance Stream

Over the past two decades, there has been an important and growing stream in the innovation and strategic management literature examining the impact of capabilities and
resources on firm performance. This research stream is typically based on the resource-based view of the firm.

Past innovation-performance relationship studies discussed in section 3.1 and 3.2 differ from the innovation capability-performance approach in several respects. Previous studies focus on investigating innovation activities/processes and their relationships with performance, but do not explicitly address the basis of these activities. Further, previous studies fail to emphasize the importance of internal capabilities and resources necessary for innovation that cannot be obtained from outside environments. Instead, previous studies explore the characteristics of innovation outcomes' impact on performance, confirm the role of the use of new knowledge and technologies, and emphasize the importance of heterogeneity in organizational factors, environmental factors and innovation practices, and so on. As a result of such shortcomings, research in innovativeness-performance and innovation strategy-performance stream provides less information on the sources of successful innovation outcomes or how could firms conduct their innovation activities.

Innovation capability/resource-performance approach emphasizes the development of tacit knowledge and internal idiosyncratic capabilities and resources necessary for innovation and firm performance. These capabilities and resources include both innovation outcomes themselves named **output-oriented innovation capabilities**, as well as capabilities and resources which may result in successful innovation outcomes, named **input-oriented innovation capabilities**.

As previously argued, no single dimension of innovation capability can adequately reflect all aspects of innovation-performance relationship. This study seeks to examine capabilities, which are most important to different stages of innovation process. It is important therefore to review the separate capabilities that logically contribute to firm performance. Chapter Two discussed several capabilities, which might be the most important innovation capabilities in different stages of innovation process. These capabilities include three main input-oriented innovation capabilities: R&D capability; absorptive capability; and manufacturing capability, as
well as three main output-oriented innovation capabilities: product development capability; process innovation capability; and marketing capability. Consistent with the discussions on important innovation capability dimensions, the review of empirical studies also focuses on the impact of these capabilities on firm performance.

3.3.1 Input-oriented innovation capabilities and firm performance

This sub-section discusses the impact of three main input-oriented innovation capabilities: R&D capability; absorptive capability; and manufacturing capability.

R&D Capability and Firm Performance

Most empirical studies concerned with firm performance have generally found that R&D capability in terms various dimensions has a positive impact on firm performance. For example, an earlier study by Brenner and Rushton (1989) find a strong association between R&D expenditure and sales growth in the chemical industry. Pegels and Thirumurthy (1996) find that the capability in R&D investment has a positive impact on firm financial performance. Dutta, Narasimhan and Rajiv (1999) find that R&D capability along with marketing capability is an important contributor to high technology firms’ performance. Others demonstrate the positive effects of R&D capability reported by R&D intensity on either financial performance or market performance (Ettlie, 1998; Patterson, 1998). McGee, Dowling and Megginson (1995) suggest that the impact of cooperative arrangements on performance will be greater in new ventures if these firms have more experienced R&D managers. Similarly, Mishra, Kim and Lee (1996) find that R&D skills and people are positively related to successful new products. The study by Atuahene-Gima and Evangelista (2000) indicates that from R&D managers’ perspective, R&D is an important factor for achieving new product performance. Ballot, Fakhfakh and Taymaz (2001) also argue that R&D is the most robust factor of production in Swedish firms.

However, the empirical findings are not always consistent with each other. For example, some researchers argue that not all R&D capabilities especially R&D investment would result in superior performance. Hitt, Hoskisson and Kim (1997) found that R&D investment reduced short-term returns on assets in product-diversified firms. Patterson (1998) confirms that
increasing R&D investment would decrease firm's current profit. Iansiti and West (1999) find that R&D resources presented by R&D personnel are negatively correlated with product performance.

Other studies have found that R&D capability does not have direct relationship with firm performance. The research by Morbey (1989), for example, indicates that R&D expenditures are not associated with profit growth regarding 800 U.S. firms. Other researchers such as Duysters and Hagedoorn (1996) as well as Iansiti and West (1999) also found that R&D investment is not associated with firm performance. Ballot, Fakhfakh and Taymaz (2001) argue that R&D has less effect on production performance in French firms if it is as isolated factor.

The above discussions provide evidence for the so-called innovation paradox. In general, R&D capability definitely contributes to innovation and firm performance, but not all R&D capability experiments especially R&D investments would necessarily result in successful innovation and superior performance. Brynjolfsson (1993) groups various explanations of the innovation paradox into four categories: (1) measurement errors of innovation input and output; (2) long lags of return on R&D; (3) redistribution of the profits; and (4) inappropriate management practices in technology development. In consistence with Brynjolfsson's explanations, there are several reasons for these two kinds of findings on the relationship between R&D capability and firm performance. First, R&D, especially in-house R&D, also means high risk, high cost and relatively long development time. The high-risk nature of R&D activities may lead to either successful or failure innovation and performance. Second, most studies regarding a negative relationship or non-relationship between R&D and firm performance focused on R&D investment measures such as R&D expenditure and R&D intensity (Ballot, Fakhfakh and Taymaz, 2001; Teece, 1987). However, not all R&D expenditures, even if they lead to innovation, would result in firm-specific advantages that lead to superior performance (Mansfield, Schwartz and Wagner, 1981; Mitchell and Hamilton, 1988; Teece, 1987). This is because firm-specific advantages require a large effective follow-up investment after the initial exploratory cost of R&D and further coordination with other factors.
The Impact of Innovation on Firm Performance: An Review on Empirical Studies

(Cool and Schendel, 1987; Pegels and Thirumurthy, 1996). Only successful exploratory and follow-up activities would result in superior performance. Third, the most studies on the relationship between R&D and firm performance examined R&D effects on short-term performance (Hitt, Hoskisson and Kim, 1997). However, R&D effects often occur with long lags and R&D resources are more efficient and productive in the long term (Loof and heshmati, 2002; Yeoh and Roth, 1999). It is not surprising that R&D effects treated as expenses would reduce short-term performance such as return on investment (Hitt, Hoskisson and Kim, 1997).

In addition to the paradox findings, these empirical studies also have some limitations. For example, Dutta, Narasimhan and Rajiv’s (1999) study focused on high technology firms, which have high competitive intensity. Is R&D capability also important to other industrial firms? On the other hand, as mentioned above, the most previous studies investigated the relationship between R&D investment-oriented capability such as R&D intensity in terms of the percentage of R&D expenditure to total sales and one type of firm performance, but did not explicitly examine the effects of other related factors of R&D capability such as R&D personnel and the ability to transform new ideas into available products and develop valuable resources which are difficult for competitors to imitate.

These paradox findings and limitations in the literature suggest that it needs further empirical evidence on the importance of R&D capability concerning broader aspects of R&D. Therefore, in this study, it is expected that R&D capability is an important determinant of competitive advantage and will have a significant impact on firm performance. The primary reason is that R&D capability refers to not only R&D investment ability but also a firm’s ability to establish long-term research and technology development directions, transform new ideas into available technologies and products, and leverage R&D resources to be more difficult for competitors to imitate (Griffin and Hauser, 1996; Pegels and Thirumurthy, 1996; Yeoh and Roth, 1999). Hence the real measure of R&D capability does not only focus on its R&D investment but how R&D resources are deployed and transformed in order to make better use in achieving superior performance. It is true that firms without or with little R&D capability can be
innovative through external innovation such as acquiring, purchasing or licensing external technologies in a short period. However, the disadvantages of relying on external R&D are obvious. Firms have to search for extensive suitable technology (Witt, 1998). To some extent, it is also expensive. Moreover, firms may also gain only limited resources that have no competitive technology advantage if they just rely on external technology development. On the other hand, the acquisition of external technology is also associated with internal R&D capability. R&D capability can help firms better assimilate and utilize external knowledge and technologies (Cohen and Levinthal, 1990).

**Absorptive Capability and Firm Performance**

Several concepts of innovation capabilities are related to knowledge and technology absorption and accumulation within a firm including absorptive capability, learning capability and technology acquisition capability, and so on. These concepts have similar implications for the present study. Several studies have discussed their relationships with firm performance. For example, in resent studies, Jones, Lanctot JR. and Teegen (2000) find that the ability of external technology acquisition has the significant effect on overall firm performance. They further argue that the impact of technology acquisition on product performance is greater than on financial performance. Based on an investigation in the chemical industry, Ahuja and Katila (2001) find that the absolute size of acquired knowledge base has a positive effect on innovation performance, but the relative size of acquired knowledge base reduces innovation performance. Lane, Salk and Lyles (2001) focus on international joint ventures. Their research indicates that the ability of knowledge acquisition from foreign parents would be positively associated with international joint venture's performance. Due to the importance of absorptive capability to both innovation and firm performance, this study also empirically examines the impact of absorptive capability on firm performance in Chinese industrial firms.

**Manufacturing Capability and Firm Performance**

The importance of manufacturing capability to firm performance was recognized in the literature. For instance, Hayes and Wheelwright (1984) provide specific evidence on how
manufacturing capability help a firm to achieve a desired competitive advantage. Wheelwright (1984) also articulated the significant influence of manufacturing capability in terms of cost efficiency, quality, flexibility and dependability of manufacturing on firm performance. A study by Ferdows, Miller, Nakane and Vollmann (1986) indicates that successful firms often emphasize several aspects of manufacturing capability simultaneously. Based on previous empirical studies, White (1996) develops a meta-analysis model of manufacturing capabilities to explain why manufacturing capability can have the significant impact on firm performance. Drawing the data from American and Korean firms, Rho, Park, and Yu (2001) suggest that manufacturing capability variables such as flexibility, quality and cost of manufacturing, show more significant contribution to the difference of firm performance. By using the components of manufacturing competence identified by themselves (1993), Droge, Vickery and Markland (1994) suggest that manufacturing capability is primarily related to financial performance reported by return on investment (ROI) and ROI growth. A recent study by Schroeder, Bates and Juntila (2002) discussed the manufacturing capabilities and their relationships with manufacturing performance. The empirical results confirm that manufacturing capabilities and resources are effective for creating a performance advantage, especially, 'the capability of the plant to incorporate internal and external learning into proprietary processes and equipment emerges as an important contributor to manufacturing performance' (2002: 113). Similarly, Swink and Hegarty (1998) suggest that manufacturing capabilities presented by different dimensions support product differentiation. Although, many of these studies discuss overall manufacturing capability, which might include the aspects less associated to innovation, they provide a useful rationale and establish the role of manufacturing capability as an important contributor to firm innovation and performance.

3.3.2 Output-oriented innovation capabilities and firm performance

This sub-section further reviews the relationship between firm performance and three output-oriented innovation capabilities: product development capability; process innovation capability; and marketing capability.
Product Development Capability, Process Innovation Capability and Firm Performance

Innovation outcomes are a significant factor contributing to the performance heterogeneity among firms (Loof and Heshmati’s, 2002). Product and process innovation are two most important innovation outcomes in industrial firms. In the literature, most empirical studies focus on the impact of product development. For example, Calantone, Vickery and Droge (1995) argue that new product development is significantly associated with at least one of firm performance dimensions such as financial performance in terms of return on investment, return on sales and market share. Using data from the pharmaceutical industry, Roberts (1999) demonstrates that product innovative propensity/ability influences firms’ persistent profitability. Luo (2002) finds that product diversification in China’s international joint ventures affects firm performance. Zirger (1997) suggests that radical products are positively associated with innovation success. While a little research focuses on the importance of capabilities related to process innovation. Hatch and Mowery’s (1998) study, for instance, indicates that the capabilities for process development and managing new process introduction is important for achieving firm performance.

Empirical studies also suggest that product and process innovation capabilities are complementary to each other, and firms need to emphasize product and process innovation capabilities simultaneously in achieving superior performance. For example, Brown and Eisenhardt (1995), claim that productive processes and attractive products, which are characterized by unique benefits and fit-with-firm competencies lead to financially successful product innovation. Weiss and Birnbaum (1989) suggest that when a firm wishes to increase its innovation performance, it needs to combine both product development and process innovative capabilities. Sen and Egelhoff (2000) argue that both product and process innovation capabilities are important to firms’ technological competitive advantage.

On the other hand, it is important to note that these findings offered a support on the significant impact of product development or process innovative capabilities on one type of performance dimensions especially innovation performance, but did not explicitly address the
effects of these capabilities on other types of performance. To a large extent, the relationship between product development, process innovative capabilities and financial or market performance may not be obvious, compared with innovation performance. For example, Leiponen (1997) argues that innovation does not appear to be associated with better economic performance by using the data from 489 Finnish manufacturing firms. In order to address the overall effects of product development and process innovative capabilities, this study will extend previous findings by hypothesizing these two types of capabilities are associated with not only innovation performance but also other firm performance dimensions such as financial and market performance.

**Marketing Capability and Firm Performance**

Marketing capability related to innovation is another output-oriented capability. Several studies in the literature have discussed the relationship of marketing capability presented by market orientation with firm performance (Atuahene-Gima, 1995; Baker and Sinkula, 1999; Jaworski and Kohli, 1993; Mishra, Kim and Lee, 1996). Most of these studies reveal that market orientation has a positive impact on one of firm performance dimensions such as financial performance, market performance or innovation performance; although a few researchers, like Jaworski and Kohli, (1993), argue that market orientation does not appear to be related to market share. Other studies discuss the relationship between marketing capability and firm performance based on different concepts of capability. For example, Fawcett, Calantone and Smith (1997) examine the relationship between market capability in terms of delivery capability and firm performance. Their results show that delivery capability related to meeting marketing requirements, achieving customer satisfaction and building a positive reputation can help a firm achieve high levels of performance. Similarly, Zhao, Droge and Stank (2001) find that customer-focused capabilities are significantly associated with firm performance. Empirical research also emphasizes the impact of marketing capability reported by sales, distribution and services on rent (Stalk, Evans and Shulman, 1992) and rent appropriability (Mitchell, 1992).
In summary, the literature shows that in general, both input-oriented and output-oriented innovation capabilities are the important determinants of firm performance. However, the relevant empirical evidence on the importance of such as product development and process innovation capability, manufacturing capability and marketing capability is still limited. This is because of the difficulty of the measures of these capabilities and the lack of relevant data. Product and process innovation are complex and multifaceted, and many manufacturing and marketing activities are not related to innovation. The present study will provide important insights and seek to fill this gap by providing technological innovation-based measures and examining their relationship with firm performance in Chinese industrial firms.

3.3.3 Complementarity and Interactions of Capabilities/resources and Firm Performance

The third sub-stream of capability-performance research focuses on the complementarity and interactions of capabilities, or the contingency among capabilities and other factors as well as their relationships with firm performance, although there are relatively less empirical studies in this stream, compared with first two sub-streams of the research.

Some researchers such as Moorman and Slotergraaf (1999) challenge prevailing views and suggest that innovation capabilities may not be valuable to firm performance as a single asset. Several empirical studies have also confirmed that the complementarity and interactions do exist among innovation capabilities, and they have more significant impact on firm overall performance. For instance, Dutta, Narasimhan and Rajiv (1999) point out that various innovation capabilities can serve as important complements to each other. Their empirical research reveals that the most important determinant of a high-tech firm’s performance is the interaction between marketing and R&D capability. Although a firm might have a strong R&D capability, it still needs to have a strong marketing capability to convert R&D effects into commercial products in order to achieve superior performance. Lee, Lee, and Pennings (2001) find that the interaction of market orientation and innovativeness positively influences firm financial performance. Similarly, Han, Kim and Srivastava (1998) confirm that innovativeness moderate the relationship between market orientation and market performance.
Others especially link the complementary and interactive capabilities to innovation performance. For example, Griffin and Hauser (1996) suggest that the coordination of R&D and marketing is an important determinant for new product success. Song, Mntoya-Weiss and Schmidt (1997) find that cooperation among R&D, manufacturing and marketing has a significant impact on new product performance. The results of Gatignon and Xuereb’s (1997) study indicate that the coordination of technological orientation and customer orientation is positively associated with innovation performance. Moorman and Slotegraaf (1999) demonstrate that the complements of firms’ product technology capability and marketing technology capability can have a positive impact on product development outcomes. Jones, Lanctot JR. and Teegen (2000) demonstrate that the level of internal resources such as R&D capability and the stock of product and process technology positively moderate the relationship between external technology acquisition and product performance.

Another line of the research focuses on the moderating impact of organizational or environmental factors such as munificence of environment, outside institutional support and size of firm, on innovation capability effectiveness. For example, Irwin, Hiffman and Gerger (1998) find that the relationship between adoption of technological innovation and financial performance is moderated by the size of organization and munificence of environment. Baker and Sinkula (1999) argue that when learning orientation of a firm is high, the market orientation has a significant and positive effect on the market share growth. Lee, Lee, and Pennings (2001) suggest that internal technological capabilities and social capital interactively influence the start-up firm’s performance.

Table 3.1 on page 84 presents some examples of empirical research concerning the relationship between innovation and firm performance.

The review of empirical research on innovation-performance relationship in terms of three research streams innovativeness-performance, innovation strategy-performance and innovation capability-performance is an important implication for the present study. These studies establish the role of innovation as a critical source of achieving superior performance.
The review also indicates that the research in first two streams is consistent with and complement to the research in the third stream. Empirical studies in innovativeness-performance stream focus on the impact of a firm’s innovation adoption and newness. They are mainly associated with the accumulation of output-oriented innovation capabilities and resources. Empirical studies in strategy-performance stream emphasize the impact of a firm’s dynamic phenomenon. Innovation strategy influences the development and deployment of input-oriented and output-oriented innovation capabilities and resources. On the other hand, research in the first two streams also provides evidence on contingent relationship of innovation with firm performance and the existence of innovation paradox. Therefore, there is much in the perspectives and methods of studies in innovativeness-performance and strategy-performance streams that the research in capability-performance stream can make use of.

More importantly, findings in the third research stream suggest that innovation capabilities play an important role in helping firms achieve their different types of superior performance. They are consistent with the focus of the resource-based view of the firm. Moreover, although the effects of innovation capabilities may not be always positive and there may be other capabilities that have greater impact on firm performance under certain environments or circumstances, the empirical findings in the literature do demonstrate that different innovation capabilities contribute to different performance aspects and the interactions of different innovation capabilities might be more important for firm performance. Therefore, both the independent and interactive impact of different dimensions of innovation capabilities should be considered when build up the research framework.

A number of weaknesses in previous studies have emerged from the review. First, the dimensions of either performance or innovation capabilities are not well operationalized. For instance, many studies only use R&D investment as a dimension of R&D capability, but ignore the role of R&D personnel or other R&D resources. Second, most studies concentrate on measuring one or a few aspects of innovation such as innovation input or outcomes, but ignore others. Few of them, for example, have dealt with capabilities necessary for manufacturing new
products. Third, most empirical studies on capability-performance relationship have been built upon the firms in market economies, few of them have discussed the relationship between innovation capabilities and performance based on the firms in a transitional economy.

Based on above literature review, this study places a firm’s innovation process in the context of the resource-based view of the firm by evaluating the capabilities required by different stages of innovation process within a firm. The present study draws on several dimensions of innovation capabilities such as R&D capability, absorptive capability, product development, process innovation, manufacturing and marketing capability, which are important for the success of technological innovation. More importantly, this study would extend previous empirical studies in the third research stream by simultaneously examining the independent impact of each innovation capability dimension on different dimensions of firm performance, as well as the interactive impact of different capabilities rather than considering the relationship of a single or an integrate dimension of innovation capabilities with firm performance in Chinese industrial firms during China’s transitional economy.

As mentioned in Chapter One, innovation activities in Chinese firm may have some different characteristics compared to their counterparts in market economies, given the different economic mechanisms and environments. In order to better understand the impact of innovation capabilities among Chinese firms, the next section discusses some specific characteristics of Chinese firms’ innovation activities.

3.4 Characterizing Innovation Activities in Chinese Industrial Firms

As Nelson (1993) points out that an economy’s innovation and technology development largely depends on the form of its national innovation system, comprising all relevant institutions and organizations, which contribute to the creation and diffusion of new knowledge. A national innovation system has a close link with a nation’s economic system, since innovation has been recognized as the driving force for economic growth in many economies. Given the economic and environmental differences such as resource availability, market environments and business support infrastructure, broad western marketing principles and technology
development systems are not necessarily fully applicable to and suitable for developing economies where the factors required for successful innovation are considerably different. In particular, transitional economies such as China’s transitional economy are undergoing transformation from a central planned economic system to a market-oriented system. There are challenges in reforming their national innovation systems. During the transformation, innovation behavior at the firm level is more likely to be different from experiences in market economies. The present study focuses on the case of China’s transitional economy. A review of innovation studies concerning China’s transitional economy is provided in this section.

China’s entire national innovation system reform paralleled economic reform in the 1980s. In 1985, the Central Committee published the document of Structural Reform of the Science and Technology System. This document set goals and guiding principles for national innovation system reform. The articulated objectives of the reform were ‘to apply results from science and technology research to production widely and rapidly; to make full use of science and technology personnel; to greatly empower science and technology as the driving force for the economy; and to promote the development of the economy and society’ (CCCPC, 1985). The reform pointed out three areas where structural reform was most needed: the operating mechanism, the institutional structure, and the management of science and technology personnel (Xue, 1997). In the area of institutional structure, the reform encouraged great coordination and integration between research institutions and industrial firms. More importantly, the reform encouraged the independent research and technology development within industrial firms with varied ownership.

The market-oriented reform of China’s national innovation system has greatly simulated firms’ innovation. The present evidence is that firm managers have recognized the importance of developing and introducing new products rather than simply produce more of their existing products (White, 2000). Firms started to emphasize the development of their internal technology capabilities and effective cooperation with research institutions. There is also evidence that
firms began to pay more attention to profit-based and efficiency-based measures of their performance instead of scale performance (White and Liu, 1998).

While the reform has led to dramatic changes in the basis of firms' innovation behavior, as well as the institutional and organizational environments in which firms operate, China's economic transition is far from complete. There are some quite specific environmental, mechanism, and institutional characteristics in the Chinese context that affect the capability-based activities of firms (White, 2000).

First, during the economic transition, China's economy is characterized by a hybrid economy of administrative mechanisms and market mechanisms. This hybrid economy reflects unusually complex and uncertain economic environments, which are substantially different from western economies. For example, in China, the market expansion is still constrained by various regulations and the market demands for innovations especially radical innovations are still limited (Lou and Park, 2001). Given these uncertain and dynamic environments, to some extent, the environment-performance relationship is more important than capability-performance relationship. In other words, market success of some firms depends on their abilities to understand environments and to respond in time to the markets and other regulatory uncertainties through maintaining the core of traditional products rather than developing new products (Luo and Park, 2001; Shenkar, 1990).

Second, China's markets are still not completely free from the centralized planning system. The administrative mechanism, which refers to the allocation of redistribution of goods and services mainly controlled by administrative agencies, still has a large influence on firms' innovation activities. On the one hand, Chinese firms try to follow market principles to get access to resources and achieve their performance. On the other hand, government administrations still control many resources and marketing outlets needed by firms' innovation activities. To a large extent, it leads to the dependence of firms' innovation activities on government support. A study by Yan and Zhang (2000) has showed that many firms, especially state-owned enterprises, only undertake innovation if they receive grants under state initiatives.
This suggests that they do not carry out technology development activities for purely market related economic considerations.

Third, the national innovation system reform is also far from complete. Differing from market economies, in China, research, manufacturing and distribution are still located in functionally specialized organizations in some areas because of the existence of administrative mechanism. This kind of structure leads to lack of independent internal innovation capabilities in industrial firms because of the limited internal technology resources. For instance, White (2000) questioned why Chinese pharmaceutical firms 'were strictly production enterprises, they received new product technology from government-sponsored research institutes and universities of pharmacy, they produced to quota, and the output could only be sold through the government distribution monopoly' (2000: 328). Although Chinese firms begin to emphasize their internal innovation capabilities, the increase of technology capabilities requires time and investment in resources.

On the other hand, although the Chinese government has been emphasizing the cooperation among industrial sectors and research institutes and universities within the national innovation system, China’s legal framework lacks well-defined property rights including intellectual property rights, which are critical in developing a market-oriented system. The difficulties involved in such as defining and protecting intellectual property rights have bedeviled technology transactions.

Fourth, like many other developing economies, Chinese firms have more knowledge of their own technologies, less about similar technologies of other firms, even in the same industry (Lall, 1994), and their technology development depends upon their own experience and skills. Although many firms have begun to pay more attention to their competitors, sometimes, technology development remains at the low level, and the output of technology development may not produce advantage over their competitors. For instance, many large firms in China have their own in-house R&D facilities, but these are often ineffective in meeting the needs of markets (Suttmeier, 1997).
Fifth, in China's transitional economy, not all sectors are entrepreneurial. The economic ownership as one of the institutional factors strongly influences firms' innovation behaviors and performance (Child, 1994). For example, the study by Siu (2000) indicates that the state-owned enterprises (SOEs) adopt more proactive rather than reactive approach to innovation and performance, compared with entrepreneurial sectors like private firms. Moreover, SOEs and collective firms are more likely to define their market activities as local customer-driven, while private firms prefer to sales-driven market activities.

Another difference related to ownership is reflected by resource acquisitions. SOEs have 'remained a persistent drain on government resources' (White, 2000), although the government has recognized that they must reduce the SOEs' drain on government resources. It is relatively easier for SOEs to get access to government monopoly resources, compared with non-SOEs. To some extent, it leads to SOEs that tend to take technology, which is administratively routed their way (Gao & Fu, 1996; Simon & Rehn, 1987; White and Liu, 1998; White, 2000). On the other hand, non-SOEs such as private firms tend to develop new technology internally. However, the difficulty is that the independent technology development capability in many private firms is not strong because of the lack of necessary resources such as skilled personnel and financial resources. In order to obtain access to resources and marketing outlets especially the government monopoly ones, these firms have to cultivate administrative relationships (guanxi) with regulatory agencies (Li, 1999). The relationship with government may be more helpful for firms to achieve their performance than innovation activities themselves.

Finally, firms' innovation is largely influenced by considerable regional variation. From a technology perspective, the regional variation can be characterized by local government influence, levels of foreign technology and inherited endowments of science and technology assets (Suttmeier, 1997). Different regions provide firms with different technology environments. In some regions of China, like Guangdong province, the role of the provincial government is strong over the activities of technology development that about 70% of the government-funded R&D is funded locally. On the other hand, firms in some regions like
Beijing have close linkages with research institutes, universities and other organizations. These provide firms with relatively stronger capabilities to explore external technology resources. Moreover, technology opportunity refers to the amount of relevant technological information that is available to the firm from outside the industry, in research institutes, universities, government laboratories, suppliers and customers (Klevorick, Levin, Nelson, and Winter, 1995; Levin, Klevorick, Nelson, and Winter, 1987). The empirical research by Davies (2001) suggests that the most effective way for Chinese government to improve firms' innovation is to increase the level of technology opportunities, since the technology opportunities allow firms to accumulate the resources required for innovative efforts.

In summary, this section presents some distinctive characteristics of innovation activities in Chinese firms and their environments related to innovation. They could have important implications for the power of capability perspective to explain the impact of innovation capabilities on firm performance.

These discussions indicate that during the economic system transition, Chinese firms have dramatically changed their innovation behavior to obtain superior performance through the emphasis on their internal innovation capabilities. The observation reinforces the previous theoretical argument that innovation capabilities should be the important determinants of firm performance.

The discussions also show that innovation activities in Chinese firms may not at a high level. Given the traditional distribution of science and technology resources, Chinese firms are lack of internal innovation capabilities, especially R&D capability and product development capability extremely emphasized by firms in market economies. The observation reinforces the theoretical discussion that individual innovation capabilities should be examined to determine which capabilities are most important for firm performance under a certain circumstance.

Firms' innovation driven by market-orientation may not be the most important factor for performance in China. During the economic transition, to some extent, other factors especially administrative mechanism, government monopoly, regional variation, entrepreneurship, and
institutional factors have the greater impact on Chinese firms’ innovation behaviors and performance, compared with their counterparts in market economies. This discussion reinforces the theoretical perspective that the relationship between innovation capabilities and firm performance cannot be isolated from specific market and organizational environments in China. These specific environmental and organizational factors mentioned above may have a moderating influence on the relationship between innovation capabilities and firm performance. The research framework of this study will incorporate specific environmental factors to permit tests of the relationship between innovation capabilities and performance in Chinese industrial firms.

3.5 Chapter Summary

Empirical research in innovation-performance relationship was reviewed in this chapter. At least, three empirical research streams can be found in the literature: innovativeness-performance; innovation strategy-performance; and capability/resource-performance relationship. The findings in these streams provide useful explanations of innovation-performance relationship. They offer overlapping and complementary insights into firm performance. In particular, based on the resource-based view of the firm, the literature review on capability-performance relationship has empirically demonstrated that idiosyncratic capabilities related to innovation are critical determinants of firm performance, although sometimes the effects of innovation capabilities are conditional. The literature also suggests that identifying the criteria necessary for capabilities to influence firms’ superior performance is an important but not well-addressed issue. The current study extends this line of research by simultaneously examining the independent impact of individual dimensions of innovation capabilities and their interactive impact on firm performance in Chinese industrial firms.

This chapter also introduced some distinctive characteristics of firms’ innovation activities in China’s transitional economy. Although the market power has been emphasized and market development has been underway, the transition is far from complete. For Chinese firms, some of non-market driven factors such as administrative mechanism and institutional factors
do strongly influence firms' innovation activities and performance, compared with the firms in market economies.

The following chapter will draw the relevant theoretical and empirical perspectives together to develop a research framework in order to examine the impact of innovation capabilities on firm performance in Chinese industrial firms.
### Table 3.1 Examples of Empirical Studies on the Impact of Innovation on Firm Performance

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Independent variables</th>
<th>Innovation measures</th>
<th>Dependent variables</th>
<th>Performance measures</th>
<th>Other variables</th>
<th>unit of analysis</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schroeder, Bates &amp; Junilla (2002)</td>
<td>Manufacturing capabilities</td>
<td>Internal learning, external learning, proprietary process &amp; equipment</td>
<td>Manufacturing performance</td>
<td>% of cost to sales, etc.</td>
<td>164 manufacturing plants in Germany, Italy, Japan, UK and US</td>
<td>The capability of the plant to incorporate internal and external learning into proprietary process and equipment emerges as an important contributor to manufacturing performance.</td>
<td></td>
</tr>
<tr>
<td>Hult and Kentche JR, (2001)</td>
<td>Market orientation, innovativeness</td>
<td>Subjective items</td>
<td>Financial performance</td>
<td>5-year average change in ROI, % change in income and stock price</td>
<td>1000 multinational corporation in more than 50 countries</td>
<td>Market orientation and innovativeness have a positive effect on firm performance.</td>
<td></td>
</tr>
<tr>
<td>Lee, Lee &amp; Pennings (2001)</td>
<td>Technological capabilities</td>
<td>No. of technologies, No. of utility models &amp; designs, No. of foreign and domestic quality assurance marks</td>
<td>Performance</td>
<td>Sales growth</td>
<td>1012 technical start-up firms in Korea</td>
<td>Technological capabilities and financial resources invested during the development period are positively associated with the start-up firm's performance. Internal capabilities and social capital interactively influence performance.</td>
<td></td>
</tr>
<tr>
<td>Zhao, Droge &amp; Stank (2001)</td>
<td>Customer-focused capabilities, information-focused capabilities</td>
<td>Subjective items</td>
<td>Performance</td>
<td>ROA, customer satisfaction</td>
<td>306 firms in North America</td>
<td>Customer-focused capabilities were significantly related to firm performance. Information-focused capabilities alone cannot be considered a distinctive factor directly relating firm performance.</td>
<td></td>
</tr>
<tr>
<td>Gopalakrishnan (2000)</td>
<td>Innovation adoption, innovation magnitude</td>
<td>Speed of adoption of innovations, number of innovations</td>
<td>Financial performance</td>
<td>ROA, effectiveness</td>
<td>101 organizations</td>
<td>Innovation speed was a significant predictor of objective financial performance (ROA), but have little effect on perceived effectiveness. Innovation magnitude has little impact on financial performance (ROA), but have a positive relationship with perceived effectiveness.</td>
<td></td>
</tr>
<tr>
<td>Stuart (2000)</td>
<td>Innovation rate</td>
<td>Number of new patents applied by a firm</td>
<td>Performance</td>
<td>Objective: Sales growth</td>
<td>150 firms from semiconductor industry world</td>
<td>Technology alliances with large and innovative partners improved baseline innovation and growth rate, but collaborations with small and technological unsophisticated partners had an immaterial effect.</td>
<td></td>
</tr>
<tr>
<td>Author(s)</td>
<td>Independent variables</td>
<td>Innovation measures</td>
<td>Dependent variables</td>
<td>Performance measures</td>
<td>Other variables</td>
<td>unit of analysis</td>
<td>Main findings</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>----------------------</td>
<td>-----------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Dutta, Narasimhan &amp; Rajiv (1999)</td>
<td>R&amp;D capabilities, marketing capabilities</td>
<td>Sales revenue, technology base, cumulative R&amp;D experience, cost of production</td>
<td>Relative performance</td>
<td>Profitability (function of capabilities)</td>
<td></td>
<td>92 semiconductor firms</td>
<td>The most important determinant of a firm's performance is the interaction of marketing and R&amp;D capabilities.</td>
</tr>
<tr>
<td>Moorman &amp; Slotegraaf (1999)</td>
<td>Product technology capability, product marketing capability</td>
<td>Patent, market share</td>
<td>Product development outcomes</td>
<td>Brand quality improvements</td>
<td></td>
<td>524 U.S. firms</td>
<td>The complements of product and marketing capability have positive effect on product development outcomes.</td>
</tr>
<tr>
<td>Roberts (1999)</td>
<td>Innovation propensity</td>
<td>Profitability</td>
<td>Objective: After-tax return on assets</td>
<td></td>
<td></td>
<td>4914 products and 40 firms in Pharmaceutical industry in US</td>
<td>The innovative propensity influences the extent to which abnormal profit outcomes persist over time.</td>
</tr>
<tr>
<td>Ettlie (1998)</td>
<td>R&amp;D capability</td>
<td>R&amp;D intensity</td>
<td>Manufacturing performance</td>
<td>Improvement of market share</td>
<td>Region, industry, firm size,</td>
<td>five industries in 20 countries (including 600 firms)</td>
<td>R&amp;D intensity shows a direct and significant effect on market share increase.</td>
</tr>
<tr>
<td>Han, Kim &amp; Srivastava (1998)</td>
<td>Innovativeness</td>
<td>Number of innovations implemented in an organization</td>
<td>Growth and profitability</td>
<td>Objective: net income growth and return on assets</td>
<td>Environmental turbulence</td>
<td>134 firms in banking industry in US</td>
<td>Technical innovations have positive and impacts on performance.</td>
</tr>
<tr>
<td>Fawcett, Calantone &amp; Smith (1997)</td>
<td>Delivery capability</td>
<td>Subjective items</td>
<td>Performance</td>
<td>Subjective items</td>
<td></td>
<td>524 U.S. firms</td>
<td>A delivery capability can help a firm achieve high levels of performance in cross-national production sharing operations.</td>
</tr>
</tbody>
</table>
Table 3.1 continued

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Independent variables</th>
<th>Innovation measures</th>
<th>Dependent variables</th>
<th>Performance measures</th>
<th>Other variables</th>
<th>unit of analysis</th>
<th>Main findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawless and Anderson (1996)</td>
<td>innovativeness</td>
<td>Portion of other firms</td>
<td>Performance</td>
<td>market share</td>
<td>Firm age, industry demand, industry growth</td>
<td>microcomputer industry in US</td>
<td>Firm performance is affected by its position on new technology relative to others. Those ahead on innovation will perform better.</td>
</tr>
<tr>
<td>Subramanian and Nilakanta (1996)</td>
<td>Innovativeness</td>
<td>Number of innovation adoptions, Time of innovation adoption</td>
<td>Efficiency and effectiveness</td>
<td>Objective: return on assets, market share</td>
<td>Firm size</td>
<td>350 firms banking industry in US</td>
<td>Organizational size was significantly associated with the time of adoptions.</td>
</tr>
<tr>
<td>McGee, Dowling &amp; Megginson (1995)</td>
<td>Market differentiation, technical differentiation</td>
<td>Market experience and activities, technology experience and activities</td>
<td>Financial performance</td>
<td>Average sales growth</td>
<td>3 high technology industries</td>
<td>Firms benefit from more experienced managers who better understand what they don’t know and what they might learn from cooperation.</td>
<td></td>
</tr>
<tr>
<td>Nicholson, Rees and Brooks-Rooney (1990)</td>
<td>Innovation</td>
<td>needs for and actual innovation, ratings of areas of possible innovation</td>
<td>Performance</td>
<td>financial viability, market security, capacity to withstand change and ability to attract and retain staff</td>
<td>Firm level, 252 in wool textiles industry in UK</td>
<td>Firms can benefit from generating a climate of innovation, in which new ideas are encouraged.</td>
<td></td>
</tr>
<tr>
<td>Hill &amp; Snell (1988)</td>
<td>Innovation</td>
<td>R&amp;D expenditure per employee</td>
<td>Financial performance</td>
<td>ROA</td>
<td>Strategy diversification</td>
<td>94 research-intensive firms</td>
<td>Innovation is associated with high profitability, whereas diversification was shown to be associated with lower profitability.</td>
</tr>
</tbody>
</table>

Note: ROA: return on assets. ROS: return on sales. ROE: return on equity.
The preceding two chapters reviewed relevant theories and empirical studies concerning the determinants of firm performance. Recently, researchers in strategic management investigating this topic have typically focused on the resource-based view of the firm, which suggests that firm internal idiosyncratic capabilities and resources drive firm performance and competitive advantage. On the other hand, traditional firm-level innovation theories in the innovation literature postulate that innovation involving technologically new or improved products and processes in an individual firm is of great importance to firm growth and competitive advantage. These theories and empirical findings have built on a theoretical grounding for developing the research framework that examines the impact of innovation capabilities on firm performance in Chinese industrial firms during China's transitional economy.

Drawing on the resource-based view of the firm as well as firm-level innovation concepts and models, especially the chain-link model of innovation, the research framework for this study is designed to examine whether several internal innovation capabilities have the independent and interactive impact on firm performance in Chinese industrial firms. The framework then allows for an exploration of how some environmental or organizational factors moderate the relationship between innovation capabilities and firm performance during China's transitional economy. The argument developed in this thesis is based on the premise that these innovation capabilities as firm internal idiosyncratic resources play a critical role in helping the firm to sustain or improve its superior performance.

This chapter is organized as follows. The first section briefly presents the innovation concepts used in this study. The second section then develops a research framework. This is followed by the dimensions of innovation capabilities in the third section and the dimensions of firm performance in the fourth section. The last section presents the chapter summary.
4.1 Definitions of Innovation and Firm Internal Innovation Capabilities

This section discusses two key concepts used in this study: innovation and firm internal innovation capabilities. These concepts are central to further discussions on the relationship between innovation capabilities and firm performance, and require elaboration.

Innovation

In conceptualizing innovation in industrial firms, this study relies on the OECD’s (1997) notions of technological innovation. Technological innovations comprise specifically ‘implemented technologically new products and processes and significant technological improvements in products and processes’ (OECD, 1997: 47). This is because technological innovation is typically significant to industrial firms where the technology and product development is a core of production. In this definition, the central criterion is that innovation must be perceived as technologically new or significantly improved to the firm. Innovation thus represents firm-specific capabilities and resources that are likely to yield meaningful differences for firms in market success and performance. Consistent with the concept of OECD’s technological innovation, innovation discussed in this study includes product innovation and process innovation. The term ‘product’ refers to both new or improved goods and services, while ‘process’ refers to new or improved processes such as equipment and production methods, as well as managerial or organizational changes and improvements (OECD, 1997).

Firm Internal Innovation Capabilities

From the resource-based view of the firm, a firm’s innovation is based upon the firm’s innovation capabilities and resources. Despite no authoritative definitions for innovation capabilities in the literature, innovation capabilities in terms of various dimensions are discussed generally as the abilities required to deal with firms’ innovation activities, such as creating and introducing new knowledge and ideas of technology, developing and introducing new products and processes, responding to environment and market changes, as well as successfully bringing new products and processes into markets (Christensen, 1995; Lall, 1994; Teece and Pisano, 1994).
Following the concepts frequently used in the literature presented in Chapter Two and the definition of 'innovation' adopted above, the present study defines *firm internal innovation capabilities* as 'the combination of a firm’s specific abilities required to consistently develop and introduce technologically new or improved products and processes as well as bring them into markets in order to provide the advantage towards achieving superior performance'.

This definition of innovation capabilities focuses on the *combination* of abilities, since innovation is a complex process and most technological innovation requires the combinations and interactions of different capabilities/resources (Christensen, 1995; OECD, 1997). The definition also emphasizes a firm’s *specific* abilities. Since specific abilities/resources are valuable, rare, inimitable and imperfectly substitutable that they are likely to lead to a firm’s superior performance (Barney, 1991). Like Subramaniam and Venkatraman’s (2001) study, the definition in this study suggests the *consistency* of innovation, because sporadic new product or process development cannot enable firms to achieve sustained performance. Moreover, the definition includes *technologically* new or improved products and processes, since technological novelty is a central measure of technological innovation (OECD, 1997). Finally, this definition focuses on *advantage* of abilities towards achieving superior performance, since the importance of capabilities to firm performance is essential to the perspective of the resource-based view of the firm.

Based on the above definition of innovation capabilities, this study seeks to have a good understanding of the relationship between innovation capabilities and firm performance in Chinese industrial firms. A research framework is needed to define what kind of analyses and research should be carried out to achieve the above objective of this study. A research framework provides a basis for a specific research and lay down paths of analyses for achieving the research objective.

### 4.2 Research framework

A large body of empirical research addresses the determinants of firm performance. Industrial organizational economics perspective indicates the nature of industrial and market
structures as the important determinant of firm performance (Bain, 1968; Mason, 1939; Porter, 1980). Organizational environment theories suggest that intra-industry organizational environments in which a firm operates are primary sources of firm performance (Hansen and Wernerfelt, 1989; Scott, 1992). The resource-based view of the firm stresses the importance of firm internal idiosyncratic capabilities/resources in shaping firm performance (Barney, 1991; Peteraf, 1993; Wernerfelt, 1984). Firm-level innovation theories posit that a firm’s innovation is the critical determinant of the firm’s growth and competition (OECD, 1997; Schumpeter, 1934; Sundbo, 1998). Designing a research framework should be based on relevant theoretical foundation and specific research issues. Thus, given the primary research issue to be explored in this study concerning how firm internal innovation capabilities influence firm performance in Chinese industrial firms during China’s transitional economy, the design of the present research framework is based on two firm-level theories: the resource-based view of the firm and the chain-link model of innovation.

Moreover, as noted previously, China’s transitional economy is characterized by a hybrid economy of administrative and market mechanisms. Chinese firms face quite different market environments than their counterparts in market economies. Some specific environmental and organizational factors may significantly influence firms’ innovation activities and the relationship between innovation and firm performance. Research framework design should also concern the influence of these environmental and organizational factors on the relationship between innovation capabilities and firm performance.

Figure 4.1 depicts the research framework that presents the factors in this study that are assumed as influencing industrial firms’ performance in China’s transitional economy.
Figure 4.1 Research Framework

Environmental Factors
- Region development
- Innovation policy support

Input-oriented Innovation Capabilities
- R&D Capability
- Absorptive capability of external technology resources
- Manufacturing capability

Output-oriented Innovation Capabilities
- Product development capability
- Process innovative capability
- Marketing capability

Organizational Factors
- Industry type
- Ownership

Performance
- Financial
- Market
- Innovation

Note: → are the focuses of this study.
First, as the primary interest of this study is to understand the impact of innovation capabilities on firm performance, and given the multidimensional nature of innovation capabilities and firm performance, the study simultaneously examines the impact of several input-oriented and output-oriented dimensions of innovation capabilities required by the different stages of innovation process, rather than a single or an integrated dimension, on different types of firm performance. The rationale for the selection is influenced by the chain-link concept of innovation as ‘interaction between market opportunities and the firm’s knowledge base and capabilities’ (OECD, 1997: 37).

This idea is also supported by the authors who suggest that innovation is an interactive process that integrates input capabilities such as R&D and technology accumulation, and output capabilities such as innovation outcomes and market opportunities (Day, 1994). In this study, input-oriented innovation capabilities include R&D capability, absorptive capability of external technology resources, and manufacturing capability, while output-oriented innovation capabilities include product development capability, process innovative capability, and marketing capability. A proposition underlying the present study is that each dimension of input-oriented and output-oriented innovation capabilities has a independent and significant impact on each firm performance dimension.

Second, this study suggests that the interaction between input-oriented and output-oriented innovation capabilities has a significant relationship with firm performance. This proposition is consistent with the interactive characteristics of innovation and the perspective of capabilities and resources complementarity (Christensen, 1995; Dutta, Narasimhan and Rajiv, 1999; Moorman and Slotegraaf, 1999, OECD, 1997). Moreover, the complementary capabilities in a firm are more likely to be difficult to imitate by competitors (Grant, 1991; Reed and DeFillippi, 1990). When a firm holds both input-oriented and output-oriented capabilities, innovation can be successful and the firm can benefit from these capabilities (Moorman and Slotegraaf, 1999). This study typically emphasizes the effect of R&D capability and marketing capability interaction, because these two capabilities are critical to achieving superior
The Development of Research Framework

performance, and their interaction, which is frequently discussed in the literature (e.g., Dutta, Narasimhan and Rajiv, 1999; Gupta, Raj and Wilemon, 1986; Hise, O’Neal, Parasuraman and McNeal, 1990), is a central interaction in innovation process (OECD, 1997).

Third, this study is built on the proposition that the impact of innovation capabilities on firm performance is moderated by environmental factors. This assumption is based on the contingency approach to the innovation-performance relationship, which postulates that a firm’s innovation and performance are influenced by environmental factors (Chryssochoidis and Wong, 1998; Cooper, 1979; Davies, 2001; Kotha and Nair, 1995; Mishra, Kim and Lee, 1996). Environmental factors include a lot of aspects such as market uncertainty, regulatory environment, technological turbulence, environmental munificence, and competitive environment, etc. This study restricts the attention to two external environmental factors: regional development and government innovation policy environment. This is because the study is concerned with a ‘transitional economy’ environment. Innovation in Chinese firms is significantly affected by regional development because of the regional variation of economic growth and specific technology resource distribution. Moreover, the variation of regional development provides firms with environmental munificence, which reflects the capacity of the environment to support firms in the markets (Dess and Beard, 1984; Yasai-Ardekani, 1989). It is argued that the environmental munificence is significantly associated with firm performance (Kotha and Nair, 1995). On the other hand, in China’s transitional economy, the government still plays a critical role in supporting firms’ innovation activities. Innovation and performance in many firms, to a large extent, rely on government support. Thus, the favorable environments created through government innovation policies provide firms with the significant effect on innovation and performance.

Finally, this study proposes that the relationship between innovation capabilities and firm performance is also affected by organizational factors. This proposition is consistent with the assumption that firms’ innovation and performance are facilitated and influenced by organizational characteristics or structures such as size, ownership, type of firm, degree of
specialization, and so on so forth (e.g., Bain, 1968; Damanpour, 1991; Hansen and Wernerfelt 1989; Markides and Williamson, 1996; Mason, 1939; Subramanian and Nilakanta, 1996). One of the specific organizational characteristics in transitional economies is economic ownership of firm. Since the beginning of economic reform, significant ownership transformation has taken place in China’s transitional economy, due to the processes of privatization and entry of foreign firms. During this transformation, the characteristics of firms with different ownership strongly influence the firms’ innovation and performance (Child, 1994). On the other hand, the concepts of high and low technology intensity imply the technological specialization of a firm. For different technology-specific firms, innovation behaviors and effectiveness may be different in order to respond to changes in markets and achieve superior performance. It is important to form typology of high and low technology intensity in studies of innovation and its relationship with firm performance. This study therefore takes into account two key organizational factors: industry type and economic ownership of firm.

In brief, the research framework presented in Figure 3.1 illustrates the significant relationship between innovation capabilities and firm performance. It should be stated that hypotheses concerning direct effects of external environmental or internal organizational factors on firm performance will not be developed in this study. There are two reasons for this. First, this study is based on the resource-based view of the firm to examine the association between innovation capabilities and firm performance. To sharpen this research purpose, the present study focuses on the development of hypotheses concerning the impact of innovation capabilities on firm performance. Second, it does not mean that the influence of those environmental and organizational factors on firm performance is not important. This study also proposes the moderating effects of environmental and organizational factors on the relationship between innovation capabilities and firm performance. Therefore, the impact of environmental and organizational factors on firm performance can be demonstrated by these moderating influences.
4.3 Dimensions of Innovation Capabilities in Chinese Firms

The research framework was designed to examine the impact of different dimensions of innovation capabilities on firm performance. It is necessary to further identify these dimensions in details, before discussing their potential impacts.

As mentioned in Chapter Two, from the resource-based view of the firm, internal innovation capabilities are firms' idiosyncratic capabilities and resources, which can result in superior performance. Researchers investigating the determinants of firm performance have come to consider innovation capabilities as key constructs in their empirical studies. In spite of the progress made by past empirical research, the conceptualization and dimensions of innovation capabilities remain rather vague. An initial conceptual task for the present research is to identify the dimensions that can be used to measure innovation capabilities. Innovation capability dimensions articulated in this study are based upon several considerations.

First, explicit and precise dimensions of innovation capabilities are an essential, prerequisite and rigorous basis of better understanding and explaining the performance implications of innovation capabilities. Previous research has found that the lack of consistency and comparability of measurement of innovation capabilities across studies is a liability for research and may cause confusing implications for innovation management (Danneels and Kleinschmidt, 2001).

Second, innovation capabilities, by definition, are a combination of knowledge basis and capabilities/resources required by a firm's consistent innovation behavior. The full extent of innovation capabilities should exhibit innovation potential and advantage. Valid dimensions of innovation capabilities should capture various characteristics of innovation. However, it is acknowledged that adequate dimensions of innovation capabilities are difficult to define.

Third, as mentioned in Chapter two, no single concept of innovation capabilities can reflect all aspects of innovation. Any valid measure of innovation capabilities should be based upon several aspects of innovation.
Due to the importance, difficulty and multidimensional nature of the innovation capability construct, the present study focuses on several dimensions of innovation capabilities, which have been frequently used or suggested in the literature and can be implemented in Chinese industrial firms. Several criteria of selecting the dimensions of innovation capabilities should be emphasized. First, these dimensions should reflect major innovation capabilities required in different stages of the innovation process. Second, the dimensions should emphasize the idiosyncratic characteristics of innovation capabilities. Third, they should focus on the characteristics of innovation capabilities in industrial firms in transitional economies. Fourth, they should be available and controllable by researchers and firm managers. Finally, the dimensions should be consistent with the interest and concerns of industrial firm innovation researchers and managers.

Based on innovation and the resource-based view of the firm literature, and combined with the exploratory survey in Chinese industrial firms, as noted in section 4.2, the dimensions of innovation capabilities used in this study encompass two types of innovation capabilities, namely input-oriented innovation capabilities and output-oriented innovation capabilities. They are identified in Figure 4.1, Research Framework, and used in data analyses in Chapter Seven.

4.3.1 Input-oriented Innovation Capabilities

Input-oriented innovation capabilities reflect a firm’s abilities to engage in new idea generation, knowledge accumulation, R&D activities and production resulting in new products or processes. This study considers three input-oriented innovation capabilities: R&D capability, absorptive capability of external technology resources, and manufacturing capability.

R&D Capability in Chinese Firms

There are two reasons to consider R&D capability as a dimension of innovation capabilities in Chinese industrial firms. First, the importance of R&D capability has been well documented in the literature (Dutta, Narasimhan and Rajiv, 1999; Hitt, Hoskisson and Kim, 1997; Lukas and Bell, 2000; Pisano, 1990). Although, not all firms conduct R&D in innovation activities, R&D capability has been identified as the basic asset/function to produce
The Development of Research Framework

technological innovation (Christensen, 1995). It also allows the firm to apply new knowledge and technologies to the production of existing or new products (Yeoh and Roth, 1999). Therefore, a firm's superior R&D capability has the predominant impact on competitive advantage, because it can provide the firm with potential to continuously dominate the markets over the generations of know-how and new products (Dutta, Narasimhan and Rajiv, 1999). Second, since economic reform, Chinese firms have begun to emphasize internal R&D capability in order to increase their internal product development. For example, from 1991 to 1997, R&D expenditures in large and medium-sized industrial firms in China increased from 5.86 billion yuan RMB to 19.13 billion yuan RMB, with an average annual growth of 21.8 percent (Figure 4.2).

![Figure 4.2 R&D Expenditures in Chinese Large and Medium-sized Industrial Firms (1991-1997) (in 100 million yuan RMB)](image)

Source: China Science and Technology Indicators (1998)

Theoretically, R&D capability in industrial firms also builds on the resource-based view of the firm's focus on the firm's specific abilities and resources such as developing and exploiting know-how, which confers advantage and hard imitation (Dutta, Narasimhan and Rajiv, 1999). Particularly, R&D capability refers to a firm's abilities to generate new idea and knowledge, develop new technology, and exploit existing knowledge and technology for specific technological innovation (Christensen, 1995; Luka and Bell, 2000; Pisano, 1990). The focus of this study on R&D capability in Chinese industrial firms is consistent with above concept.
Absorptive Capability of External Technology Resources in Chinese firms

The point of departure of absorptive capability taken by Cohen and Levinthal (1989, 1990) indicates that external technology resources are important to innovation process. Absorptive capability of external technology resources is complementary to internal technology development capabilities, and determined by internal stock of prior knowledge, technological change, and external learning (Cohen and Levinthal, 1990; Costa, 2001). As mentioned in Chapter Two, absorptive capability is conceptualized as a firm’s ability to identify, acquire, assimilate, transform and exploit knowledge for innovation from external technology resources (Cohen and Levinthal, 1990; Zahra and George, 2002). Absorptive capability encompasses not only the ability to acquire and imitate other organizations’ technology and products, but also the ability to exploit less commercially focused knowledge from external technology resources. In the context of industrial firms in transitional economies, the development of absorptive capability pays more attention to the technology acquisition and imitation from external technology resources based on learning processes. This is because of their relative weakness of internal knowledge stock and technology development. This kind of absorptive capability associated with learning refers to a firm’s ability to identify, absorb, assimilate and utilize external knowledge and technology (Adams, Day and Dougherty, 1998; Cohen and Levinthal, 1990; Lane and Lubatkin, 1998).

Based on the above discussion, it is necessary to view absorptive capability of external technology resources as a dimension of innovation capabilities in Chinese industrial firms. Moreover, consistent with the above focus on the concept of absorptive capability, this study considers absorptive capability of external technology resources as a firm’s ability to absorb and acquire technology and skills through cooperation with outside organizations and inter-firm resources, and to utilize these skills and technology for internal technology development. Thus, absorptive capability of external technology resources is the result of a series of a firm’s activities of technology acquisition that are embedded in innovation.
Manufacturing Capability in Chinese Firms

Academics have indicated that manufacturing capability related to innovation has a close relationship with innovation success and firm performance (Cil and Evren, 1998; Jonsson, 1999; Rho, Park and Yu, 2001; Safizadeh, Ritzman and Mallick, 2000; Schroeder, Bates and Junttila, 2002; Swink and Hegarty, 1998). Capabilities contained within a firm’s manufacturing processes provide coordinated manufacturing support for the essential ways in which products are differentiated from competitors’ products in the markets that give the firm a distinct advantage (Cil and Evren, 1998; Swink and Hegarty, 1998; Skinner, 1969). In fact, some researchers view manufacturing capability as a part of technological capabilities, and it covers both process and product technologies (Lall, 1994; Verona, 1999). Empirical research suggests that manufacturing capability can positively affect innovation outcomes. For example, Pisano (1996) argues that manufacturing capability of process innovation has a positive relationship with the lead-time of new product development. Thus, manufacturing capability offers a useful dimension that can be used to measure innovation capabilities.

Moreover, the elements of manufacturing capability can be characterized in different ways including quality control, flexibility, and equipment improvement, and so on, based on the different focuses of research (Lall, 1994; Schroeder, Bates and Junttila, 2002; White, 1996). In China’s transitional economy, managers in industrial firms have paid more attention to manufacturing equipment introduction and improvement to meet the requirements of new product production. It is recognized that the lack of equipment with advanced technology and management, sometimes, leads to innovation failure. The equipment introduction and improvement is a direct way for Chinese firms to acquire and implement new technology to build manufacturing capability for innovation success, since new manufacturing equipment comprises a broad menu of technologies.

Based on the above discussion, manufacturing capability used in this study refers to a firm’s abilities to increase the efficiency and function of product production system through the introduction and implementation of new or improved equipment and production methods, which
are expected to involve advanced manufacturing technologies and management. In the empirical analysis part, this concept is used to develop the measures of manufacturing capability in the empirical analyses.

4.3.2 Output-oriented Innovation Capabilities

Output-oriented innovation capabilities focus on a firm's ability to successfully introduce new products, adopt new processes and bring them to the markets. In this study, product development capability, process innovative capability, and marketing capability are three important output-oriented innovation capabilities.

Product Development Capability in Chinese Firms

Product innovation is one of the most important types of technological innovation in industrial firms (OECD, 1997, Schumpeter, 1934). Product innovation may allow firms to gain a monopoly position in markets and present great opportunities for firms in terms of competitive advantage, growth and performance (Schumpeter, 1934). Product innovation requires various resources and capabilities. These capabilities, such as product technical resources and skills, creation of new product ideas and integration of technologies in new product development, are the first important driven-force of product innovation (Gatignon and Xuereb, 1997; Moorman and Slotegraaf, 1999; Verona, 1999). Indeed, a capability for creating new products 'enables a firm to stay a step ahead of competitors who do not possess this capability' (Sharma and Vredenburg, 1998). The importance of product innovation and related capabilities ensure product development capability is an important dimension of firm-level innovation capabilities.

In the context of Chinese industrial firms, product innovation capability refers to a firm's abilities to successfully introduce or develop new products, as well as improve existing products technologically. The focus on this dimension in the current study is consistent with Subramaniam and Venkatraman's (2001) concept of product development capability, which emphasizes successful product development. This is used in the data analyses to develop the measures of product development capability in the empirical part of this study.
Process Innovative Capability in Chinese Firms

Process innovation is another important category of technological innovation (OECD, 1997; Schumpeter, 1934). Although, compared with product innovation, the impact of process innovation has received less attention, researchers, who are interested in process innovation, have emphasized that the role of process innovation relates not only to the improvement of manufacturing and production, but also to the aspects such as production management and product performance (Christensen, 1995). Moreover, process innovation is as a great obstacle to producing and bringing new products into markets (Hatch and Mowery, 1998). In some areas, a firm’s innovation activities are based on new product development, or new process introduction, but these two activities are complementary, no matter what is dominant (Christensen, 1995; OECD, 1997). Accordingly, the capabilities required by process innovation are different from the capabilities inherent in product development. However, capabilities related to process and product development converge for successful innovation (Weiss and Birnbaum, 1989). Because of the importance of process innovation and its complementarity to product development capability, process innovative capability is needed to be a dimension of innovation capabilities.

In this study, based on the OECD’s (1997) definition of technological process innovation, process innovative capability refers to a firm’s abilities to develop and improve methods with new or significantly improved processes, materials, elements, components and management in order to bring new products into markets. Specifically, following Christensen’s (1995) concept of process innovative assets, process innovative capability not only refers to the abilities for process development outcomes such as new equipment, but also involves the abilities for production management and organization, logistics, as well as the use of new knowledge.

Marketing Capability in Chinese Firms

Marketing is a part of innovation activities when its purpose is to implement the product and process development outcomes (OECD, 1997). Various studies on innovation and strategic management support the notion that firms need to develop innovation-related marketing capability in order to achieve innovation success and superior performance. The importance of
marketing capability is evident in two aspects. First of all, marketing capability represents special abilities and skills required to capturing and understanding customer requirements, expectations and preferences (Dutta, Marasimhan and Rajiv, 1999; Verona, 1999). It is important for firms to increase the fit with customer needs in new product and process development. These abilities and skills to obtain customer feedback require the development of channel and network bonding as well as building and maintaining relationships with customers (Dutta, Marasimhan and Rajiv, 1999; Moorman and Slotegraaf, 1999). Second, marketing capability offers special abilities to satisfy current and potential customers through the distribution and services of new products and processes in the markets. It is also important for firms to obtain rent appropriability (Mitchell, 1992; Teece, 1987; Tripsas, 1997; Verona, 1999). These characteristics of innovation-related marketing capability enable firms to achieve superior performance, since it is often firm specific and not easily imitated (Dutta, Narasimhan and Rajiv, 1999; Moorman and Slotegraaf, 1999; Zahra and Covin, 1993; Zhao, Droge and Stank, 2001).

In China's transitional economy, managers in industrial firms are increasingly emphasizing the importance of marketing capability in bringing their products to the markets. For instance, managers in industrial firms, concerned with sales growth and market share in especially home markets, have begun to focus on the construction of product distribution network.

Based on the above discussion, marketing capability is, and should be, recognized as an important dimension of innovation capabilities. Marketing capability used in this study refers to a firm's abilities to develop and maintain relationships with customers through the construction of product marketing networks and channels in order to bring suitable new products and processes to the markets. It is important for the present study to develop appropriate measures of marketing capability.

In summary, two types of innovation capabilities are conceptualized in this study: input-oriented innovation capabilities and output-oriented innovation capabilities. Input-oriented
innovation capabilities are examined by R&D capability, absorptive capability of external technology resources, and manufacturing capability. While output-oriented innovation capabilities are presented by product development capability, process innovative capability, and marketing capability. These dimensions of innovation capabilities are not exhaustive in scope as they do not reflect all aspects of innovation capabilities, for example, they do not touch on more organizational innovation. It is impossible to enumerate all possible innovation capabilities as they vary from firm to firm due to the nature of innovation activities and environments, and it should be noted that this study does not attempt to capture all dimensions of innovation capabilities. This is because, for this study, it is more important to establish reasonable and valid assessments of innovation capabilities to examine the impact of innovation capabilities on firm performance in a transitional economy, rather than develop complex innovation capability measurements. This study therefore focuses on main assessments of capabilities in industrial firms' innovation process. In general, the choices on these six dimensions of innovation capabilities enjoy broad focus and prominence in the innovation and strategic management literature. They are considered fundamental and meaningful to innovation and can influence firm performance. Moreover, these six dimensions are associated with technological innovation in industrial firms, albeit some more directly than others. The following proposition provides the basis for developing specific hypotheses of this study.

**Proposition 1:** Based on the resource-based view of the firm and the chain-link model of innovation, innovation capabilities in Chinese industrial firms in China's transitional economy can be briefly conceptualized by six dimensions: R&D capability; absorptive capability of external technology resources; product development capability; process innovative capability; manufacturing capability; and marketing capability.

In order to develop more specific rubric for examining the importance of innovation capabilities, it is important to un-bundle the notion of firm performance. The next section will discuss the dimensions of firm performance presented in the research framework.
4.4 Dimensions of Firm Performance in Chinese Firms

The concept of performance is a firm’s central consideration (Venkatraman and Ramanujam, 1986). It is well known that firm performance is a multidimensional construct and any single dimension may not provide fully understanding of all aspects of performance (e.g., Damanpour and Evan, 1984; McGee, Dowling and Megginson, 1995; Simerly and Li, 2000; Slater and Olson, 2000; Gopalakrishnan, 2000; Subramanian and Nilakanta, 1996). The choice of firm performance dimensions is indeed a major issue that warrants careful consideration.

At least, three primary factors should be considered in the choice of performance dimensions. First, performance dimensions should reflect the fulfillment of firms’ economic and strategic goals, since performance is at the heart of firm development (Venkatraman and Ramanujam, 1986). Second, performance dimensions should be appropriate for the research purposes, because different research has different questions and purposes that require the different measures of performance (Hofer, 1983). Third, the data of performance dimensions should be available and comparative among the relevant firms (Damanpour and Evan, 1984). On the other hand, the strategic management literature suggests that firm performance dimensions should focus on several factors: financial profitability and efficiency; customers; market effectiveness; technological efficiency; and product development (Delaney and Huselid, 1996; Ittner and Larcker, 1998; Shortell and Zajac, 1988; Venkatraman and Ramanujam, 1986).

Based on these considerations, it is important and appropriate to use multiple dimensions of firm performance in this study. Meanwhile, this research attempts to provide an overall understanding of the relationship between innovation capabilities and firm performance. In order to illustrate the ways in which innovation capabilities could be related to firm performance, the present study assesses performance through three dimensions: financial performance; market performance; and innovation performance. This is because these three dimensions of firm performance reflect a firm’s primary economic, market-based and innovation goals of development. Financial performance focuses on a firm’s overall economic goal. It is ultimate for all firms (Damanpour, Szabat and Evan, 1989). Market performance
emphasizes factors such as market competitive advantage, market share achievement and customer satisfaction. It is one of the most important strategic goals of a firm’s development. Obviously, innovation performance reflects the direct effectiveness of firm innovation. An examination of these three dimensions allows for a comparison of the relative impacts of innovation capabilities in different aspects, and should provide some confirmatory information on how innovation capabilities are associated with firm performance. These concepts are illustrated in Figure 4.1.

Financial performance is widely used to describe firm performance in strategic management research (Hofer, 1983; Venkatraman and Ramanujam, 1986). It refers to the dominance of firms’ financial goals and reflects aggregate firm performance. The financial performance dimension includes both efficiency-oriented measures such as input/output relationship, and effectiveness-oriented measures such as firm growth. Many empirical studies suggest that some innovation capabilities have a significant impact on firm financial performance (Baker and Sinkula, 1999; Ballot, Fakhfakh and Taymaz, 2001; Calantone, Vickery and Droge, 1995; Gemser and Leenders, 2001; Pegels and Thirumurthy, 1996). In this study, financial performance focuses on efficiency-oriented measures such as return on sales, due to the availability of data among firms.

Market performance is another widely recognized dimension of firm performance (Slater and Olson, 2000). Market performance provides information on the fulfillment of firms’ market goals. The market performance dimension focuses on market-oriented measures such as market-share, sales growth and customer satisfaction. Some market performance indicators are correlated with financial performance indicators. For example, market-share is highly associated with profitability (Delaney and Huselid, 1996; Venkatraman and Ramanujam, 1986). On the other hand, market performance is adopted as a dimension of firm performance since it has been suggested by some empirical studies in strategic management that market development and growth are indicative of innovation success (Atuahene-Gima, 1995; Ettlie, 1998; Jaworski and Kohli, 1993; Patterson, 1998). This study measures market performance by evaluating the
achievement of innovation-oriented market goals of a firm such as the increase of market share and the development of new markets.

_Innovation performance_ refers to the effectiveness of product and process development on achieving the firm's overall goals. As the term suggests, innovation capabilities should have a direct and close relationship with innovation performance (Iansiti and West, 1999; Mishra, Kim and Lee, 1996; Zirger, 1997). The emphasis of innovation performance dimensions may differ according to whether the innovation is product or process innovation (Lilien and Yoon, 1989). In this study, the measures of innovation performance focus on the effectiveness of new product development.

The above discussion of the dimensions of firm performance leads to the following proposition. They are incorporated into the research framework and used for the data analyses in Chapter Seven.

**Proposition 2:** Chinese industrial firms' performance in China's transitional economy can be generally characterized by three dimensions that may be influenced by innovation capabilities: financial performance; market performance; and innovation performance.

**4.5 Chapter Summary**

In this chapter, a research framework was developed to illustrate the independent impact of innovation capabilities and the interactive impact of R&D capability and marketing capability on firm performance, as well as the moderating effect of environmental and organizational factors on the relationship between innovation capabilities and firm performance based on the resource-based view of the firm and the chain-link model of innovation. In this study, innovation capabilities in Chinese industrial firms were conceptualized by R&D capability, absorptive capability of external technology resources, product development capability, process innovative capability, manufacturing capability, and marketing capability. Firm performance was measured by three dimensions: financial performance; market performance; and innovation performance. These dimensions provide a prerequisite to the development of more specific hypotheses. On the other hand, as mentioned above, although
these dimensions of innovation capabilities and firm performance may not be exhaustive, innovation capability dimensions represent significant characteristics of innovation, while firm performance dimensions reflect fundamental goals of a firm's development. Thus, these dimensions used in the present study are meaningful in providing some specific insights into the association between innovation capabilities and firm performance in Chinese industrial firms during China's transitional economy.

The next Chapter will develop the relevant hypotheses concerning the independent, interactive and moderated impacts of innovation capabilities on firm performance in Chinese industrial firms.
CHAPTER FIVE
THE IMPACT OF INNOVATION CAPABILITIES ON FIRM PERFORMANCE AMONG CHINESE FIRMS - THE DEVELOPMENT OF HYPOTHESES

From the resource-based view of the firm, firms can be seen to differentiate their performance on the basis of their internal innovation capabilities, since innovation capabilities comprise new knowledge, know-how, specific technology skills that are valuable and difficult to imitate by other firms. The research framework developed in Chapter Four therefore proposes the independent, interactive and moderated impact of innovation capabilities on firm performance, based on six innovation capability dimensions, three firm performance dimensions and four environmental and organizational factors. This chapter presents the relevant hypotheses based on six major arguments:

1. Innovation capabilities among Chinese industrial firms will have a significant and positive impact on firm performance;
2. The interaction of R&D capability and marketing capability among Chinese industrial firms will have a significant and positive impact on firm performance;
3. The impact of innovation capabilities on firm performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low development regions;
4. The impact of innovation capabilities on firm performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak;
5. The impact of innovation capabilities on firm innovation performance is likely to be significantly higher in Chinese industrial firms of high technology industries than it is in firms of low technology industries; and,
6. The impact of innovation capabilities on firm performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and LJV's than it is in SOEs.
It should be noted that this study seeks to examine how different innovation capabilities associated with different stages of innovation process influence three different firm performance objectives. Consistent with this objective of the study, the above three types of impact of innovation capabilities are examined by investigating the relationship between each innovation capability dimension and each firm performance dimension that lead to the development of a large number of hypotheses.

This chapter proceeds as follows. Section 5.1 presents the hypotheses concerning the independent impact of each dimension of innovation capabilities on firm performance. Section 5.2 hypothesizes the interactive impact of R&D capability and marketing capability on firm performance. This is followed by a presentation of hypotheses related to the moderating effects of environmental and organizational factors on the relationship between innovation capabilities and firm performance in Section 5.3. The last section offers a summary of this chapter.

5.1 The Independent Impact of Innovation Capabilities on Firm Performance

Given the different characteristics of each dimension of innovation capabilities, the next issue is to determine which type of innovation capability has stronger impact on different firm performance dimensions. This section discusses the impact of each innovation capability dimension on performance in Chinese industrial firms and leads to a set of hypotheses towards which the analyses in the empirical part of this thesis are directed.

5.1.1 R&D capability and Firm Performance

R&D capability is critical to firm performance for several theoretical reasons. First, R&D capability can be directed toward firms' internal development activities, or the absorption of outside new knowledge (Cohen and Levinthal, 1990), which leads to creation of new technology and exploitation of existing technology. These new or improved technologies are of competitive and specific nature, which makes it difficult for other firms to imitate (Christensen, 1995). Moreover, R&D activities enable firms to apply required know-how and tacit knowledge continuously to the production of existing and new products that provide more competitive advantage in the markets (Dutta, Narasimhan and Rajiv, 1999; Yeoh and Roth, 1999). Second,
R&D capability is closely linked to product and process development. Strong R&D capability can help firms to capture environmental and technological changes to ensure effective product and process development (Atuahene-Gima and Evangelista, 2000; Moenaert, and Souder, 1996). Third, the importance of R&D capability can be understood from product lifecycle theory. Due to the rapid technology changes, the lifecycle of products in many markets, especially in high technology markets are relatively shorter than before. R&D capability, which focuses on creating new knowledge and technology, as well as improving existing technology, provides firms with the potential to increase the domination of the markets through continuous generation and diversification of products, in turn to achieve superior performance (Lukas and Bell, 2000).

As mentioned in Chapter Three, some empirical research results have shown the importance of R&D for firm performance. For example, R&D capability reported by R&D intensity can be positively associated with firm performance (Ballot, Fakhfakh and Taymaz, 2001; Brenner and Rushton, 1989; Dutta, Narasimhan and Rajiv, 1999; Ettlie, 1998; Patterson, 1998; Pegels and Thirumurty, 1996). Other resources related to R&D such as R&D skills and people (Mishra, Kim and Lee, 1996) and R&D managers (Atuahene-Gima and Evangelista, 2000; McGee, Dowling and Megginson, 1995) are also important for improving firm performance. These empirical studies highlighted the role of R&D capability as an important determinant of creating superior performance in market economies.

However, this study takes these findings as problematic for China's business environment. This is because questions may be raised concerning whether Chinese firms have to develop their own internal R&D capability, whether it is critical or not, since Chinese firms lack independent R&D capabilities during the transitional process (White, 2000). Chinese firms may be innovative and achieve their performance especially in local markets through acquiring outside technology resources and capabilities, or other types of resources. However, as mentioned in Chapter Two, it has to be with a relatively strong ability to get access to suitable technology resources, if a firm just relies on external technology. This kind of ability in a firm is
closely related to the firm’s internal R&D capability (Cohen and Levinthal, 1990). Further, one of the central arguments in this study is that it is especially true that R&D capability is critically important when Chinese firms must move from acquiring new ideas and technology from outside research organizations such as research institutes and universities to inwardly developing their own technology. Traditionally, Chinese firms have obtained new technology from R&D carried out through government-sponsored research and development institutes and universities rather than internally. However, due to the opening of markets during the reform period, Chinese firms have to rely less on government sponsored technology resources, but more on their own internal R&D efforts. On the other hand, the lack of intellectual property rights protection and the difficulty of transaction costs in China’s transitional economy make it difficult, to some extent, for them to acquire necessary technology from outside organizations in an effective way. Nevertheless, Chinese firms have to improve their independent R&D capability in order to achieve superior performance. It is therefore important to explore this question in the context of a large and varied sample of firms in China. This leads to the following hypothesis that will provide a standing point for further analyses:

**Hypothesis 1**: R&D capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.

5.1.2 Absorptive Capability of External Technology Resources and Firm Performance

According to modern innovation theory, innovation is understood as a result of feedback loops between knowledge and technology base/stocks, capabilities and market opportunities (OECD, 1997). Absorptive capability of external technology resources provides firms with the capacity to obtain new technology resources from outside resources to enlarge internal knowledge base and resources in order to respond to market opportunities and comply with rapidly changing environments. In other words, absorptive capability of external technology resources has a recursive relationship with innovation. It can influence the speed, frequency and magnitude of innovation, and is determined by internal technology development (Kim and Kogut, 1996; Helfat, 1997; Van Den Bosch, Volberda and deBoer, 1999). Absorptive capability
emphasizes the acquisition of adequate and advanced technology for competing in new technology, and novel combinations of existing technologies and know-how (Kogut and Zander, 1992; Lane, Koka and Pathak, 2002; Van Den Bosch, Volberda and deBoer, 1999). Thus, absorptive capability of external technology resources should be valuable and inimitable for a firm that forms one of the basic determinants of superior performance.

However, the situation is complicated by the specific characteristics of certain technology. Cohen and Levinthal’s (1990) absorptive capability allows a firm to better assimilate and exploit relevant new knowledge and technology, since absorptive capability helps to obtain some of particular knowledge and technologies, which are closely associated with required new knowledge, technology and products. Moreover, absorptive capability permits firms to better understand and predict new technology opportunities, which ‘provide signals as to the eventual merit of a new technology development’ (Cohen and Levinthal, 1990: 136). Thus, firms with stronger absorptive capability will be in a better position to assimilate and utilize new technology in innovation and increase the feed-back in the process of interaction between technology and market opportunities that leads to competitive advantage and superior performance.

These different perspectives demonstrate that the primary purpose of developing absorptive capability is to enlarge a firm's specific knowledge and technology stocks, which may lead to successful innovation, in turn, lead to superior performance. Nevertheless, these perspectives are consistent with each other and provide a rationale for anticipating positive relationship between absorptive capability and firm performance.

In the context of transitional economies, much of knowledge and technology accumulated during the central planned economy may not be suitable and may be obsolete in new environmental conditions (Murell and Wang, 1993). In order to adapt to changing environments and market competitions, firms have to develop new resources and improve their current knowledge and technology stocks. Given the lack of internal new technology resources and tacit knowledge, absorptive capability of external technology resources is more important for firms
The Impact of Innovation Capabilities on Firm Performance among Chinese Firms—The Development of Hypotheses

in transitional economies to improve their existing knowledge and technology stocks through effectively acquiring, imitating and utilizing external new technologies and knowledge. The analytical framework developed here anticipates that the absorption of external technology may help the firm to better understand and respond to the changing markets, and achieve competitive advantage. These arguments lead to the development of following hypothesis:

**Hypothesis 2**: Absorptive capability of external technology resources among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.

5.1.3 Product Development Capability, Process Innovative Capability and Firm Performance

According to Schumpeter's (1934) approach to innovation theory, a firm's high profits may come from product and process innovation, since an innovative product or process tends to be in a relative monopolistic position at the introduction stage to the markets that the firm can have relatively higher profits than its competitors (Roberts, 1999). Based on this theory, capabilities of continuously developing and introducing product and process innovations provide a firm with the potential to have competitive advantage and achieve superior performance.

From the resource-based view of the firm, product development and process innovative capabilities are combined by firm-specific resources and assets related to product and process development. For example, they may include technological knowledge, know-how generated by R&D, advanced engineering infrastructure, new managerial methods in production and quality control procedures, and other technology-specific intellectual resources. These firm-specific resources tend to be complex to acquire and difficult to imitate. Thus, they become enduring sources for firms' competitive advantage and superior performance. Moreover, product development capability and process innovative capability may directly lead to successful product and process innovations, on which firms can rely to compete on short lifecycle product markets. Without product and process innovation, firms would have to rely on traditional
products or services that may result in failure due to resource shortcomings and questionable reputation of products (Lee, Lee and Pennings, 2001).

As mentioned previously, capabilities inherent in process innovation are different from the capabilities required by developing new products. Although, the importance of process innovative capability has received little attention in empirical research literature compared with product development capability, it is evident that process innovative capability is closely related to product development capability. In industrial firms, process innovation is often 'as great an obstacle to bringing new products to markets as product development' (Hatch and Mowery, 1998: 1461). The combination of product development capability and innovative process capability is imperfectly imitable.

A large body of empirical research has acknowledged the importance of product development and process innovative capabilities to a firm’s competitive advantage. For example, empirical research suggests that capabilities associated with product innovation are the important determinants of profitability (Calantone, Vickery and Droge, 1995; Roberts, 1999) or innovation success (Zirger, 1997). On the other hand, process innovative capability in terms of process development and managing new process introduction is significantly associated with firm innovation performance (Hatch and Mowery, 1998). More importantly, many empirical studies suggest that in order to improve performance especially innovation performance, firms must develop both product and process innovation capabilities (Brown and Eisenhardt, 1995; Loof and Heshmati; 2002; Sen and Egelhoff, 2000; Weiss and Birnbaum, 1989). These empirical findings are consistent with the emphasis of the resource-based view of the firm on firm internal specific capabilities and resources as criteria necessary for firm performance.

The importance of product development capability and process innovative capability in Chinese industrial firms is derived from the fact that during the economic transition process, firms have to introduce and develop new products rather than simply produce more of their existing products in order to achieve their efficiency-based performance (White, 2000). At the same time, to meet with this new characteristic of performance achievement, firms need to
improve production methods and adopt advanced management in production systems to bring new products to the markets successfully. Some empirical studies on Chinese industrial firms argue that lack of product advantage and specific quality components, dated production technologies and management, low level of automation, and infrastructure bottlenecks are critical obstacles to more comprehensive firm development (Child, 1987; Holden, 1985; Simon and Rehn; 1987; Song and Parry, 1994). As a result, Chinese industrial firms need to differentiate themselves from incumbents by strengthening their product development and process innovative capabilities.

It is also important to note that the above arguments offered some explanations for why Chinese firms might internally develop product development and process innovative capabilities. However, the prime focus of this study is to understand to what extent and how product development and process innovative capabilities within a firm are related to firm performance. This is investigated through hypothesis 3 and hypothesis 4:

**Hypothesis 3:** Product development capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.

**Hypothesis 4:** Process innovative capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.

### 5.1.4 Manufacturing Capability and Firm Performance

Manufacturing capability offers a firm with the potential to increase its competitive advantage (Skinner, 1969). Manufacturing capability can be characterized by several competitive priorities of manufacturing such as cost efficiency, quality, flexibility, time and dependability (Rho, Park and Yu, 2001; Safizadeh, Ritzman and Mallick, 2000; White, 1996). Manufacturing capability derives from improvement, innovation and integration of new resources, methods or technology, as well as from the abilities of acuity, control, agility, and responsiveness of manufacturing processes (Swink and Hegarty, 1998). The characteristics and
elements of manufacturing capability imply that manufacturing capability is difficult to imitate or substitute what make it valuable.

Many empirical studies have suggested that effective manufacturing capability can produce better performance and competitive advantage for firms (Ferdows, Miller, Nakane and Vollmann, 1986; Hayes and Wheelwright, 1984; Rho, Park, and Yu, 2001; Wheelwright, 1984; White, 1996). For example, manufacturing capability is positively associated with financial performance in terms of return on investment and its growth (Droge, Vickery and Markland, 1994). Moreover, it is not surprising that manufacturing capability has a significant impact on manufacturing and production performance (Bates and Juntilla, 2002; Swink and Hegarty, 1998).

Improving firms’ manufacturing capability through the introduction of advanced and proprietary production methods and equipment to strengthen new product production performance and competitive ability is an important strategy of Chinese firms in China’s transitional economy. From 1988 to 1993, the total volume of technology introduction including equipment, technology and management introduction and improvement increased from 35.5 billion US dollars to 61.1 billion US dollars. In order to improve new product production and achieve high performance, managers in Chinese industrial firms have begun to emphasize the abilities related to efficiency and productivity of manufacturing resources and improvement of manufacturing performance through the development and introduction of new methods and technologies.

Therefore, it is likely that production processes in Chinese industrial firms that incorporate idiosyncratic resources and methods are those, which might be a potential resource for successful innovation and achieving superior performance. This is investigated through hypothesis 5, which concerns the link between manufacturing capability and firm performance:

**Hypothesis 5:** Manufacturing capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.
5.1.5 Marketing Capability and Firm Performance

Marketing Capability is conceptualized by a firm's ability to capture, disseminate and respond to information gleaned from the markets (Baker and Sinkula, 1999; Kohli, Jaworski and Kumar, 1993; Jaworski and Kohli, 1993). From the view of innovation theories, marketing capability specifically represents superior ability to respond to and satisfy customers' needs and preferences through bringing new products and processes into markets (Deshpande, Farley and Webster, Jr., 1993; Dutta, Narasimhan and Rajiv, 1999; OECD, 1997; Verona, 1999). These firm-specific abilities are rare and not easily imitated, since building these abilities requires 'the development of a deep marketing expertise and a broad knowledge of a firm's capabilities' (Verona, 1999), which are significantly tacit (Day, 1994). The notion that firms emphasize specific marketing capability in an effort to achieve superior performance is also consistent with the resource-based view of the firm, which states that firms' superior performance is determined by firm internal specific capabilities. Based on these theoretical discussions, it is proposed here that marketing capability associated with the implementation of new products and processes will have a significant impact on firm performance.

Empirical evidence on firms in market economies offers support for the above proposition. For example, marketing capability measured by market orientation has the positive relationship with firm performance (Atuahene-Gima, 1995; Baker and Sinkula, 1999; Jaworski and Kohli, 1993; Mishra, Kim and Lee, 1996). Bowersox, Closs and Stank (1999) also find that firms with high customer integration scores are better performers in the markets. More importantly, based on the resource-based view of the firm, empirical findings in previous studies suggest that capabilities highly associated with marketing such as delivery capability (Fawcett, Calantone and Smith, 1997) and customer-focused capabilities (Zhao, Droge and Stank, 2001) are important sources of firm performance such as the firm's rent's (Calantone and Smith, 1997; Mitchell, 1992).

In the Chinese context, firms, especially state-owned enterprises, traditionally sold their products through a centrally planned government distribution monopoly (White, 2000). This
provided little incentive for the development of marketing skills in Chinese firms. Even in a transitional economy, some Chinese firms still benefit from administrative relationships (guanxi) and local protection policy in some regions (e.g., Li and Atuhene-Gima, 2002). Do Chinese firms need to particularly emphasize the importance of marketing capability given these administrative networks and lack of marketing skills? The argument in this study is that the more successful firms are those, who have introduced products that have satisfied customers in the marketplace. In order to sustain long-term competitive advantage in the markets, Chinese firms have to strengthen their marketing capability to maintain the relationship with the current and potential customers and satisfy them, rather than the relationship with government distribution. A few empirical studies have examined the importance of marketing in Chinese firms. These studies suggest that marketing factors such as marketing potential, proficiency, communication effort, are very important elements for new product success of Chinese firms in China's transitional economy (Calantone, Schmidt and Song, 1996; Song and Parry, 1994). Consistent with these arguments and findings, it is expected that, in China's transitional economy, firms, that have strong marketing capability, will be more likely to achieve superior performance. This analytical expectation is investigated through hypothesis 6:

**Hypothesis 6:** Marketing capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.

### 5.2 The Interactive Impact of Innovation Capabilities on Firm Performance

Hypotheses in Section 5.1, acknowledged the impact of each innovation capability on firm performance. However, a capability in firms sometimes may not be valuable enough as a single asset (Moorman and Slotegraaf, 1999). In Chapter Three, it was argued that the interaction of different types of capabilities was more important than an individual factor. Furthermore, in addition to each of the independent impact on performance, based on the resource-based view of the firm, innovation capabilities can co-evolve to collectively enhance firm superior performance. Meanwhile, the chain-link model of innovation emphasizes the interactions between different knowledge, capabilities and functions in a firm (Kline and
Rosenberg, 1986; OECD, 1997). Interactions are thus expected to appear between different capabilities. For instance, Teece (1986) suggests that the interactive and complementary assets imply more profitable technological innovation.

The notion of interaction can involve many different capabilities. In operationalizing this proposition for the present study, the prime focus is on the interaction between R&D capability and marketing capability. This will emphasize the central interaction in innovation processes (OECD, 1997) most frequently discussed in the literature.

The interaction between R&D and marketing is acknowledged in the literature as an important determinant of firm competitive advantage and performance, especially to new product development success (Hise, O’Neal, Parasuraman and McNeal, 1990; Moenaert, Souder, Meyer and Deschoolmeester, 1994; Song and Dyer, 1995). For instance, it is argued that the cooperation, communication and conflict between R&D and marketing within a firm are associated with product development success (Griffin and Hauser, 1996; Ruekert and Walker, 1987). Moreover, Gupta and his colleagues (Gupta, Raj, and Wilemon, 1986; Gupta, Raj and Wilemon, 1987; Gupta, Raj and Wilemon, 1988; Gupta, and Wilemon 1990) have consistently argued that R&D-marketing interface has the significant relationship with product innovation success. Based on the review of published research, Griffin and Hauser (1996) discuss the methods for achieving functional integration of R&D and marketing in order to enhance new product development. Other findings have demonstrated the positive relationship between R&D-marketing interaction such as the communication between R&D and marketing departments, and product innovation performance (Hise, O’Neal, Parasuraman and McNeal, 1990; Li and Atuahene-Gima, 2001b; Moenaert, Souder, Meyer and Eschoolmeester, 1994). These empirical studies conclude the importance of the R&D-marketing interaction as a possible resource, and emphasize the effects of R&D-marketing interaction on innovation performance.

Despite its importance for innovation success, the direct impact of R&D-marketing interaction on other firm performance aspects remains under studied (Gupta, Raj and Wilemon,
1986). Many studies have examined the conflict relation between R&D and marketing rather than creative co-operation or complementarity (Ruekert and Walker, 1987). Only a few studies have discussed the impact of R&D-marketing relationship in terms of the interaction between R&D capability and marketing capability based on the resource-based view of the firm. For example, Dutta, Narasimhan and Rajiv (1999) argue that the interaction of R&D and marketing capability is the most important determinant of firm performance in high-technology industries. They propose a conceptual framework, in which R&D capability and marketing capability are a function of one another; in turn the interaction of these two capabilities is a function of firm performance. Consequently, most of the literature on R&D-marketing interaction concentrates on Western firms (Song and Dyer, 1995). Little is known about the effects of R&D-marketing interaction in the firms of transitional economies. To challenge these limitations in the literature, the present study suggests that the interaction between R&D capability and marketing capability may influence Chinese industrial firms’ performance in China’s transitional economy.

Further, this study seeks to understand the creative interaction between R&D capability and marketing capability. It is proposed that R&D and marketing capability can be interactive in two ways. First, marketing capability can help a firm to convert R&D outcomes to commercially viable products (Dutta, Narasimhan and Rajiv, 1999) to achieve superior performance. More specifically, according to market principles, in order to achieve superior performance, a firm needs to develop the market fit products or services. This means that a firm has to understand which products and services can enjoy customer loyalty. Marketing capability offers a firm the abilities to find and assess new applications for products and technologies in the markets. Firms rely on the feedback from customers’ needs to set R&D goals and develop market fit technologies and products. To some extent, it may be harder for a firm to develop required technologies, if the firm does not have an extensive customer relationship or network (Dierickx and Cool, 1989). On the other hand, strong marketing capability provides a broader
range of ideas from markets that make R&D relied on these ideas have broader applications (Dutta, Narasimhan and Rajiv, 1999).

Second, R&D capability provides valuable resources for bringing suitable technologies and products to the markets. R&D capability can help the firm to keep abreast of competitive technology, identify and fix technology development for future product releases (Griffin and Hauser, 1996). Technologies from R&D allow firms for frequent product updates, which provide a valuable resource for dominating the markets. In other words, a strong R&D capability would imply a wider stock of know-how or tacit knowledge. When a firm gets feedback from markets, this stock enables the firm to rapidly develop and improve its products through the application of new technology in response to customer demands. The interaction is also evident in Dutta, Narasimhan and Rajiv's (1999) examples that the impact of a firm's marketing capability would be stronger, if the technological base and resources are richer. On the other hand, a firm with a stronger R&D capability will not only collect and disseminate information about markets but also constantly create new knowledge and technology and examine the quality of knowledge and technology stocks relevant to entire innovation process including marketing. Hence, marketing capability is enhanced by valuable technology resources.

More importantly, from the resource-based view of the firm, the interaction between R&D and marketing capability increases a firm's effectiveness and competitive advantage (Walker and Ruekert, 1987b), since it is characterized as firm-specific synergy and integration, which are valuable and difficult to imitate (Baldwin and Clark, 1994; Mcduffie and Krafcik, 1992; Moorman and Slotegraaf, 1999; Park and Zaltman, 1987).

In China's transitional economy, the interaction between R&D and marketing capability is important for Chinese industrial firms, although many firms have relatively weak capabilities, and the interaction among departments within a firm has been poor. The interaction between R&D and marketing capability may facilitate the information exchange between R&D and marketing to counteract each capability's weakness. On the other hand, given the relative
weakness of R&D and marketing capability in Chinese industrial firms, to some extent, single R&D or marketing capability may not perform its impact effectively as a critical source. The interaction between R&D and marketing capability may facilitate a reliable source to ensure superior performance. It is also consistent with the resource dependence view, which suggests that the resources of an organization are scar and dependent that need to be integrated to ensure effective outcomes (Pfeffer and Salancik, 1978). Some research has examined the impact of R&D-marketing interaction on performance in Chinese firms. For example, Li and Atuahene-Gima (2001b) suggest that the interaction of R&D and marketing reported by information exchange, influence and conflict is positively associated with new product performance in Chinese high technology firms. These discussions lead to the following hypothesis:

**Hypothesis 7**: The interaction between R&D capability and marketing capability among Chinese industrial firms will be positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.

### 5.3 The Moderated Impact of Innovation Capabilities on Firm Performance

The hypotheses in section 5.1 and 5.2 suggest that firm internal specific innovation capabilities influence firm performance by excluding the role played by either external or internal environmental factors. In fact, environments are objective facts independent of firms (Kim and Lim, 1988). Every firm operates in certain environments and faces various environmental constraints and contingencies. Environments can be characterized as **dynamism**, **complexity**, **munificence**, **uncertainty**, and **hostility** (Dess and Beard, 1984). Specific environmental characteristics shape the nature of competition and influence the strategy and operation of a firm (Luo and Park, 2001).

Research in strategic management has drawn attention to the importance of both external and internal environmental settings to firm performance (Ackoff, 1970; Hansen and Wernerfelt, 1989; Hatten, Schendel and Cooper, 1978; Kotha and Nair, 1995). On the one hand, the literature suggests that the effectiveness of a firm’s operation and strategies on performance is influenced by environmental and organizational factors, and the successful firms are those that
fit their strategies and operation to environmental settings (Glazer, 1991; Miles and Snow, 1978; Moorman and Slotegraaf, 1999). On the other hand, environmental and organizational factors also have the close relationship with firm capabilities and resources. For example, Ghoshal and Nohria (1993) argue that it is critical to build firms’ capabilities, which can help firms to fit their environmental conditions. Moreover, environments influence firm internal capabilities, which result in superior performance, also because they provide access to valuable resources such as information, market resources, technology, and human and financial capital (Lee, Lee and Pennings, 2001). In this study, it is expected that the effectiveness of firm capabilities to firm performance is contingent on environmental and organizational factors.

Despite the importance of innovation capabilities as well as environmental and organizational factors to firm performance, there has been little study on the impact of environmental and organizational factors on the relationship between innovation capabilities and firm performance in a transitional economy like China. This study extends previous research in the strategic management and innovation literature by including environmental and organizational factors as moderating factors of the effectiveness of innovation capabilities on firm performance. The purpose of this study is to understand whether and how these environmental and organizational factors influence the impact of innovation capabilities on Chinese industrial firms’ performance in China’s transitional economy. Drawing on the literature, this study investigates four environmental and organizational factors that may capture the environmental impact. These factors include two environmental factors: the difference of regional development and innovation policy support, as well as two organizational factors: industry type in terms of industrial technology intensity, and firm economic ownership.

5.3.1 Regional Development and the Impact of Innovation Capabilities

Research in the strategic management and innovation literature has also sought to explain the relevance of geographic proximity of firms and how this might influence a firm’s innovation and performance (Hartung and Macpherson, 2001). Firms’ innovation and performance is largely associated with regional variation and difference, since the market of a firm is generally
The Impact of Innovation Capabilities on Firm Performance among Chinese Firms—The Development of Hypotheses

due to geographically limited. The present study considers the difference of regional economic development as an external environmental factor, which might influence the relationship between innovation capabilities and firm performance. There are several reasons for this.

First, the level of regional economic development and competition is related to environmental munificence. Munificence refers to the capacity of the environment to support firms’ sustained growth (Aldrich, 1979; Dess and Beard, 1984; Kotha and Nair, 1995; Starbuck, 1976; Yasai-Ardekani, 1989). In the regions with more munificent environment, firms can get access to more available resources, which enable firms to generate slack resources (Cyert and March, 1963, Dess and Beard, 1984). More importantly, the slack provides resources for a firm’s innovation (Bourgeois, 1981; Chakravarthy, 1982), and is associated with better firm performance (e.g., Kotha and Nair, 1995).

Second, the difference of regional development leads to a difference in market environments, which relates to the ‘heterogeneity or divergence in customer needs/preferences, product and information awareness, and purchasing habits/practices’ (Chryssochoidis and Wong, 1998). In the regions with more heterogeneous markets, firms face greater pressure to introduce diversified products to fit different customers’ needs in order to achieve expected performance.

Third, the difference of regional development is associated with the intensity of competition. Greater competitive environments place greater pressure on the firm to build its innovation capabilities and conduct innovation activities to survive, since successful firms are usually those who are technologically superior in the competitive environments (Schumpeter, 1934).

Fourth, the difference of regional development relates to different technology opportunities. Technological opportunities refer to the technological resources and information allocated in firm outside technology network such as research institutes, universities, government laboratories, suppliers and customers (Klevorick, Levin, Nelson, and Winter, 1995; Levin, Klevorick, Nelson, and Winter, 1987). In the regions which have more technological
resources and information, firms might have more opportunities to accumulate resources and build capabilities required for innovative effort (Davies, 2001), in turn, lead to superior performance.

In General, regional development difference results in the difference of environmental munificence, market heterogeneity, intensity of competition, and technology opportunities. Greater environmental munificence, market heterogeneity, competition and technology opportunities provide firms with greater external valuable resources. Innovation capabilities are a combination of various resources. Therefore, one could expect that firms will be more aware of innovation capabilities and act more effectively in greater developed regions.

In China's transitional economy, the regional development paths are dramatically different among provinces and cities. For example, Guangdong and Jiangsu province are the leaders in economic reform, the economic development in both provinces is faster, but the overall S&T assets or resources in these two provinces are relatively limited. Beijing occupies dominant positions in S&T resources, but it is a little bit slow in the economic development at first. Liaoning province is recorded slow economic growth and less S&T resources. Given the extreme differences in economic, social and technology development, which imply the greater environmental munificence, heterogeneity, competition and technology opportunities, the differences of regional development are expected to be associated with Chinese industrial firms' innovation and performance. Suttmeier (1997), for example, argues that technological innovation in Chinese firms is characterized by considerable regional resources and development variation. Several studies have already drawn attention to the influence of regional differences in firm-level innovation in China (Gao and Liu, 1990; Gao and Fu, 1996; Suttmeier, 1997, White, 2000). However, little research has addressed the impact of regional development in terms of several environmental characteristics on the relationship between innovation capabilities and performance in Chinese industrial firms. This study would expect to extend the research by developing and examining following hypotheses.
Hypothesis 8: The impact of R&D capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.

Hypothesis 9: The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.

Hypothesis 10: The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.

Hypothesis 11: The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.

Hypothesis 12: The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.

Hypothesis 13: The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.

5.3.2 Innovation Policy Support and the Impact of Innovation Capabilities

Another external environmental factor, which might influence the relationship between innovation capabilities and firm performance, is innovation policies. Innovation policy environment refers here to government policies and regulations, which dictate the situations and conditions for a firm’s innovation activities. Government policies related to innovation include R&D, technology development, taxation policy, accounting regulations, industrial regulation, intellectual property rights, patent and copyright systems, etc. (OECD, 1997).

Governments in most economies have attempted to formulate innovation policies to stimulate firms’ innovation activities, as innovation is important to nation’s economic growth and competition. On the other hand, Although, firms’ innovation in both market and non-market
economies such as transitional economies is influenced by government policies, such influence through various policies is more significant in a transitional economy, as its innovation system is developed based on the close industry-government relationships (Nelson and Rosenberg, 1993). In contrast, the innovation systems in market economies have predisposed firms to minimize the influence of their governments in their innovation activities (Schoening, Souder, Lee and Cooper, 1998).

Since economic reform, policy initiatives for increasing innovation have become the important components of China's reform process (Baark, 2001, Turpin and Liu, 2000). These policy initiatives aim at restructuring China's science and technology and innovation system to enhance especially the industrial innovation capabilities. Specific innovation policies embodied in various technology and industry policies have been continuously focused on firm internal technology development capabilities, financial incentives such as tax credits and low interest government loans, regulatory system such as patents and intellectual property rights, human capital, technology resources, and so on so forth. These policies provided a supportive environment for firms' innovation. Under this necessary environment, it is expected that Chinese firms should build up their independent innovation capabilities.

However, as argued above, China's economic transition is far from complete. During the transitional process, Chinese firms have not developed to a relatively high level of independence and self-sufficiency like their counterparts in market economies. More limited development of capabilities and resources leads to more dependence on the government to support innovation. On the other hand, the construction of a firm's innovation capabilities is a process of resource combination. Innovation effectiveness is largely based on a firm's ability to get access to and combine valuable resources in its innovation activities. In China's transitional economy, industrial firms are lack of their own technology stocks and resources, and their abilities to obtain significant technology information and resources as well as get to the markets are relatively weak, given the historical administrative technology resources distribution and underdeveloped technology markets. For example, R&D conducted by government-sponsored
institutes and universities are major sources of industrial firms' technologies and innovation in China. Moreover, as shown in Figure 5.1, R&D expenditures in Chinese industrial firms account for less percentage and have a relatively little influence compared with their counterparts in developed countries.

**Figure 5.1 R&D Expenditures in Selected Countries by Performing Sectors (%)**

![Figure 5.1 R&D Expenditures in Selected Countries by Performing Sectors (%)](chart)

*Source: China Science and Technology Indicators (1998)*

Given the dependent nature of innovation activities and lack of technology resources in Chinese industrial firms, it might be expected that the favorable environments created through supportive innovation policies such as technology development and transfer policy, financial incentives policy, taxation policy, and intellectual property rights would play a critical role in the success of Chinese industrial firms' innovation. On the other hand, some previous studies suggest that government regulations such as intellectual property protection, patent and copyright protection, to some extent, may impede the creation and commercialization of new products and technologies during the transitional process (Chryssochoidis and Wong, 1998; Schoening, Souder, Lee and Cooper, 1998). Based on the above discussion, this study proposes the following hypotheses:
Hypothesis 14: The impact of R&D capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.

Hypothesis 15: The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.

Hypothesis 16: The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.

Hypothesis 17: The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.

Hypothesis 18: The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.

Hypothesis 19: The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.

5.3.3 Industry Type and the Impact of Innovation Capabilities

There is a significant variation in innovation and firm performance between different industries because of industrial specific resources and environments. The relationship between innovation and performance is contingent upon the industry specificity such as high and low technology industries. Compared with traditional or low technology industries, high technology industries are characterized as technology intensity, complex manufacturing process, short product lifecycle, and high rate of new product introductions etc. (Dutta, Narasimhan, and Rajiv, 1999; Iansiti and West, 1999; Yeoh and Roth, 1999). For example, OECD (1997) defines and classifies high technology industries by R&D intensity (the proportion of R&D expenditure in total sales). The industries with their R&D intensities remarkably higher than average R&D intensity of total industries were defined as high technology industries. Firms in high technology industries require a commitment to the strong dependence on technology and new
product development for their performance. Continuous innovation is an important source of competitive advantage in high technology-intensive industries (Barczak, 1995; Henderson and Cockburn, 1994).

Within high technology-intensive industries, firms would prefer a focus upon innovation resources and capabilities, especially R&D, technology development and improvement, and new product development capabilities. This is due to the nature that a firm’s competition in high technologies is based on highly complex and specific knowledge and technology which is unlike the mature technology structure of firms in traditional industries (Deeds, DeCarolis and Coombs, 1999; Pisano, 1994). On the other hand, these capabilities related to technology intensity closely link to technology opportunity, since R&D, technology improvement and development activities will yield marketable innovation (Hundley, Jacobson and Park, 1996). Prior studies in strategic management suggest that in high technology-intensive industries, a firm’s ability to develop new technologies and products is to be a critical determinant of competitive advantage (Hitt, Hoskisson, Johnson and Moesel, 1996).

Moreover, the nature of relatively short product lifecycle and rapid technology change in high technology markets implies that a firm in high technology-intensive industries has a limited time period of product advantage by which to obtain superior performance (e.g., Dutta, Narasimhan, and Rajiv, 1999). To extract the maximum level of performance within these markets, firms need to continuously develop new technologies, products and processes, which are inimitable and imperfectly substitutable by other firms and convert these technology development outcomes into markets rapidly. In other words, in high technology-intensive industries, in which the product and process technologies are constantly changing, a firm’s innovation capabilities play much significant roles in achieving superior performance. In contrast, in traditional or low technology-intensive industries, product and processes technologies are relatively stable, and firms have relatively less pressures on innovation, especially radical innovation (Hill and Snell, 1988). Thus, the effectiveness of innovation
The impact of innovation capabilities on firm performance among Chinese firms—The development of hypotheses

capabilities on firm performance is contingent upon industry technology intensity in terms of high and low technology-intensive industries.

Since the 1980s, developing high technology and industries has become an important strategy of China in promoting economic growth and enhancing competitive advantage. Chinese government has paid great attention to the importance of high technology development through setting a number of strategic programs such as '863' Program aimed at promoting high technology research and development, and 'Torch' Program for promoting the industrialization and commercialization of high technologies. With the emphasis on high technology development, the new and high technology firms emerged and have become important components of high technology development strategy. Compared with traditional firms, these new firms significantly emphasize innovation as a critical strategy for their development and competitive advantage. A few empirical studies on Chinese new and high technology firms suggest that innovation especially product innovation, has much greater impact on new and high technology firms’ performance (Li and Atuahene-Gima, 2001a). In consistent with the above discussion, this study proposes the following hypotheses:

**Hypothesis 20:** The impact of R&D capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.

**Hypothesis 21:** The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.

**Hypothesis 22:** The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.

**Hypothesis 23:** The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese
industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.

**Hypothesis 24**: The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.

**Hypothesis 25**: The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.

5.3.4 Firm Ownership and the Impact of Innovation Capabilities

Firms with all forms of ownership tend to conduct innovation to sustain their competitive advantage, but the innovation behavior and performance may different in firms with different ownership (Damanpour, 1991). So far, a large number of studies have examined the relationship between alternative ownership and firm performance (e.g., Thomsen and Pedersen, 2000), as well as the differences of innovation in firms with different ownership (e.g., Coombs and Tomlinson, 1998).

The stream of research concerning the relationship between ownership and firm performance in western countries focuses on the impact of insider or outsider stock ownership. For example, Li and Simerly (1998) point out that greater stock ownership by managers combines with managers' interests with those of other stockholders thus enhancing firm performance. They further argue that greater insider ownership may lead to better firm performance under a greater environmental dynamism.

Many other studies on the differences of innovation in different firms have concerned with the private (profit) and public (non-profit) organizations, as well as domestic and foreign firms. For example, Damanpour (1991) suggests that the type of organization reported by private and public organization is significantly associated with functional differentiation, formalization and centralization of organizational innovation, and the distinction between
private and public is a useful contingency for innovation theories. Coombs and Tomlinson (1998) argue that foreign companies operating in the UK are adopting a more aggressive innovative posture than the UK domestic firms.

In contrast to market economies, ownership in transitional economies is characterized by a diversity of organizational forms such as state-owned enterprises (SOEs), non-SOEs such as collective firms and private firms, and international joint ventures (IJVs) (Luo, 1999). However, only a small group of studies has examined the influence of these specific forms of ownership in transitional economies. Prior research on variations in SOEs, non-SOEs and IJVs supports the proposition that non-SOEs including collective and private firms, and IJVs conduct more effective innovation and superior performance, compared with SOEs, thus privatization is an important mechanism for transitional economies to transform the central planned economic system to market-driven system (Ramaswamy, 2001). For example, Vishwasrao and Bosshardt (2001) argue that foreign-owned firms like IJVs are more likely to adopt new technology and to adopt more of it than SOEs in India. Based on Aharoni's (1986) discussion on the poor performance of SOEs, Ramaswamy (2001) concludes the general reason as '(i) pay differentials between SOE managers and their counterparts in the private sector, (ii) poor accountability and the lack of consequences for failure in SOEs, (iii) ownership dispersion and constraints on transfer of property rights, (iv) lack of adequate monitoring by the state, and (v) subsidization of poor SOE performance from government funds' (2001: 990).

In China's transitional economy, SOEs still account for a large percentage of production and national economy. For example, SOEs create about 43% of gross value of industrial output (Suttmeier, 1997). Since the economic reform, SOEs have paid great attention to the development of technology resources as a result of market competition. Compared with other types of firms, SOEs may get easily to government monopoly resources because of the historical relationship with government. To some extent, SOEs especially large SOEs have relatively more technology resources, but these sometimes are ineffective in meeting the needs and development of firms (Suttmeier, 1997), since SOEs tend to conduct innovation and
technology development, only when the technology is administratively routed on their ways (White, 2000). On the other hand, most SOEs still carry heavy social burdens and face crises such as laid-off, managerial and structural problems (Suttmeier, 1997; White, 2000). It leads to SOEs that cannot put innovation and technology development as the most primary consideration in improving their performance.

Compared with SOEs, non-SOEs including private and collective firms are more likely to be the entrepreneurial sectors, which have shown great dynamism and growth with no central government financial support. While many non-SOEs established with relatively low technology and less government monopoly resources, there is a large demand for new technologies in non-SOEs in order to improve firm performance, and a large number of non-SOEs especially some new types of firms like new technology firms are becoming more technology-intensive (Suttmeier, 1997). Innovation is a critical determinant of performance in these entrepreneurial and technology-intensive firms (McCann, 1991).

IJVs in China, establish their own technology systems in line with technology behaviors and market contexts of their foreign parents. Prior research suggests that IJVs have a significant ability to leverage current resources or preempt new opportunities by integrating their technology within a dynamic and new market context (Luo, 2002). On the other hand, IJVs in transitional economies are collaborations between parents firms (Lane, Salk and Lyles, 2001). The purpose of collaborations is to enhance superior performance and competitive advantage through the knowledge creation and application in joint venture organization (Grant and Baden-Fuller, 1995). The relatedness with two parents leads to IJVs that may benefit more from internal learning, resource sharing, R&D activities, product and process improvement, and technology or market integration (Luo, 2002; Lou and Park, 2001). The above discussion suggests the following hypotheses:

**Hypothesis 26**: The impact of R&D capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.
Hypothesis 27: The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

Hypothesis 28: The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

Hypothesis 29: The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

Hypothesis 30: The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

Hypothesis 31: The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

5.4 Chapter Summary

This chapter discussed the development of hypotheses on the independent and interactive impact of innovation capabilities on firm performance, as well as the moderating effect of organizational and environmental factors on the relationship between innovation capabilities and firm performance. Table 5.1 summarizes these hypotheses.

In preparation for testing the relevant hypotheses, Chapter Six will present the sample, data selection, the operationalizations of variables used in data analyses and the empirical model specifications of data analyses.
### Table 5.1 Summary of Hypotheses

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>R&amp;D capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.</td>
</tr>
<tr>
<td>H2</td>
<td>Absorptive capability of external technology resources among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.</td>
</tr>
<tr>
<td>H3</td>
<td>Product development capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.</td>
</tr>
<tr>
<td>H4</td>
<td>Process innovative capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.</td>
</tr>
<tr>
<td>H5</td>
<td>Manufacturing capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.</td>
</tr>
<tr>
<td>H6</td>
<td>Marketing capability among Chinese industrial firms will be significantly and positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.</td>
</tr>
<tr>
<td>H7</td>
<td>The interaction between R&amp;D capability and marketing capability among Chinese industrial firms will be positively associated with firm (a) financial performance, (b) market performance, and (c) innovation performance.</td>
</tr>
<tr>
<td>H8</td>
<td>The impact of R&amp;D capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
</tr>
<tr>
<td>H9</td>
<td>The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
</tr>
<tr>
<td>H10</td>
<td>The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
</tr>
<tr>
<td>H11</td>
<td>The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
</tr>
<tr>
<td>H12</td>
<td>The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
</tr>
<tr>
<td>H13</td>
<td>The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
</tr>
</tbody>
</table>
Table 5.1 continued

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H14</td>
<td>The impact of R&amp;D capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
</tr>
<tr>
<td>H15</td>
<td>The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
</tr>
<tr>
<td>H16</td>
<td>The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
</tr>
<tr>
<td>H17</td>
<td>The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
</tr>
<tr>
<td>H18</td>
<td>The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
</tr>
<tr>
<td>H19</td>
<td>The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
</tr>
<tr>
<td>H20</td>
<td>The impact of R&amp;D capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
</tr>
<tr>
<td>H21</td>
<td>The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
</tr>
<tr>
<td>H22</td>
<td>The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
</tr>
<tr>
<td>H23</td>
<td>The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
</tr>
<tr>
<td>H24</td>
<td>The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
</tr>
<tr>
<td>H25</td>
<td>The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
</tr>
</tbody>
</table>
The impact of innovation capabilities on firm performance among Chinese firms—The development of hypotheses

Table 5.1 continued

H26. The impact of R&D capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

H27. The impact of absorptive capability of external technology resources on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

H28. The impact of product development capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

H29. The impact of process innovative capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

H30. The impact of manufacturing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.

H31. The impact of marketing capability on firm (a) financial, (b) market, and (c) innovation performance is likely to be significantly higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is in SOEs.
PART TWO

EMPIRICAL ANALYSIS, DISCUSSION AND CONCLUSIONS
CHAPTER SIX
RESEARCH METHODOLOGY AND ANALYTICAL FRAMEWORK

Chapter Four and Chapter Five developed the research framework and relevant hypotheses for examining the impact of innovation capabilities on firm performance in China’s transitional economy. This chapter focuses on the methodology used in this study including hypotheses testing models and techniques. Data of 3843 Chinese industrial firms used in the present study are drawn from a dataset produced by a large technological innovation survey in Chinese industrial firms that was carried out in six provinces and cities of China in 1996.

This data set was chosen for two primary reasons. First, up to now, it is the largest comprehensive technological innovation questionnaire survey in Mainland China. The questionnaire design was based on the OECD’s (1992, 1997) guiding document *Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*. Thus, the data are comparable with other surveys conducted in some market economies. Meanwhile, in order to understand some specific natures of technological innovation in Chinese industrial firms, the questionnaire design also considered some special issues such as the influence of innovation capabilities, cooperation with institutions and universities in innovation activities, and the influence of government policies.

Second, this survey was conducted during the period of China’s economic transition. It provided special information about the characteristics of innovation at firm level at the height of the transitional process. Up to now, China’s economic transition is far from complete. At this stage, the data from this survey are still significant for researchers to understand the difference of firms’ innovation activities in a transitional economy from their counterparts in market economies. While the data were collected in 1996, very little use has been made to the data. In particular, although it is useful for examining firm innovation capabilities and their relationship with firm performance, the survey data has not been used for this purpose.

The chapter is organized into six sections. Section 6.1 briefly introduces the process of the technological innovation survey including sample selection, questionnaire design, and data
collection. Section 6.2 describes the sample used in this study. Section 6.3 presents the operationalizations of variables used in this study. Section 6.4 tests the validity and reliability of relevant variable measures. Section 6.5 develops data analysis methods. Finally, section 6.6 offers a chapter summary.

6.1 The Introduction of the Technological Innovation Survey

The empirical information used in this study was drawn from the results of the technological innovation survey in Chinese industries firms that was conducted in Beijing, Liaoning, Harbin City, Shanghai, Jiangsu and Guangdong province in 1996. The purpose of this survey was to provide information on the characteristics of technological innovation activities, the development of innovation capabilities and their impact in Chinese industrial firms. The information of this survey was mainly used to improve firms' innovation capabilities and China's international competitiveness by facilitating the development of government policies to support future innovative activities in Chinese firms.

This survey is the largest official technological innovation survey ever carried out in Mainland China. The research centre under the Commission of Science of Technology of China was responsible for the organization and implication of the survey. The author of this thesis was involved in the whole process of the survey as a key member of the research group, including questionnaire design, interview, training program, data collection and data analyses. This survey provides a rich dataset, which can be used to analyze the characteristics of technological innovation in Chinese industrial firms during China's transitional economy.

6.1.1 Sample Selection of the Survey

The sample for the survey was selected on the basis of a random procedure. Initially, all 600 industrial sectors defined at the 4-digit CSICs (China Standard Industrial Classification), in six provinces and cities: Beijing; Liaoning; Harbin City; Shanghai; Jiangsu; and Guangdong province were included for creating an original sample of the survey. As shown in Figure 6.1, these cities and provinces were chosen because they are located in the coastal region of China where rapid industrial development and active innovation has been identified. As a result of
ongoing economic transformation along with social transformation process, China has operated a mixed economy and the coastal, central and western region development strategies reflect different patterns of development. From a policy perspective, the coastal region was expected to develop high technology industries and to actively participate in global markets, while the central and western regions were expected to develop energy, agriculture, and mineral industries (Wei, 1998).

**Figure 6.1 The Location of the Six Surveyed Provinces and Cities**

At the same time, technological innovation in Chinese firms reflects the existence of various regional resources (Suttmeier, 1997). As mentioned in Chapter Five, although some cities and provinces are located in the same general region, their development paths and resources allocations during the reform period differ dramatically. More importantly, the number of the industrial firms in these six provinces and cities is larger than other regions. In 1999, the industrial firms of these six provinces and cities account for 37.2% of total industrial firms in China.
The survey was focused on firms in the industrial sectors because they are ones where innovation is anticipated to be most obvious. From a policy point of view, innovation activities in industrial firms form a platform for economic development. Industrial firms also provide useful and available measures of internal innovation at the firm level (Hitt, Hoskisson, Johnson and Moesel, 1996). In addition, industrial sectors represent a significant inter-sector difference in characteristics of industrial development, technology intensity, innovation and performance. For example, they can offer a useful comparison between high-tech industries and other sectors. Furthermore, the population also included new and high technology firms in the National High Technology Experimental Zones located in six provinces and cities. A firm is defined as a high and new technology firm when it meets two major criteria: (1) the percentage of scientists and engineers with higher education background or above should be over 30 percent of total employees in the firm; and (2) the R&D and technology development expenditures should be 3% or above of total income. All high and new technology firms in the zones hold the New-Tech Enterprise Certificate and Instrument of Ratification issued by National High Technology Experimental Zone Office.

In China's transitional economy, a firm's ownership can be categorized as state-owned enterprises, collective firm, private firm, domestic joint firm, share-holdings, and international joint ventures. The sample of this survey was sufficiently large enough to allow for the analysis of different size firms and with different forms of ownership.

On account of the limited budget, it was impossible to approach all firms in the population in these six provinces and cities. Sample frame was selected on the basis of an equal-distance random procedure. At the same time, two criteria were used in selecting the sample. First, a firm had to be an established firm. This is because newly establishing firms are unlike to reflect general performance experiences. Second, a firm had to have at least 10 employees. Very small firms may not ensure international comparability (OECD, 1992, 1997), and they may not have the resources necessary to create innovation and performance (Zahra and Nielsen, 2002).
Based on above considerations, 10100 established firms were identified across the selected regions.

6.1.2 Questionnaire Design for the Innovation Survey

Data collection was primarily based on a questionnaire (OECD, 1992, 1997). The questionnaire for the technological innovation survey was developed and refined on the basis of several procedures. First, the questionnaire was informed by a review of innovation literature and several previous studies on innovation surveys carried out by the OECD (1992), the European Communities (1993), the Australian Bureau of Statistics (1993), the National Bureau of Statistics of China (1991), and Tsinghua University (1989).

Second, structured interviews were carried out with 10 industrial firms in Beijing. These preliminary interviews followed three procedures: (1) every interviewee received the same questions in the same set order; (2) there was no flexibility or latitude allowed to either interviewer or respondents; and, (3) the interviewee’s responses were then scored.

The interview questions focused on the nature of technological innovation activities, the impact of innovation activities on firm performance, the role of government policies, cooperations with R&D institutions and universities as well as other major issues related to innovation and performance, which were drawn from the literature review. The results of these preliminary interviews were summarized and assessed to ensure that each question and item in questionnaire was appropriately understood in the Chinese context.

Third, based on the previous literature review and experience of structured interviews, the questionnaire was divided into two parts. The first part collected quantitative and general information about technological innovation activities in the firm. This quantitative part of the questionnaire combined the data collection at the firm level (subject approach) with the data collection at the product level (object approach). The second part included qualitative questions and focused on some specific topics of technological innovation in a firm.

Fourth, a pilot test of the questionnaire was carried out in order to identify the specific issues and improve the clarity and understanding of the questionnaire. Preliminary
questionnaires were sent to 20 firms in Beijing. They were asked to identify any ambiguities in the question terms and concepts. Face to face interviews were later conducted in 8 of these 20 firms. The questionnaire was revised and adjusted on the basis of the pilot test.

The final version of the quantitative part of the questionnaire was structured into seven sections. The first section collected firm general information. The second section focused on characteristics of technological innovation in the firm including the number of innovations, type of innovation, and government support on innovation activities. The third section asked questions about technology acquisition and transfer. The fourth section investigated technological innovation costs. The fifth section concentrated on the economic impact of innovation activities. The sixth and seventh sections collected information about case studies of a particular innovation outcome in the firm. The qualitative part of the questionnaire asked questions about: sources of innovation activities; factors hampering innovation activities; innovation capabilities; objectives of innovation; impact of innovation activities such as the impact on market and innovation performance; the role of government policies; and co-operations with external technology developers such as universities and R&D institutions. An English version of the questionnaire is included as Appendix A.

6.1.3 Data Collection

Data were collected using a mail survey and some follow-up interviews in 1996. Questionnaires were distributed to 10,100 selected firms. Addresses and basic information about these firms were obtained from the National Bureau of Statistics of China (NBS).

To reduce the survey cost, among the 10,100 firms, letters explaining the general purpose of this survey and questionnaires were mailed to 5500 firms as an attachment of Annual Industrial Statistical Form (AISF) in assistance of the NBS. At the same time, questionnaires were directly mailed to other 4600 firms' chief executive officers (CEO) or general managers who were considered to be most knowledgeable about his/her firm's technological innovation and strategic issues. This approach is consistent with the selection method mentioned by McEvily and Zaheer (1999) that the key informants are selected to be knowledgeable about the
firm's matters by virtue of their position. In order to maximize the response rate, Dilman's (1978) techniques were implemented. For example, in addition to initial survey mailing, further communications with firms was carried out by asking local statistical bureaus in charge for the statistics of local industrial firms, to make an attempt to contact each firm's CEOs or other senior managers in the firms by phone to secure their firm in completing the survey. A reminder letter was sent one month after the first round of mailing, and sending a second round of mailings to non-responding firms.

The OSLO Manual (OECD, 1992, 1997) indicates that both postal survey and interview have different strengths and weaknesses. The postal survey is relatively less expensive, but it has to be extremely well designed to get sufficient response rates and the answers would be different from different respondents even in the same firm. Direct interview produces higher quality answers, but the cost is comparatively high. In order to avoid some problems with postal survey and not increase the costs of the survey too much, in assistance of statisticians, face-to-face interviews with senior managers were conducted in 500 firms randomly selected from those firms, which had received the questionnaires. The interviews were conducted by 150 interviewers hired and trained by the local statistical bureaus and the research group. An initial phone contact identified the senior manager in the firm selected to be interviewed. Following the initial interviews, the informants were provided with questionnaires. During the interview, each question was asked as it appeared in the questionnaire especially in the qualitative part. The purpose of the interviews was to evaluate the clarity and understanding of the items in order to increase the response rate. In fact, this approach improved the overall response rate and ensured a wide range of appropriate responses.

Responses were largely received in the spring of 1997. As shown in Table 6.1, the mailing process resulted in 5075 firms (93%) returned the quantitative part of the questionnaire from the 5500 firms who received the questionnaire as an attachment of NBS's AISF survey. The same mail out yielded 2347 firms (42.7%) returned the qualitative part of the questionnaire. Of these 5500 firms, 2209 firms (40.2%) responded both quantitative and qualitative parts of
questionnaire. From the 4600 firms contacted directly, 2647 firms (57.5%) returned the quantitative part of the questionnaire, and 4186 firms (91%) returned the qualitative part of the questionnaire. Among these respondents, 1987 firms (43.2%) completed both quantitative and qualitative parts of the questionnaire.

Table 6.1 Analysis of the Technological Innovation Questionnaire Returns

<table>
<thead>
<tr>
<th>Number of questionnaire distributed</th>
<th>Returns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quantitative part</td>
<td>Qualitative part</td>
</tr>
<tr>
<td>Mailed as an attachment of NBS's AISF survey</td>
<td>5500</td>
<td>5075</td>
</tr>
<tr>
<td>Mailed directly</td>
<td>4600</td>
<td>2647</td>
</tr>
<tr>
<td>Total</td>
<td>10100</td>
<td>7722</td>
</tr>
</tbody>
</table>

In order to check the possibility of non-response bias, firm attributes (including the number of employees, annual sales and profit) between responding and non-responding firms were compared. Data on the number of employees, annual sales and profit for 100 randomly selected non-responding firms from the National Bureau of Statistics of China were obtained. The mean differences of the above three indicators between responding and non-responding firms were tested using t-test. The results revealed no significant differences between number of employees, annual sales and profit of responding and non-responding firms. The representativeness of the sample firms was further compared with those of population in six cities and provinces as well as nationwide, using information obtained from the *China Statistical Yearbook* (1994, 1995 and 1996) and *Statistical Book of Industries* (1994, 1995 and 1996). For the variables of number of employees, annual sales and profit, no significant difference was found between the sample and the relevant population. These results provided adequate assurance that the sample firms responding to questionnaires were representative of the broader population.
6.2 Data and Sampling for this Study

Last section briefly introduced the technological innovation survey in Chinese industrial firms as a background of data, which are used in the present study. This study is examining the impact of innovation capabilities of industrial firms in China’s transitional economy. The data drawn from above innovation survey captured, in general, the characteristics of technological innovation in industrial firms during the transitional economy because of the purpose of the survey. The present study would be the first one to provide a systemically empirical analysis on the relationship between firm-level innovation capabilities and performance in China’s industrial firms by considering the samples of this technological innovation survey.

Sampling of firms for this study presents some unique problems. For example, not all firms responded to both quantitative and qualitative parts of the questionnaire, nor had all firms engaged in innovation activities. The present study combines the quantitative and qualitative part of the questionnaire as a whole and recalculated the overall response rate. As shown in Table 6.1, for these 10,100 firms, the response rates were 76.5% (7722 firms) for the quantitative part of the questionnaire, and 64.7% (6533 firms) for the qualitative part of the questionnaire. However, only 4196 of 10100 firms responded to both quantitative and qualitative part of the questionnaire. Therefore, the overall response rate of the entire questionnaire including both quantitative and qualitative parts is calculated as 41.5%. This response rate appears to be consistent with other reported innovation surveys (OECD, 1997).

Although firms from a variety of industries were surveyed, samples for this study are defined narrowly to include those respondents who claimed that they conducted technological innovation activities using their technology resources. This definition is considered important in that the data collection should be similar across firms and it is appropriate to put the data together (Yeoh and Roth, 1999). Of course, it does not mean that non-innovative firms do not have innovation capabilities. Non-innovative firms are excluded from this study, because the purpose of this study is to examine the impact of innovation capabilities on firm performance, and it is difficult to say that innovation capabilities sufficiently make contribution to firm
performance at this stage, if a firm does not carry out any innovation activities and has no innovation outcomes.

Finally, the analysis for this study is limited to the sample of firms that responded to both quantitative and qualitative sections of the questionnaire, and carried out one or more innovation activities from 1993 to 1995. A total of 3843 industrial firms fitted this requirement and produced the sample for the present study. Table 6.2 and Table 6.3 present the distribution of the final sample firms and general information about sample firms used in this study.

Table 6.2 Distribution of the Sample Firms

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent (%) of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total sample</strong></td>
<td>3843</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>By region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beijing</td>
<td>964</td>
<td>25.1</td>
</tr>
<tr>
<td>Liaoning</td>
<td>437</td>
<td>11.4</td>
</tr>
<tr>
<td>Harbin</td>
<td>311</td>
<td>8.1</td>
</tr>
<tr>
<td>Shanghai</td>
<td>392</td>
<td>10.2</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>1109</td>
<td>28.9</td>
</tr>
<tr>
<td>Guangdong</td>
<td>630</td>
<td>16.4</td>
</tr>
<tr>
<td><strong>By industry type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-tech industries</td>
<td>809</td>
<td>21.1</td>
</tr>
<tr>
<td>Medium-high-tech industries</td>
<td>1631</td>
<td>42.4</td>
</tr>
<tr>
<td>Medium-low-tech industries</td>
<td>559</td>
<td>14.5</td>
</tr>
<tr>
<td>Low-tech industries</td>
<td>361</td>
<td>9.5</td>
</tr>
<tr>
<td>Others</td>
<td>483</td>
<td>12.6</td>
</tr>
<tr>
<td><strong>By ownership</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State-owned enterprises (SOEs)</td>
<td>1854</td>
<td>48.2</td>
</tr>
<tr>
<td>Non-SOE s</td>
<td>1385</td>
<td>36.0</td>
</tr>
<tr>
<td>International Joint Ventures</td>
<td>604</td>
<td>15.7</td>
</tr>
</tbody>
</table>
### Table 6.3 Profile of Sample Firms

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Beijing</th>
<th>Liaoning</th>
<th>Harbin</th>
<th>Shanghai</th>
<th>Jiangsu</th>
<th>Guangdong</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of employees</strong></td>
<td>4067</td>
<td>592</td>
<td>807</td>
<td>413</td>
<td>652</td>
<td>1085</td>
<td>517</td>
</tr>
<tr>
<td><strong>Gross production outputs</strong></td>
<td>576.45</td>
<td>70.77</td>
<td>92.29</td>
<td>24.43</td>
<td>139.86</td>
<td>137.43</td>
<td>111.66</td>
</tr>
<tr>
<td><strong>Total assets</strong></td>
<td>829.66</td>
<td>105.78</td>
<td>168.77</td>
<td>54.60</td>
<td>211.25</td>
<td>150.84</td>
<td>138.43</td>
</tr>
<tr>
<td><strong>Total liabilities</strong></td>
<td>555.97</td>
<td>63.36</td>
<td>120.59</td>
<td>34.95</td>
<td>107.42</td>
<td>135.24</td>
<td>94.41</td>
</tr>
<tr>
<td><strong>Total sales</strong></td>
<td>557.24</td>
<td>73.11</td>
<td>78.80</td>
<td>27.02</td>
<td>144.95</td>
<td>129.49</td>
<td>103.86</td>
</tr>
<tr>
<td><strong>Total profits</strong></td>
<td>33.29</td>
<td>7.15</td>
<td>0.67</td>
<td>0.28</td>
<td>14.59</td>
<td>6.10</td>
<td>4.50</td>
</tr>
<tr>
<td><strong>Export sales</strong></td>
<td>6.44</td>
<td>0.57</td>
<td>1.07</td>
<td>0.22</td>
<td>1.42</td>
<td>1.29</td>
<td>1.85</td>
</tr>
<tr>
<td><strong>Innovation expenditure</strong></td>
<td>22.48</td>
<td>2.14</td>
<td>1.89</td>
<td>1.60</td>
<td>6.38</td>
<td>7.44</td>
<td>3.04</td>
</tr>
<tr>
<td><strong>R&amp;D expenditure</strong></td>
<td>3.41</td>
<td>0.49</td>
<td>0.42</td>
<td>0.17</td>
<td>0.86</td>
<td>1.02</td>
<td>0.46</td>
</tr>
<tr>
<td><strong>R&amp;D personnel</strong></td>
<td>145</td>
<td>31</td>
<td>19</td>
<td>11</td>
<td>23</td>
<td>47</td>
<td>14</td>
</tr>
<tr>
<td><strong>Number of innovations</strong></td>
<td>28434</td>
<td>5909</td>
<td>2084</td>
<td>1301</td>
<td>5019</td>
<td>9287</td>
<td>4834</td>
</tr>
<tr>
<td><strong>Number of new products</strong></td>
<td>19444</td>
<td>4359</td>
<td>1441</td>
<td>919</td>
<td>2951</td>
<td>6490</td>
<td>3284</td>
</tr>
<tr>
<td><strong>Process innovations</strong></td>
<td>8989</td>
<td>1550</td>
<td>643</td>
<td>382</td>
<td>2068</td>
<td>2797</td>
<td>1549</td>
</tr>
<tr>
<td><strong>New product sales</strong></td>
<td>143.88</td>
<td>19.77</td>
<td>12.15</td>
<td>4.03</td>
<td>38.79</td>
<td>41.78</td>
<td>27.36</td>
</tr>
<tr>
<td><strong>New product profits</strong></td>
<td>10.61</td>
<td>1.18</td>
<td>0.25</td>
<td>0.20</td>
<td>4.14</td>
<td>3.14</td>
<td>1.70</td>
</tr>
<tr>
<td><strong>New product export sales</strong></td>
<td>2.24</td>
<td>0.32</td>
<td>0.24</td>
<td>0.13</td>
<td>0.37</td>
<td>0.37</td>
<td>0.80</td>
</tr>
</tbody>
</table>

**Note:** The unit for number of employees and R&D personnel is in Million Person. The unit for number of innovations, number of new products and number of process innovations is in Item. The unit for gross production outputs, total assets, liabilities, sales and profits, innovation expenditure, R&D expenditure, new product sales and new product profits is in Billion Yuan. The unit for total export sales and new product export sales is in Billion U.S. dollars.
6.3 Hypotheses Testing Model and Techniques

The results of any empirical study are affected by research methods. One solution is to synthesize previous studies conducted in the similar area (Palich, Cardinal and Miller, 2000). Multivariate data analysis is one of the frequently used methods in the strategic management and innovation literature. Following previous studies, the hypothesized relationships between innovation capabilities and firm performance outlined in Chapter Five were tested using a multi-regression methodology. This approach was selected because the hypotheses testing deals with a large sample, and a complex set of independent and dependent variables. This section presents relevant model and techniques.

6.3.1 Hypotheses Testing Model

As mentioned above, to determine the impact of innovation capabilities on firm performance, in general, this study assesses the following linear regression model:

\[
\text{Firm performance} = \alpha + \sum \beta \text{ (innovation capabilities)} + \sum \delta \text{ (environmental & organizational factors)} + \sum \gamma \text{ (control variables)} + \epsilon
\]

On the left-hand side, the linear model presents firm performance. On the right-hand side, the model includes variables that reflect innovation capabilities, environmental and organizational factors, and control variables.

It is important to emphasize that the goal of this study is not to estimate all determinants of firm performance. Rather, this study specifically seeks to reveal the impact of innovation capabilities on firm performance in Chinese industrial firms. Therefore, it is important to consider the level of the influence of the variables on both innovation and performance in choosing relevant dependent and independent variables. Given the goal of this study, both dependent and independent variables and their measurements were selected through two stages. First, the secondary literature was reviewed to determine indicators of innovation capabilities and resources already identified as having some impacts on firm performance. The second stage involved interviews with several firm managers as well as professionals of innovation. They
were requested to provide the factors that they are consideration as important for firm performance.

In summary, three dimensions of performance consisting of financial performance, market performance, and innovation performance are employed in this study. These dimensions were measured by using either objective measures or perceptual measures. For example, financial performance is measured by return on sales (ROS), which is an objective performance measure, while market performance is measured using three constructs such as: (1) achieved or enlarged market share; (2) entered new domestic markets; and (3) entered new foreign markets.

On the right-hand side, Innovation capabilities were measured using six dimensions: R&D capability; absorptive capability of external technology resources; product development capability; process innovative capability; manufacturing capability; and marketing capability. Additional right-hand side variables as depicted in the equation reflect environmental and organizational factors including regional development, innovation policy support, industry type in terms of industrial technology intensity, and ownership, which might influence firm performance. Four control variables: firm size; firm age; production scale; and financial structure are also included. The details of variable operationalizations are presented in section 6.4.

6.3.2 Hypotheses Testing Techniques

Multiple regression analysis was used to test the hypotheses described in Chapter Five. The analyses proceeded through three steps. In the first step, the hypotheses in this study implicitly dealing with the impact of innovation capabilities regardless of the difference of environmental and organizational factors were tested. For example, hypotheses 1 through to 6 concern the independent impact of each innovation capability dimension on firm performance. The regression equations therefore included innovation variables and all environmental and organizational variables to test the main effects of innovation capabilities on each firm performance dimension.
In the second step, moderated regression analysis was adopted to examine interactive effects of innovation capabilities in terms of the interaction of R&D capability and marketing capability, and moderating effects of three environmental factors: regional development; innovation policy support; and industry type. Moderated regression is considered as a relatively conservative method for examining interaction effects, as ‘the interaction terms are tested for significance after all main effects have been entered into the regression equation’ (Steensma, Marino, Weaver and Dickson, 2000: 961). This study generates interactive terms for R&D capability with marketing capability, as well as for each innovation capability dimension with regional development, innovation policy support and industry type, separately. These interactions are significant only if they explain significantly larger portions of the variance in dependent variables than those portions already explained by other independent variables.

In the third step, the split sample regressions were tested to examine the impact of innovation capabilities under different conditions of ownership. In order to carry out the analysis in this study, a firm’s ownership is separated into three categories: (1) state-owned enterprises (SOEs); (2) non-state-owned enterprises (non-SOEs) such as collective firm, private firm and share-holdings; and (3) international joint ventures (IJVs). Split sample regressions relating to SOEs, non-SOEs and IJVs are therefore estimated separately. All regressions were estimated using SPSS version 9.

6.4 Variable Operationalizations

The analysis employs multi-measure approaches to operationalize variables. As noted in Section 6.3, some of relevant measurements available from previous extant research are used to operationalize variables in this study, but are modified to make them more appropriate and robust for the present study.

6.4.1 Dependent Variables - Firm Performance

Performance is a complex multidimensional construct. Any single measure of performance may not fully cover all aspects and provide a comprehensive understanding of firm performance (Combs and Ketchen JR., 1999; Li and Simerly, 1998; Venkatraman and
Ramanujam, 1986). In an attempt to reveal the direct impact of innovation capabilities, this study models firm performance by three dimensions of performance: financial performance; market performance; and innovation performance. These are important indicators of firm performance, which would be considered as relevance regardless of firm's strategy level (Slater and Olson, 2000).

**Financial Performance.** Strategic management researchers generally measure financial performance using either accounting profitability or efficiency (Brush, Bromiley and Margaretha, 2000). In order to avoid common method bias, financial performance is measured in the present study by using an accounting measure return on sales (ROS). This is one of the most frequently used measures of performance at the firm level in management studies (Bharadwaj, 2000; Terwiesch, Loch and Niederkofler, 1998; Zahra and Covin, 1993), although ROS as a measure of performance has some limitations. For example, the measure may be distorted because of its aggregateness (Venkatraman and Ramanujam, 1986). Nevertheless, it is an appropriate measure when the firms are relatively stable and mature (Kotha and Nair, 1995). In this study, ROS was operationalized as the ratio of profit to total sales, $\text{ROS} = \frac{P}{SR}$, where $P$ is pretax profit and $SR = \text{total sales and lease revenues}/100$.

**Market Performance.** Earlier studies have employed several measures of market performance such as market growth (Lee, Lee and Pennings, 2001; McGee, Dowling and Megginson, 1995), market share (Lawless and Anderson, 1996) and market development. While this study examines the impact of innovation capabilities on performance, there is no commonly accepted set of market performance measures in the literature. One of the most important purposes of innovation is to bring new products into either current or new markets. Therefore, it seems to be reasonable to base the evaluation of market performance on measures that take into account the enlargement and development of product markets. In this study, market performance is measured by perceived measures with three items, which tap the extent to which the firm have achieved market share or entered new markets. These items were: (1) maintained desired market share; (2) increased market share and sales growth; and (3) entered/opened up
new domestic or overseas markets. The degree of achievement was measured using a 5-point Likert-type scale, in which '1' represented 'not achieved', and '5' represented 'highly achieved'. The results of reliability test and factor analysis shown in Table 6.5 on page 163 indicated that the three items could be aggregated (eigenvalue = 1.734, Cronbach $\alpha = 0.71$) to create a single composite indicator for market performance.

**Innovation Performance.** Innovation performance requires a multi-dimensional conceptualization (Griffin and Page, 1993) and can be measured in terms of different innovation outputs such as patents (Ahuja and Katila, 2001), or some objective indicators like market share gains, return on investment, and meeting objective targets of product innovation (Kleinschmidt and Cooper, 1991). However, the more direct measure is product innovation outcomes. For example, the number of new products creates a new market niche (Lumpkin and Dess, 1996; Hage, 1980; Lee, Lee and Pennings, 2001). In order to distinguish innovation performance measures from other firm performance measures, this study measures innovation performance as new product intensity by two indices: (1) ratio of new product sales to total sales, and (2) ratio of numbers of product innovations to total products sold by a firm. To create a single measure for innovation performance, two indicators were standardized separately by using the mean and standard deviation of the corresponding indicator. Since the reliability test and factor analysis indicated that two standardized indicators could be aggregated to produce one indicator (eigenvalue = 1.744, Cronbach $\alpha = 0.85$), each standardized score was multiplied by factor loading and then was added up.

**6.4.2 Independent Variables - Innovation Capabilities**

Moorman and Slotegraaf (1999) summarize that there are two ways to measure firm capabilities. The first way is to measure underlying knowledge and skills, which are likely to constitute firm capabilities. The second way is to measure observable outcomes associated with firm capabilities. This study implemented their suggestions to measure innovation capabilities. As discussed in previous chapters, in particular, innovation capabilities can be specified in terms of six dimensions: R&D capability; absorptive capability of external technology
Research Methodology and Analytical Framework

resources; product development capability; process innovative capability; manufacturing capability; and marketing capability.

R&D Capability. R&D intensity is employed as an indicator of R&D capability. This study selects this measure, given empirical evidence of a relationship between R&D intensity and innovation as well as performance (Brenner and Rushton, 1989; McGee, Dowling and Megginson, 1995; Pegels and Thirumurthy, 1996). R&D intensity is not a perfect measure of innovation capability. For example, R&D intensity may be influenced by firm size. In large firms, R&D intensity may be proportionally lower than that in small firms (Baysinger and Hoskisson, 1989). Despite these limitations, however, previous studies suggest that this measure is a useful indicator of innovation capability across firms (Ettlie, 1998; Hill and Snell, 1988; Patterson, 1998; Pegels and Thirumurthy, 1996). This is largely because R&D intensity reflects 'a firm’s commitment to innovative activity and permits relative comparison among firms’ (Hoskisson and Hitt, 1988: 612).

There are several proxies that can be used as indicators for R&D intensity. Such proxies include R&D expenditure as a percentage of sales, R&D personnel as a percentage of total employees, and R&D expenditure per employee and patent. This study extends previous research by aggregating the first two indices to create a single measure of R&D intensity. These two indices are commonly used in previous studies and are prone to greater distortions than R&D expenditure per employee (Hay and Morris, 1979; Hill and Snell, 1988; Scherer, 1984). Patent data are not available for this study, since only a few firms reported their patent data in the survey.

The deviation of a firm’s R&D expenditure as a percentage of sales from its mean was computed, and all deviations expressed as standardized Z-scores. Similarly, standardized Z-scores for R&D personnel as a percentage of total employees were computed. Reliability and factor analysis indicated that these two dimensions could be aggregated to produce one indicator (eigenvalue = 1.002, Cronbach α = 0.64). Each standardized score was multiplied by the factor loading and was added together.
Other innovation capabilities were measured by subjective indicators containing thirteen items. These items were extracted from the technological innovation survey. An orthogonal factor analysis with a varimax rotation of these items yielded four significant factors representing: (1) absorptive capability; (2) product development capability; (3) process innovative capability; and (4) manufacturing capability, each with an eigenvalue above 1.0. These four factors explained 59.88 percent of variance. This procedure justified the use of these four factors for measuring innovation capabilities.

Absorptive Capability of External Technology Resources. In the context of transition economies, a firm's internal capability of technology development may not be strong, and its technology accumulation may be obsolete in new conditions. Therefore, learning and obtaining technology from outside resources is important. This study concentrates on a firm's capability of technology acquisition and absorption to measure absorptive capability of external technology resources. According to the result of the factor analysis, three items were used to measure absorptive capability of external technology (factor three): (1) enhancement of technology acquisition; (2) enhancement of technology improvement based on external technology; and (3) enhancement of transfer and absorption of foreign technology. Assessments were scored on a 5-point Likert-type scale (1 = not at all, and 5 = crucial). Reliability and factor analysis indicated that the dimensions of absorptive capability could be aggregated to produce one indicator (eigenvalue = 1.140, Cronbach α = 0.67).

Product Development Capability. Product development capability has been a key concept in many empirical studies. However, the measurement of product development capability remains rather vague and is not as ‘fine-tuned’ as it could be (Danneel and Kleinschmidt, 2001). Two dimensions of product development capability have been frequently discussed in the literature: product development and product innovativeness (e.g., Booz, Allen, and Hamilton Inc., 1982; Danneel and Kleinschmidt, 2001; Lee, Lee and Pennings, 2001; Roberts, 1999; Zirger, 1997). Following these empirical studies and the result of factor analysis, this study measured product development capability by three items (factor four): (1) internal product and
technology development; (2) external co-operative product and technology development; and (3) development and access to new knowledge and resources of new products. These were measured using a 5 point Likert-type scale ranging from 1 = not at all, to 5 = crucial. Reliability test and factor analysis indicated that these three items could be combined to create one indicator of product development capability (eigenvalue = 1.037, Cronbach α = 0.65).

Process innovative capability. As Christensen (1995) suggests, capabilities for process innovation should include not only the capabilities for the development of process technology, but also the organizational and managerial capabilities associated with innovation activities. However, it is difficult to quantify organization innovation. From the factor analysis, in this study process innovative capability was measured by four items reflecting the extent to which a firm’s process innovation capability is critical (factor one): (1) reduction of materials consumption; (2) reduction of energy consumption; (3) improvement of work conditions and environments; and (4) reduction of product costs. The assessments were scored on a 5-point Likert-type scale ranging from 1 = not at all, to 5 = crucial. Reliability test and factor analysis indicated that these items could be aggregated into one indicator for process innovative capability (eigenvalue = 4.313, Cronbach α = 0.84).

Manufacturing Capability. Manufacturing capability was defined in terms of the adoption of advanced production related to new products. This is because strategic management studies tend to emphasize those manufacturing capabilities that relate to production costs and investments as well as rapid product change (Jonsson, 1999). The process of manufacturing new products may be different from production processes used for old products. Moreover, transaction from an R&D outcome to a new product requires the development and improvement of production processes. This often requires investment in and training for workforces’ skills and developing intangible technological assets (Song, 2002). Therefore, the improvement of new product trial production and the adoption of advanced production can be viewed as indicators of manufacturing capability. Based on the result of factor analysis, manufacturing capability was measured by three items (factor two): (1) adoption of advanced production
technology and equipment introduced from foreign organizations; (2) managerial restructuring of production based on the introduction of foreign advanced technology and equipment; and (3) enhancement of workers' skills through implementing staff training programs. The assessments were scored on a 5-point Likert-type scale ranging from 1 = not at all, to 5 = crucial. Reliability test and factor analysis indicated that these three items could be aggregated into one indicator for process innovative capability (eigenvalue = 1.393, Cronbach α = 0.77).

Marketing Capability. Firms have access to or obtain various marketing capabilities (Day, 1994). In this study, marketing capability is conceptualized as the firm's ability to develop the relationship with customers. The measurement of marketing capability focuses on one key marketing capability the orientation of marketing networks/channels development. There are several reasons for this. First, marketing networks/channels are important complementary assets to technology capabilities. They are one of the firm resources determining market share and profitability of the firm (Leiponen, 1997). Second, to some extent, the development of marketing networks/channels reflects a firm's relationship with its customers, and by extension, it reflects a firm's market position to its competitors. The capability to build a defensible market position has been used as a key element of a firm's marketing activity (Hooley and Saunders, 1993; Hooley, Cox, Beracs, Fonfara and Snoj, 2000; Porter, 1996; Ries and Trout 1982). Therefore, it seems reasonable to expect that firms with broader distribution and marketing networks/channels will improve their market success. In particular, marketing capability in terms of the breadth of marketing networks/channels development in this study was measured by five items reflecting the extent to which the marketing networks/channels have been constructed: (1) have less marketing networks/channels (coded as 1); (2) orient to the development of provincial marketing networks/channels (coded as 2); (3) orient to the development of regional marketing networks/channels, (4) orient to the development of nationwide marketing networks/channels (coded as 4); and (5) orient to the development of overseas marketing networks/channels (coded as 5).
Although marketing capability variable could be strengthened with some complementary marketing measures, the innovation survey questionnaire did not allow for the construction of further marketing capability indicators.

6.4.3 Environmental and Organizational Variables

The importance of a firm's environmental context for innovation and performance was discussed in previous chapters. In this study, four sets of environmental and organizational variables are used: regional development; innovation policy support; industry type in terms of the industrial technology intensity; and firm ownership.

*Regional Development.* The difference of economic development across regions provides firms with different environments and resources for innovation. Given the importance of regional development, six survey regions were categorized into highly developed and competitive or lowly developed and competitive regions on the basis of the annual growth rate of regional per capita GDP. Each firm was categorized using a dichotomous variable, highly developed and competitive equaled to 1, if it was in one of the provinces or cities, in which the annual growth rate of per capita GDP exceeded average level of national per capita GDP growth rate, and 0 otherwise. Table 6.4 shows the average annual growth rate of per capita GDP throughout 1979-98 in six provinces and cities.

<table>
<thead>
<tr>
<th>Table 6.4 Regional Per Capita GDP (1979-1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Province</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Nation</td>
</tr>
<tr>
<td>Guangdong</td>
</tr>
<tr>
<td>Jiangsu</td>
</tr>
<tr>
<td>Shanghai</td>
</tr>
<tr>
<td>Beijing</td>
</tr>
<tr>
<td>Liaoning</td>
</tr>
<tr>
<td>Heilongjiang</td>
</tr>
</tbody>
</table>

*Source:* State Statistical Bureau.

*Innovation Policy Support.* Innovation policy support indicates the positive influence of government policies in a firm's innovation capabilities and activities. In this study, innovation
policy support was measured by four items: (1) specialized technology development loans policy; (2) financial incentives for technology development; (3) pricing policy; and (4) specialized human resources (or assets) policy. The extent to which innovation policies are critical was measured on a 5-point Likert-type scale (1 = not at all, and 5 = very important). The inter-item reliability was quite high (eigenvalue = 1.028, Cronbach $\alpha = 0.74$). The four items were therefore combined to represent one construct.

**Industry Type.** It has been argued elsewhere that industry type affects both innovation and performance, and that innovation capabilities vary across industrial sectors. For example, differences of competition and maturity across industries may affect the performance such as profitability and growth (Thomsen and Pedersen, 2000). Competition in high technology industries is higher, while most low or medium technology industries are mature industries. This analysis aims to reveal the difference in the impact of innovation capabilities in high technology-intensive industries and other industry sectors. Industries were therefore classified as high technology-intensive industries (coded as 5), medium-high technology-intensive industries (coded as 4), medium-low technology-intensive industries (coded as 3), low technology-intensive industries (coded as 2), and extremely low technology intensive industries (coded as 1) according to OECD’s (1997) classification of industries.

**Ownership.** Ownership of a firm is one of the determinants of organizational complexity and structure (Kimberly, 1976; Geeraerts, 1984). Ownership may influence a firm’s innovation capabilities and performance. For example, Coombs and Tomlinson (1998) found that the technology innovation styles are quite different between the domestic firms and International Joint Ventures (IJVs) in UK. The UK domestic firms follow a product improvement style, while

---

1 Manufacturing industries are classified according their global technological intensity: direct and indirect R&D intensity. Two direct intensity indicators were used, and one for overall R&D intensity (sum of direct and indirect intensity). The two direct indicators were constructed for each of the 22 manufacturing sectors in 10 OECD countries, and the OECD list was obtained by weighting each sector for its share in the production or value added of all ten countries, taking GDP purchasing power parities as exchange rates. With the overall intensity indicator, direct intensity was calculated in the same way. For indirect intensity, account had to be taken of technology (R&D expenditure) embodied in intermediates and capital goods purchased on the domestic market or imported. Industries classified in a higher category have a higher OECD-average intensity for all indicators than industries in a lower category. Four groups of manufacturing industry were identified as results: i) high-technology; ii) medium-high-technology; iii) medium-low-technology; and iv) low-technology. (Hatzichronoglou, 1997:5). Appendix B presents a table of industries in these four groups.
the radical innovation style is more closely associated with IJVs in UK. In the past, China’s economy was characterized by state-owned enterprises (SOEs). Since the beginning of economic transaction, ownership transformation has taken place in China, due to the emergence of private firms and the entry of foreign firms with ascension to WTO, this process has gained further impetus.

As mentioned in Chapter Three, firm ownership in China is characterized by a diversity of organizational forms such as state-owned enterprises, collective firms, private firms, international joint ventures, etc. In order to compare the difference of the impact of innovation capabilities on performance in firms with different forms of ownership, in this study, the ownership of firm was defined as a string variable that was coded 1 to indicate state-owned enterprises (SOEs), 2 to indicate non-state-owned enterprises (non-SOEs), and 3 to indicate international joint ventures (IJVs). Non-SOEs include collective firms, private firms and other non-SOEs.

‘Collectives’ is a form of publicly owned enterprises. However, the collective form does not have a precise legal definition in China. It includes traditional urban and rural collective firms and some recently established science and technology enterprises. Unfortunately, the science and technology enterprises could not be separated from other general collective forms. Other non-state owned enterprises include share-holding firms and joint ventures. A joint venture is a firm that is owned by two or more firms. In the context of this study, joint ventures are typically created only by two or more domestic firms.

6.4.4 Control Variables

The analysis in this study proceeds with four control variables firm size, firm age, production scale and financial structure.

*Firm size.* Firm size provides a measure of a firm’s economies of scale (Steensma, Marino, Weaver and Dickson, 2000) and affects the scope of resource allocation (Ettlie, 1983; Yeoh and Roth, 1999). A large body of empirical research has examined the relationship between firm size and innovation. For example, some studies have shown that firm size has an
effect on R&D expenditures (Baysinger and Hoskisson, 1989), as well as product innovation and marketing efforts (Ettlie and Rubenstein, 1987; Capon, Farley and Lehmann, 1992; Chaney and Devinney, 1992; Hitt, Hoskisson, Johnson and Moesel, 1996). The different measures used to quantify innovation and distribution of firm sizes have led to seemingly inconsistent findings (Audretsch and ACS, 1991). Although specific hypotheses concerning firm size were not provided, this study controlled for it in regression equations. In China, the criteria for classifying the firm size vary across industrial sectors. Number of employees, fixed asset, production capabilities and sales are the measures most often used for identifying firm size in different industries. Since the samples covered different sectors, in this study, firm size was measured as the number of employees in the firm and the log of size was used in order to simplify the data analyses, and to generate consistence with most empirical studies in the literature.

**Firm age.** This study also controlled for firm age. Several previous studies have pointed out that older established firms are more likely to be frequently innovative (Deeds and Hill, 1996; Zahra and Nielsen, 2002). Firm age was measured in this study by the number of years that the firm has existed.

**Production scale.** Production scale is one of the indicators related to firm size and firm performance. In this study production scale was measured as the gross production outputs of the firm. Similar to the measure of firm size, the log value of the gross production outputs was used.

**Financial structure.** Financial structure in terms of liquidity of the firm has been shown to be associated with firm performance (Hitt, Hoskisson and Kim, 1997; Hitt and Smart, 1994; Jensen, 1989). Liquidity is usually measured by current assets divided by current liabilities in the literature (Baysinger and Hoskisson, 1989). This study used the same procedure to measure financial structure.

Table 6.5 summarizes the operationalizations of all variables related to firm performance, innovation capabilities, environmental and organizational factors and control variables, as well as the results of construct reliability assessments for those construct measures.
Table 6.5 Operationalizations and Measurement of Variables

<table>
<thead>
<tr>
<th>Performance</th>
<th>Internal consistency reliability (α)</th>
<th>Factor loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financial Performance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return on sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Market Performance</strong> (eigenvalue = 1.734)</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>Maintained desired market share</td>
<td>.781</td>
<td></td>
</tr>
<tr>
<td>Increased market share and sales growth</td>
<td>.815</td>
<td></td>
</tr>
<tr>
<td>Entered/opened up new domestic or overseas markets</td>
<td>.678</td>
<td></td>
</tr>
<tr>
<td><strong>Innovation Performance</strong> (eigenvalue = 1.744)</td>
<td>.85</td>
<td></td>
</tr>
<tr>
<td>Ratio of new product sales to total product sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of numbers of product innovations to total products</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Innovation Capability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>R&amp;D capability</strong> (eigenvalue = 1.002)</td>
<td>.64</td>
<td></td>
</tr>
<tr>
<td>Ratio of R&amp;D expenditure to total sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of R&amp;D personnel total employees</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Absorptive capability of external technology</strong> (eigenvalue = 1.140)</td>
<td>.67</td>
<td>.817</td>
</tr>
<tr>
<td>Enhancement of technology acquisition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancement of technology improvement based on external technology</td>
<td>.471</td>
<td></td>
</tr>
<tr>
<td>Enhancement of transfer and absorption of foreign technology</td>
<td>.784</td>
<td></td>
</tr>
<tr>
<td><strong>Product development capability</strong> (eigenvalue = 1.037)</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>Internal product and technology development</td>
<td>.782</td>
<td></td>
</tr>
<tr>
<td>External co-operative product and technology development</td>
<td>.563</td>
<td></td>
</tr>
<tr>
<td>Development and access to new knowledge and resources of new products</td>
<td>.459</td>
<td></td>
</tr>
<tr>
<td><strong>Process innovative capability</strong> (eigenvalue = 4.313)</td>
<td>.84</td>
<td></td>
</tr>
<tr>
<td>Reduction of materials consumption</td>
<td>.876</td>
<td></td>
</tr>
<tr>
<td>Reduction of energy consumption</td>
<td>.888</td>
<td></td>
</tr>
<tr>
<td>Improvement of work conditions and environments</td>
<td>.678</td>
<td></td>
</tr>
<tr>
<td>Reduction of product costs</td>
<td>.691</td>
<td></td>
</tr>
<tr>
<td><strong>Manufacturing capability</strong> (eigenvalue = 1.393)</td>
<td>.77</td>
<td></td>
</tr>
<tr>
<td>Adoption of advanced production technology and equipment introduced from foreign organizations</td>
<td>.805</td>
<td></td>
</tr>
<tr>
<td>Managerial restructuring of production based on the introduction of foreign advanced technology and equipment</td>
<td>.777</td>
<td></td>
</tr>
<tr>
<td>Enhancement of workers' skills through implementing staff training programs</td>
<td>.549</td>
<td></td>
</tr>
</tbody>
</table>

163
Table 6.5 continued

**Marketing capability** (Construction of distribution networks)
- Have less marketing networks/channels (=1)
- Orient to the development of provincial marketing networks/channels (=2)
- Orient to the development of regional marketing networks/channels (=3)
- Orient to the development of nation-wide marketing networks/channels (=4)
- Orient to the development of overseas marketing networks/channels (=5)

**Environmental and organizational factors**

**Regional development**
- Highly developed and competitive regions
- Lowly developed and competitive regions

**Innovation policy support** (eigenvalue = 1.028)
- Specialized technology development loans policy
- Financial incentives for technology development
- Pricing policy
- Specialized human resources policy

**Industry type**
- High-technology-intensive industries (=5)
- Medium-high-technology-intensive industries (=4)
- Medium-low-technology-intensive industries (=3)
- Low-technology-intensive industries (=2)
- Extremely low technology intensive industries (=1)

**Ownership**
- State-owned enterprises (SOEs)
- Non-state-owned enterprises (non-SOEs)
- International joint ventures (IJVs)

**Control Variables**
- **Firm size**: Log of the number of full-time employees
- **Firm age**: establishment years
- **Production scale**: Log of gross industrial output value
- **Financial structure**: Ratio of total debts to total assets
6.5 Reliability and Validity Assessment

As mentioned above, several variables were measured using construct methods. It is necessary to assess reliability and validity for these constructs.

**Reliability**

Reliability refers to 'the degree to which a set of two or more indicators share in their measurement of a construct' (Hair, Jr., Anderson, Tatham and Black, 1992: 431). Indicators in reliable constructs are inter-correlated, indicating they are measuring the same construct. In this study, reliability was initially assessed using Cronbach's coefficient alpha (Cronbach, 1951). Alpha provides a conservative estimate of the measure's reliability (Carmines and Zeller, 1979). Large alpha indicates that indicators of a construct highly correlate and they contribute equally to the overall variance (Homburg, Krohmer and Workman, Jr., 1999).

As can be seen in Table 6.5, alphas of relevant measures: market performance ($\alpha = 0.71$), innovation performance ($\alpha = 0.85$), process innovative capability ($\alpha = 0.84$), manufacturing capability ($\alpha = 0.77$) and innovation policy support ($\alpha = 0.74$), were above 0.70 level advocated by Nunnally (1978). Alphas for R&D capability ($\alpha = 0.64$), absorptive capability of external technology resources ($\alpha = 0.67$) and product development capability ($\alpha = 0.65$) were lower than 0.70, but they were above the 0.60 level, which was suggested as appropriate and acceptable for exploratory research (Dess and Beard, 1984; McEvily and Zaheer, 1999).

**Validity**

Validity refers to the extent to which a measure of a construct actually assesses what it purports to measure (Carmine and Zeller, 1979). Construct validity reflects the fitness and correlation of multiple indicators of same construct. There are two methods for assessing construct validity: convergent validity and discriminant validity. Convergent validity refers to the degree to which multiple indicators measuring the same construct by different methods are highly correlated (Capbell and Fiske, 1959: Phillips, 1981). Discriminant validity refers to the degree to which different constructs differ from each other (McEvily, and Zaheer, 1999).
This study mainly assessed convergent validity by calculating alpha coefficient of each construct measure of relevant variables for respondent sub-samples from high development regions and low development regions. As shown in table 6.6, all alphas were above the 0.60 level, suggesting that the measures of these variables seem to be reliable, even in samples from different regions.

Table 6.6 Cronbach Alpha Levels of Relevant Construct Measures in High and Low Development Regions

<table>
<thead>
<tr>
<th>Variables</th>
<th>High development regions</th>
<th>Low development regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market performance</td>
<td>.69</td>
<td>.73</td>
</tr>
<tr>
<td>Innovation performance</td>
<td>.81</td>
<td>.87</td>
</tr>
<tr>
<td>R&amp;D capability</td>
<td>.62</td>
<td>.63</td>
</tr>
<tr>
<td>Absorptive capability</td>
<td>.62</td>
<td>.66</td>
</tr>
<tr>
<td>Product development capability</td>
<td>.61</td>
<td>.65</td>
</tr>
<tr>
<td>Process innovative capability</td>
<td>.84</td>
<td>.85</td>
</tr>
<tr>
<td>Manufacturing capability</td>
<td>.75</td>
<td>.78</td>
</tr>
<tr>
<td>Innovation policy support</td>
<td>.74</td>
<td>.75</td>
</tr>
</tbody>
</table>

6.6 Chapter Summary

This chapter discussed the methodological issues related to examining the relationship between innovation capabilities and firm performance and explained the construction of variables and indicators.

The dataset provided the present study with original information through the technological innovation survey, rather than secondary data source. These original data enable the current study to address specific issues and test specific hypotheses with a comparative large sample. Data used in this study are limited to 3843 industrial firms who carried out innovation activities during 1993-1995.

The multiple regression analysis was employed to test the hypotheses developed in Chapter Five. In preparation for data analyses, this chapter addressed the operationalizations of all variables. Financial performance, innovation performance and R&D capability were
measured by objective measures, while market performance, absorptive capability, product
development capability, process innovative capability, manufacturing capability and marketing
capability were presented by construct measures. This chapter also introduced four
environmental and organizational variables as well as their constructions and roles in the
analysis. These included regional development, innovation policy support, industry type and
ownership. Four control variables to be used in the analysis were also introduced. They were
firm size, firm age, production scale and financial structure of the firm. The logic underlying the
development of the variables and the results of reliability and validity assessment indicated that
it is reasonable to characterize firm performance and innovation capabilities by these
dimensions proposed in this study. These results provided a methodological foundation for the
hypotheses testing discussed in the next chapter.
CHAPTER SEVEN
REVEALING THE COMPLEX IMPACT OF INNOVATION CAPABILITIES – THE RESULTS OF DATA ANALYSES

This chapter presents the data analyses and major findings in this study. It is organized in four sections. The first section presents the results concerning the main effects of innovation capabilities on firm performance. The second section describes the interactive impact of innovation capabilities in terms of the interaction of R&D capability and marketing capability. The third section presents an analysis of the moderating effects of environmental and organizational factors on the relationship between innovation capabilities and firm performance. Finally, the fourth section summarizes the major findings from data analyses and hypotheses testing.

Descriptive statistics of all dependent and independent variables used in data analyses are displayed in Table 7.1 on page 170. These data presents the means, standard deviations and inter-correlation matrix for all three firm performance variables, six innovation capability variables, four environmental and organizational factors, and four control variables. All analyses of correlations were based on data from the 3843 Chinese industrial firms included in the sample of the technological innovation survey. As shown in Table 7.1, means of the variables were generally in the middle of range. Means of innovation performance and R&D capability were near zero as they are each the sum of standardized scores.

First, these data show a statistical significance for R&D capability, which had a significant and positive association with financial performance ($r=0.402, p<0.01$), market performance ($r=0.017, p<0.05$), and innovation performance ($r=0.283, p<0.01$). Second, absorptive capability of external technology resources was positively associated with market performance ($r=0.422, p<0.01$), but negatively related to innovation performance ($r=-0.075, p<0.01$). Third, product development capability was positively associated with market performance ($r=0.395, p<0.01$) and innovation performance ($r=0.141, p<0.01$). Fourth, the measure of process innovative capability had relatively stronger and positive association with
market performance \((r=0.441, p<0.01)\) and innovation performance \((r=0.155, p<0.01)\). Fifth, manufacturing capability was also positively correlated with market performance \((r=0.402, p<0.01)\) and innovation performance \((r=0.049, p<0.01)\). Finally, marketing capability was negatively correlated with financial performance \((r=-0.082, p<0.01)\), but positively correlated with market \((r=0.102, p<0.01)\) and innovation performance \((r=0.078, p<0.05)\).

These statistically significant correlations between innovation capability variables and performance measures suggest that innovation capabilities can significantly influence firm performance and vice versa. A further observation that can be made is that several statistically significant correlations among innovation capability variables and environmental factors suggest that innovation capabilities are influenced by those factors. Although, the large and significant inter-correlations exist between firm performance, innovation capabilities, environmental and organizational variables and control variables, not all capability variables reflecting the hypothesized effects are highly correlated with each performance dimension. For example, product development capability was not correlated with financial performance. Marketing capability had relatively weak correlations with financial and innovation performance. These effects of correlations suggest the need for multivariate analyses to further explain the influence of each innovation capability dimension on each performance dimension.

Based on the results of inter-correlations, hierarchical standard regression analysis was used to test the hypotheses developed in this study. There were three steps in this analytical process. First, four control variables firm size, firm age, production scale and financial structure were entered into each performance equation: financial performance; market performance; and innovation performance equation. Second, six independent variables: R&D capability; absorptive capability of external technology resources; product development capability; process innovative capability; manufacturing capability; and marketing capability; along with four environmental and organizational factors: regional development; innovation policy support; industry type; and ownership were added to test the main effects of innovation capabilities on each performance dimension.
Table 7.1 Descriptive Statistics and Correlations for all Dependent, Independent and Control Variables (N = 3843)

|                      | Mean   | Std.   | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   | 13   | 14   | 15   | 16   | 17   | 18   |
|----------------------|--------|--------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| **Performance**      |        |        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 1. Financial performance (FINPFM) | 9.23   | 248.96 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 2. Market performance (MKTPFM)     | 4.05   | .81    | .004 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 3. Innovation performance (INNPFM) | 0.00   | 1.86   | .050 | .027 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| **Innovation capability**           |        |        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 4. R&D capability (RDCAPA)          | 0.00   | 1.43   | .402 | .017 | .283 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 5. Absorptive capability (ABTCAPA) | 3.58   | .75    | -.011| .422 | -.075| .092 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 6. Product development capability (PRDCAPA) | 3.91   | .68    | .010 | .395 | .141 | .024 | .364 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 7. Process innovative capability (PRCCAPA) | 3.78   | .86    | -.009| .441 | .155 | -.120| .358 | .353 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 8. Manufacturing capability (MNFCAPA) | 3.98   | .76    | .018 | .402 | .049 | -.050| .337 | .404 | .486 |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 9. Marketing capability (MKTCAPA)   | 2.91   | 1.26   | -.082| .102 | .078 | -.091| .106 | .042 | .002 | .050 |      |      |      |      |      |      |      |      |      |      |      |      |
| **Environmental factors**          |        |        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 10. Regional development (REGDEV)  | .55    | .50    | .036 | .122 | .184 | -.203| .138 | .079 | .129 | .081 | .126 |      |      |      |      |      |      |      |      |      |      |      |
| 11. Innovation policy support (INNPSPT) | 3.72   | .76    | .021 | .319 | .051 | .052 | .272 | .350 | .311 | .311 | .021 | -.044 |      |      |      |      |      |      |      |      |      |      |
| 12. Industry type (INDSTYPE)       | 3.39   | 1.55   | -.053| .104 | -.084| -.170| .088 | .049 | .053 | .050 | .147 | .274 | .011 |      |      |      |      |      |      |      |      |      |
| 13. Ownership (OWNSHIP)            | 1.67   | .73    | -.003| .053 | .194 | .042 | .012 | -.016| -.045| -.035| .132 | .060 | -.065| -.007 |      |      |      |      |      |      |      |      |
| **Control variables**              |        |        |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 4. Firm size (FSIZE)               | 5.71   | 1.76   | -.060| .119 | -.448| -.401| .229 | .025 | .217 | .135 | .179 | .346 | -.011| .342 | -.284 |      |      |      |      |      |      |      |
| 7. Production scale (PSCALE)       | 10.04  | 2.06   | -.077| .136 | -.306| -.333| .209 | .043 | .173 | .126 | .267 | .461 | -.034| .333 | -.048 | .798 | .392 |      |      |      |      |
| 8. Financial structure (FSTRUK)    | 95.69  | 992.53 | -.044| .028 | .004 | -.005| .010 | .014 | -.006| .003 | .023 | .005 | .000 | .014 | -.008 | .012 | .024 | .013 |      |      |      |

Note: * Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
*** Correlation is significant at the 0.001 level (2-tailed).
Finally, relevant interaction terms were added to the equations in order to test for moderating effects. The following sections discuss the main effects of innovation capabilities, interactive effects of R&D capability and marketing capability, moderating effects of regional development, innovation policy support and industry type, and the difference of the effects of innovation capabilities in different ownership firms.

7.1 Main Effects of Innovation Capabilities on Firm Performance (Hypotheses 1 through to 6)

Hypotheses 1 through to 6 concern the main effects of innovation capabilities on firm performance. As mentioned before, firm performance was measured by three dimensions: financial performance; market performance; and innovation performance, and the main effects of innovation capabilities on each performance dimension were examined on the basis of the following linear models:

\[ Y_{ii} = \beta_{0i} + \beta_{1i}FSIZE + \beta_{2i}FAGE + \beta_{3i}PSCALE + \beta_{4i}FSTRUK + \varepsilon_{ii} \] (1)

\[ Y_{ii} = \beta_{0i} + \beta_{1i}FSIZE + \beta_{2i}FAGE + \beta_{3i}PSCALE + \beta_{4i}FSTRUK + \beta_{5i}REGDEV + \beta_{6i}INNPSPT + \beta_{7i}INDSTYPE + \beta_{8i}OWNSHIP + \beta_{9i}RDCAPA + \beta_{10i}ABTCAPA + \beta_{11i}PRDCAPA + \beta_{12i}PRCCAPA + \beta_{13i}MNFCAPA + \beta_{14i}MKTCAPA + \varepsilon_{ii} \] (2)

where \( Y_{ii} \) is performance \( i \) (\( i = 1 \): financial performance; \( i = 2 \): market performance; \( i = 3 \): innovation performance) in model \( j \), and \( FSIZE \) = firm size, \( FAGE \) = firm age, \( PSCALE \) = production scale, \( FSTRUK \) = financial structure, \( REGDEV \) = regional development, \( INNPSPT \) = innovation policy support, \( INDSTYPE \) = industry type, \( OWNSHIP \) = ownership, \( RDCAPA \) = R&D capability, \( ABTCAPA \) = absorptive capability of external technology resources, \( PRDCAPA \) = product development capability, \( PRCCAPA \) = process innovative capability, \( MNFCAPA \) = manufacturing capability, and \( MKTCAPA \) = marketing capability.

Equation 1 is a baseline model just including the control variables. Equation 2 is a main effect model including both independent, environmental and organizational, and control variables.
Given the relatively high correlations between some independent variables, the potential for multicollinearity could exist (Lane and Lubatkin, 1998). In order to account this possibility, the tolerance value and its inverse – the variance inflation factor (VIF) for all non-dependent variables in each regression model were calculated. All these tolerance values presented in Table 7.2 fell within an acceptable range indicating no multicollinearity problems. Very small tolerance values and thus large VIF values denote high collinearity. A common cutoff threshold is a tolerance value of 0.10, which corresponds to a VIF value above 10 (Fox, 1991; Hair, JR., Anderson, Tatham and Black, 1998).

Table 7.2 Collinearity Statistics for Control Variables, External and Internal Environmental Variables, and Innovation Capability Variables

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>Tolerance</th>
<th>Variance Inflation Factor (VIF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm size (FSIZE)</td>
<td>.208</td>
<td>4.812</td>
</tr>
<tr>
<td>Firm age (FAGE)</td>
<td>.500</td>
<td>1.999</td>
</tr>
<tr>
<td>Production scale (PScale)</td>
<td>.274</td>
<td>3.644</td>
</tr>
<tr>
<td>Financial structure (FSTRUK)</td>
<td>.998</td>
<td>1.002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation capabilities</th>
<th>Tolerance</th>
<th>Variance Inflation Factor (VIF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D capability (RDCAPA)</td>
<td>.826</td>
<td>1.210</td>
</tr>
<tr>
<td>Absorptive capability (ABTCAPA)</td>
<td>.740</td>
<td>1.352</td>
</tr>
<tr>
<td>Product development capability (PRDCAPA)</td>
<td>.708</td>
<td>1.413</td>
</tr>
<tr>
<td>Process innovative capability (PRCCAPA)</td>
<td>.656</td>
<td>1.524</td>
</tr>
<tr>
<td>Manufacturing capability (MNFCAPA)</td>
<td>.658</td>
<td>1.519</td>
</tr>
<tr>
<td>Marketing capability (MKTCAPA)</td>
<td>.881</td>
<td>1.136</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental and structural Factors</th>
<th>Tolerance</th>
<th>Variance Inflation Factor (VIF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regional Development (REGDEV)</td>
<td>.734</td>
<td>1.361</td>
</tr>
<tr>
<td>Innovation Policy Support (INNPSPT)</td>
<td>.782</td>
<td>1.280</td>
</tr>
<tr>
<td>Industry type (INDSTYPE)</td>
<td>.826</td>
<td>1.210</td>
</tr>
<tr>
<td>Ownership (OWNSHIP)</td>
<td>.716</td>
<td>1.397</td>
</tr>
</tbody>
</table>
Table 7.3 on page 174 presents the results of standardized regression analyses using financial performance, market performance and innovation performance as dependent variables. For each performance test, a series of tests comparing successive models were also carried out by using model indices \( \text{adjusted } R^2 \), \( R^2 \text{ change} \) and \( F\text{-change} \). They are shown below in Table 7.3.

Model 1, 4 and 7, are related to equation 1 that test for control variables. Together these variables significantly contributed to the \( \text{adjusted } R^2 \) of 0.01 in financial performance model \( (p<0.001) \), \( \text{adjusted } R^2 \) of 0.03 in market performance model \( (p<0.001) \), and \( \text{adjusted } R^2 \) of 0.23 in innovation performance model \( (p<0.001) \). These confirm the priori expectations of the general influence of these selected control variables on each firm performance dimension.

Model 2, 5 and 8 examine the main effects of innovation capabilities on firm performance, including innovation capability variables, environmental and organizational variables, and control variables. It is notable that these models explained performance better than the models that just included control variables. Specifically, for financial performance models, model 2 was significant and explained above 18 per cent of variance in financial performance \( (\text{adjusted } R^2=0.18, p<0.001) \) based on a significant change of \( \text{adjusted } R^2 \) \( (R^2\_\text{change}=0.17, F\text{-change}=69.549 \text{ at } p<0.001) \) from model 1. Model 5 explained over 35 per cent of variance in market performance \( (\text{adjusted } R^2=0.35, p<0.001) \), and the \( R^2 \) was significantly increased compared with model 4 \( (R^2\_\text{change}=0.33, F\text{-change}=167.195 \text{ at } p<0.001) \). Model 8 explained 26 per cent of variance in innovation performance with significant \( F\text{-value} \) and \( R^2 \text{ change} \) \( (\text{adjusted } R^2=0.26, p<0.001; R^2\_\text{change}=0.04, F\text{-change}=15.909 \text{ at } p<0.001) \) from Model 7. These tests indicate that it is reasonable to consider innovation capability variables, environmental and organizational variables, and control variables together in order to better explain firm performance. Therefore, each of the hypotheses regarding the independent impact of innovation capabilities on firm performance is tested on the basis of these models.
Table 7.3 Results of Regression Analyses for Firm Performance: Main and Interactive Effects of Innovation Capabilities (N = 3843)

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>Financial performance</th>
<th>Market performance</th>
<th>Innovation performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
</tr>
<tr>
<td>Firm size (FSIZE)</td>
<td>.153***</td>
<td>.243***</td>
<td>.163***</td>
</tr>
<tr>
<td>Firm age (FAGE)</td>
<td>-.045</td>
<td>-.039</td>
<td>-.024</td>
</tr>
<tr>
<td>Production scale (PSCALE)</td>
<td>-.108***</td>
<td>-.117***</td>
<td>-.113***</td>
</tr>
<tr>
<td>Financial structure (FSTRUK)</td>
<td>.047**</td>
<td>.048**</td>
<td>.043**</td>
</tr>
<tr>
<td>Independent Variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D capability (RDCAPA)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absorptive capability (ABTCAPA)</td>
<td>-.009</td>
<td>.002</td>
<td></td>
</tr>
<tr>
<td>Product development capability (PRDCAPA)</td>
<td>-.012</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>Process innovative capability (PRCCAPA)</td>
<td>.017</td>
<td>-.001</td>
<td></td>
</tr>
<tr>
<td>Manufacturing capability (MNFCAPA)</td>
<td>.026</td>
<td>.022</td>
<td></td>
</tr>
<tr>
<td>Marketing capability (MKTCAPA)</td>
<td>-.085*</td>
<td>-.013</td>
<td></td>
</tr>
<tr>
<td>Environmental Factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional development (REGDEV)</td>
<td>.040*</td>
<td>.026</td>
<td></td>
</tr>
<tr>
<td>Innovation policy support (INNPSPT)</td>
<td>-.006</td>
<td>-.004</td>
<td></td>
</tr>
<tr>
<td>Industry type (INDSTYPE)</td>
<td>-.023</td>
<td>-.031</td>
<td></td>
</tr>
<tr>
<td>Ownership (OWNSHIP)</td>
<td>.036</td>
<td>.034</td>
<td></td>
</tr>
<tr>
<td>Moderating effects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDCAPA*MKTCAPA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model indices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>.01***</td>
<td>.18***</td>
<td>.25***</td>
</tr>
<tr>
<td>$R^2$ change</td>
<td>.17</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>$F$ change</td>
<td>69.549***</td>
<td>308.643***</td>
<td></td>
</tr>
</tbody>
</table>

Note: *P<0.05; **P<0.01; ***P<0.001
7.1.1 Main effects of innovation capabilities on firm performance

Hypothesis 1 predicted that R&D capability is positively associated with each performance dimension: financial performance (H1a); market performance (H1b); and innovation performance (H1c). The test results showed that R&D capability had a significant and positive effect on financial performance ($\beta=0.454, p<0.001$), market performance ($\beta=0.048, p<0.05$) and innovation performance ($\beta=0.108, p<0.001$), although the effect on market performance was relatively weak. These results supported Hypothesis 1.

Hypothesis 2 proposed that absorptive capability of external technology resources is positively associated with financial performance (H2a), market performance (H2b), and innovation performance (H2c). The results indicated that absorptive capability had a significant and positive effect on market performance ($\beta=0.202, p<0.001$), but negative effect on innovation performance ($\beta=-0.096, p<0.01$). Absorptive capability was not associated with financial performance. Thus, these results partially supported Hypothesis 2: H2a not supported; H2b supported; and H2c refuted.

Hypothesis 3 stated that product development capability positively affects a firm's financial performance (H3a), market performance (H3b) and innovation performance (H3c). Partially supporting this hypothesis, product development capability was significantly and positively associated with market performance ($\beta=0.140, p<0.001$) and innovation performance ($\beta=0.151, p<0.01$), but had no association with financial performance. These results therefore supported H3b and H3c, but not supported H3a.

Hypothesis 4 tested the positive relationship between process innovative capability and each performance dimension: financial performance (H4a); market performance (H4b); and innovation performance (H4c). The results showed that process innovative capability was positively and significantly related to market performance ($\beta=0.217, p<0.001$) and innovation performance ($\beta=0.187, p<0.001$). It was however not associated with financial performance. Similar to Hypothesis 3, H4b and H4c was supported, but H4a was not supported.
Hypothesis 5 predicted a positive association of manufacturing capability with financial performance (H5a), market performance (H5b), and innovation performance (H5c). As shown in Table 7.3, only H5b was weakly supported by the data that manufacturing capability was positively and significantly associated with market performance ($\beta=0.136, p<0.01$). H5a and H5c were not supported.

Hypothesis 6 proposed a positive effect of marketing capability on financial performance (H6a), market performance (H6b), and innovation performance (H6c). The analyses indicated that marketing capability in terms of the breadth of marketing networks/channels development was positively and significantly related to market performance ($\beta=0.096, p<0.05$) and innovation performance ($\beta=0.088, p<0.05$), but negatively related to financial performance ($\beta=-0.085, p<0.05$). It was notable that the $\beta$ value and the significant level of marketing capability in each performance model were low. Thus, Hypothesis 6 was partially and weakly supported.

7.1.2 The Effects of Control variables

Table 7.3 also suggested that firm size was positively associated with financial ($p<0.001$) and market performance ($p<0.01$), but negatively associated with innovation performance ($p<0.001$). Firm age was not related to financial performance, but negatively related to market ($p<0.05$) and innovation performance ($p<0.001$). Production scale had a significant and negative relationship with financial performance ($p<0.001$), but a positive relationship with market ($p<0.01$) and innovation performance ($p<0.01$). Financial structure only had a significant and positive relationship with financial performance ($p<0.01$).

7.2 The Interactive Effect of R&D Capability and Marketing Capability on Firm Performance (Hypothesis 7)

This section presents the analysis concerning the interactive effect of R&D capability and marketing capability on firm performance. Hypothesis 7 proposed that the effect of R&D capability on financial performance (H7a), market performance (H7b) and innovation
performance (H7c) would be significantly stronger when marketing capability in terms of the breadth of marketing networks/channels development is stronger than weaker.

Moderated multiple regression models were estimated to examine the effect of the interaction of R&D capability and market capability on firm performance. Similarly, the effect of this interaction on each firm performance dimension was examined separately based on following specification including control variables, environmental and organizational variables, innovation capability variables and interactive term of R&D capability and marketing capability:

\[
Y_{ij} = \beta_{0ij} + \beta_{1ij}\text{FSIZE} + \beta_{2ij}\text{FAGE} + \beta_{3ij}\text{PSCALE} + \beta_{4ij}\text{FSTRUK} + \beta_{5ij}\text{REGDEV} + \beta_{6ij}\text{INNPSPT} \\
+ \beta_{7ij}\text{INDSTYPE} + \beta_{8ij}\text{OWNSHIP} + \beta_{9ij}\text{RDCAPA} + \beta_{10ij}\text{ABTCAPA} + \beta_{11ij}\text{PRDCAPA} \\
+ \beta_{12ij}\text{PRCCAPA} + \beta_{13ij}\text{MNFCAPA} + \beta_{14ij}\text{MKTCAPA} + \beta_{15ij}\text{RDCAPA*MKTCAPA} + \epsilon_{ij} \quad (3)
\]

where \( Y_{ij} \) = firm performance (\( i=1 \): financial performance, \( i=2 \): market performance, \( i=3 \): innovation performance) in Model \( j \), and RDCAPA*MKTCAPA = the interaction of R&D capability and marketing capability.

Multicollinearity in the models was checked by examining the variance inflation factors (VIF) for each independent variable. The results of VIFs ranged from 1.028 to 1.822 were well below the upper limit of 10, and confirmed that multicollinearity was not a concern when testing the moderated models.

Model 3, 6 and 9 in Table 7.3 were associated with equation 3. To test H7a, the financial performance model (model 3) was estimated using control variables, environmental and organizational variables, innovation capability variables and the interaction term of R&D capability and marketing capability. As indicated in Table 7.3, the inclusion of the interactive variable in model 3 led to a significant increase of \( R^2 \) (\( R^2_{\text{change}}=0.07, F_{\text{change}}=308.643 \) at \( p<0.001 \) ) over the main effect model of financial performance (model 2). This implies that an interactive effect of R&D capability and marketing capability on financial performance does exist. More importantly, model 3 was significant (\( \text{adjusted } R^2=0.25, p<0.001 \) ), but the interaction term was significantly and negatively associated with financial performance
Revealing the Complex Impact of Innovation Capabilities - The Results of Data Analyses

\( \beta = -0.355, \ p < 0.001 \). The use of partial derivative can reveal some of the complicating relationships here. Taking a partial derivative of the financial performance model with respect to the R&D capability variable can find the point at which R&D capability variable becomes effective. This helps to explain the context in which the effect of the interaction on financial performance comes into play. Set the following partial derivative equal to zero, and solve for marketing capability.

\[
\frac{\partial \text{FINPFM}}{\partial \text{RDCAPA}} = 0.399 - 0.355\text{MKTCAPA} = 0, \text{ then } \text{MKTCAPA} = 1.124
\]

where FINPFM = financial performance, RDCAPA = R&D capability, and MKTCAPA = marketing capability.

The partial derivative result showed that the value of MKTCAPA was within the observed range of marketing capability (from 1 to 5) in the sample. Thus the effect of R&D capability on financial performance was non-monotonic over the range of marketing capability. In other words, as the partial derivative equation indicated, R&D capability had a positive effect on financial performance \( (\frac{\partial \text{FINPFM}}{\partial \text{RDCAPA}} > 0) \) when the value of marketing capability was larger than 1 and less than 1.124. In contrast, R&D capability had a negative effect on financial performance \( (\frac{\partial \text{FINPFM}}{\partial \text{RDCAPA}} < 0) \) when the value of marketing capability was larger than 1.124 and less than 5. This result implies that the negative sign before the interaction term of R&D capability and marketing capability does not simply mean the stronger the marketing capability, the weaker effect the R&D capability on financial performance at all levels of marketing capability. However, it means that if marketing capability is at a relatively high level (>1.124) the positive relationship between R&D capability and financial performance is weak. Thus, H7a was refuted.

To test H7b, the interaction term of R&D capability and marketing capability was introduced into the market performance model (Model 6). Although, Model 6 was significant \( (\text{adjusted } R^2=0.35, \ p < 0.001) \), the change of \( R^2 \) was not significant, compared to the main effect model of market performance (model 5). Specifically, the interaction term was not insignificant in market performance, and the statistical significance of other variables did not change.
Revealing the Complex Impact of Innovation Capabilities—The Results of Data Analyses

significantly. This suggests, but is not conclusive, that the impact of the interaction of R&D capability and marketing capability on market performance is not significant. Thus, H7b was not supported.

H7c predicted a significant and positive impact of the interaction of R&D capability and marketing capability on innovation performance. The results in Table 7.3 indicated that the entry of the interaction term in model 9 (adjusted $R^2=0.27$, $p<0.001$) led to a significant increase of $R^2 (R^2_{change}=0.01, F_{change}=9.712$ at $p<0.01$), compared to main effect model of innovation performance (model 8). At the same time, the interaction term of R&D capability and marketing capability had a significant and positive impact on innovation performance ($\beta=0.063$, $p<0.01$). Since R&D capability was positively associated to innovation performance in Model 9, the partial derivative equation of model 9 with respect to R&D capability was always less than zero. This result indicates that the marginal value of marketing capability would be out of the range of marketing capability observed in the sample (from 1 to 5). Therefore, the effect of R&D capability on innovation performance was monotonic over the range of marketing capability. Thus, H7c was supported.

7.3 Moderating Effects of Environmental and Organizational Factors on the Relationship between Innovation Capabilities and Firm Performance (Hypotheses 8 through to 31)

Previous sections presented the main and interactive effects of innovation capabilities on firm performance. In addition, as shown in the correlation matrix, the impact of innovation capabilities on firm performance might be influenced by some environmental and organizational factors. This section examines the influence of several environmental and organizational factors concerning regional development, innovation policy support, industry type and ownership of the firm. To do so, two methods were used. First, moderated regression analyses for testing the hypotheses concerning the influence of first three factors: regional development; innovation policy support; and industry type, were used. Second, coefficient
comparisons among different groups were used for testing the hypotheses related to the influence of ownership.

For the first method, three sets of interaction terms were produced: the interaction terms of regional development and innovation capabilities; the interaction terms of innovation policy support and innovation capabilities; and the interaction terms of industry type and innovation capabilities. Although the sample size was large enough to 'dump' all interaction terms to a single model, each set of interaction terms was tested separately. This is because correlations between interaction terms were high, and therefore putting all variables together would produce multicollinearity problems. More importantly, the purpose of the relevant hypotheses developed in this study is to examine the influence of each environmental and structural factor on the relationship between innovation capabilities and firm performance. Thus, far less would be learned about the problem if the combined effectiveness of all environmental and organizational factors were investigated as one set. Furthermore, previous empirical studies have provided evidence that separate testing of moderated effectiveness of variables is valid (e.g., Zahra and Nielsen, 2002), and useful for the present study. The following subsections present the results of data analyses of each set of interaction terms as shown in Table 7.4.

7.3.1 Regional Development

Hypotheses 8 through to 13 predicted that each innovation capability dimension and regional development would have a positive interactive effect on firm performance. The hypotheses were tested on the basis of the following equation:

\[ Y_{ij} = \beta_{10j} + \beta_{11j}FSIZE + \beta_{12j}FAGE + \beta_{13j}PSCALE + \beta_{14j}FRSTRUK + \beta_{15j}REGDEV + \]
\[ \beta_{16j}NNPSPT + \beta_{17j}INDSTYPE + \beta_{18j}OWNSHIP + \beta_{19j}RDCAPA + \beta_{20j}ABTCAPA + \]
\[ \beta_{21j}PRDCAPA + \beta_{22j}PRCCAPA + \beta_{23j}MNFCAPA + \beta_{24j}MKTCAPA + \]
\[ \sum_{j=1}^{9} \beta_{ijmn} (\text{Innovation capabilities} \ast \text{REGDEV}) + \varepsilon_{ij} \]  

where \( Y_{ij} \) is performance \((i=1: \text{financial performance}, i=2: \text{market performance}, i=3: \text{innovation performance})\) in model \( j \), and \( \sum_{j=1}^{9} \beta_{ijmn} (\text{Innovation capabilities} \ast \text{REGDEV}) = \beta_{ij15}RDCAPA \ast \text{REGDEV} + \beta_{ij16}ABTCAPA \ast \text{REGDEV} + \beta_{ij17}PRDCAPA \ast \text{REGDEV} + \beta_{ij18}PRCCAPA \ast \text{REGDEV} + \beta_{ij19}MNFCAPA \ast \text{REGDEV} + \beta_{ij20}MKTCAPA \ast \text{REGDEV}. \)
Table 7.4 Results of Regression Analyses for Firm Performance: Moderating Effects of Regional Development, Innovation Policy Support and Industry type (N = 3843)

<table>
<thead>
<tr>
<th></th>
<th>Financial Performance</th>
<th>Market Performance</th>
<th>Innovation Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>β</td>
<td>β</td>
</tr>
<tr>
<td><strong>Control Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FSIZE</td>
<td>.212***</td>
<td>.212***</td>
<td>.242***</td>
</tr>
<tr>
<td>FAGE</td>
<td>-.043</td>
<td>-.029</td>
<td>-.035</td>
</tr>
<tr>
<td>PSCLAE</td>
<td>-.116***</td>
<td>-.114***</td>
<td>-.120***</td>
</tr>
<tr>
<td>FSTRAUK</td>
<td>.046**</td>
<td>.048**</td>
<td>.048**</td>
</tr>
<tr>
<td><strong>Independent Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDCAPA</td>
<td>.497***</td>
<td>.372***</td>
<td>.451***</td>
</tr>
<tr>
<td>ABTCAPA</td>
<td>-.010</td>
<td>-.007</td>
<td>-.009</td>
</tr>
<tr>
<td>PRDCAPA</td>
<td>-.109*</td>
<td>-.001</td>
<td>-.087*</td>
</tr>
<tr>
<td>PRCCAPA</td>
<td>.022</td>
<td>.016</td>
<td>.017</td>
</tr>
<tr>
<td>MNFCAPA</td>
<td>.060*</td>
<td>.022</td>
<td>.027</td>
</tr>
<tr>
<td>MKTCAPA</td>
<td>-.061**</td>
<td>-.029</td>
<td>-.033*</td>
</tr>
<tr>
<td><strong>Environmental Factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REGDEV</td>
<td>.025</td>
<td>.036*</td>
<td>.038*</td>
</tr>
<tr>
<td>INNPSPT</td>
<td>-.003</td>
<td>.004</td>
<td>-.008</td>
</tr>
<tr>
<td>INDSTYPE</td>
<td>-.015</td>
<td>-.027</td>
<td>-.019</td>
</tr>
<tr>
<td>OWNSHIP</td>
<td>.026</td>
<td>.035</td>
<td>.037*</td>
</tr>
<tr>
<td><strong>Moderating Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RDCAPA*REGDEV</td>
<td>.152***</td>
<td>.021</td>
<td></td>
</tr>
<tr>
<td>ABTCAPA*REGDEV</td>
<td>.005</td>
<td>-.158**</td>
<td></td>
</tr>
<tr>
<td>PRDCAPA*REGDEV</td>
<td>.119**</td>
<td>.175**</td>
<td></td>
</tr>
<tr>
<td>PRCCAPA*REGDEV</td>
<td>-.022</td>
<td>-.124**</td>
<td></td>
</tr>
<tr>
<td>MNFCAPA*REGDEV</td>
<td>-.041</td>
<td>.002</td>
<td></td>
</tr>
<tr>
<td>MKTCAPA*REGDEV</td>
<td>.038</td>
<td>-.021</td>
<td></td>
</tr>
<tr>
<td>RDCAPA*INNPSPT</td>
<td>.159***</td>
<td>.019</td>
<td></td>
</tr>
<tr>
<td>ABTCAPA*INNPSPT</td>
<td>.010</td>
<td>.127**</td>
<td></td>
</tr>
<tr>
<td>PRDCAPA*INNPSPT</td>
<td>.003</td>
<td>.102**</td>
<td></td>
</tr>
<tr>
<td>PRCCAPA*INNPSPT</td>
<td>.044</td>
<td>.112***</td>
<td></td>
</tr>
<tr>
<td>MNFCAPA*INNPSPT</td>
<td>.022</td>
<td>.042</td>
<td></td>
</tr>
<tr>
<td>MKTCAPA*INNPSPT</td>
<td>.021</td>
<td>.013</td>
<td></td>
</tr>
<tr>
<td>RDCAPA*INDSTYPE</td>
<td>-.105**</td>
<td>.097**</td>
<td></td>
</tr>
<tr>
<td>ABTCAPA*INDSTYPE</td>
<td>.015</td>
<td>.030</td>
<td></td>
</tr>
<tr>
<td>PRDCAPA*INDSTYPE</td>
<td>.096*</td>
<td>.128*</td>
<td></td>
</tr>
<tr>
<td>PRCCAPA*INDSTYPE</td>
<td>.016</td>
<td>-.107*</td>
<td></td>
</tr>
<tr>
<td>MNFCAPA*INDSTYPE</td>
<td>.024</td>
<td>.003</td>
<td></td>
</tr>
<tr>
<td>MKTCAPA*INDSTYPE</td>
<td>.054**</td>
<td>.017</td>
<td></td>
</tr>
<tr>
<td><strong>Model indices</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.20***</td>
<td>.20***</td>
<td>.19***</td>
</tr>
<tr>
<td>R² change</td>
<td>.02</td>
<td>.02</td>
<td>.01</td>
</tr>
<tr>
<td>F change</td>
<td>13.530***</td>
<td>13.410***</td>
<td>2.990**</td>
</tr>
</tbody>
</table>

Note: *P<0.05; **P<0.01; ***P<0.001.
As presented in Table 7.4, model 10 (financial performance), model 13 (market performance) and model 16 (innovation performance) were related to equation 4. In all cases adding the interaction terms significantly improved the results from their main effects models (model 2, 5 and 8):

- financial performance \((adjusted \ R^2=0.20, R^2_{\text{change}}=0.02, F_{\text{change}}=13.539 \text{ at } p<0.001)\);
- market performance \((adjusted \ R^2=0.36, R^2_{\text{change}}=0.01, F_{\text{change}}=2.955 \text{ at } p<0.01)\); and,
- innovation performance \((adjusted \ R^2=0.27, R^2_{\text{change}}=0.01, F_{\text{change}}=4.011 \text{ at } p<0.05)\).

Hypothesis 8 proposed that the effect of R&D capability on financial performance \((H9a)\), market performance \((H9b)\) and innovation performance \((H9c)\) would be stronger in high economic development regions than that in low economic development regions. The relevant results in Table 7.4 shows that the interaction of R&D capability and regional development was significantly and positively associated with financial performance \((\beta=0.152, p<0.001)\) and innovation performance \((\beta=0.168, p<0.001)\). The interaction however was not associated with market performance. This suggests that the effect of R&D capability on financial and innovation performance is higher when the level of regional development is high than low. Thus, \(H8a\) and \(H8c\) were supported, while \(H8b\) was not supported.

Hypothesis 9 predicted that the effect of a firm’s absorptive capability of external technology resources on each performance dimension: financial performance \((H9a)\); market performance \((H9b)\); and innovation performance \((H9c)\) would be stronger in high economic development regions than that in low economic development regions. The results presented in Table 7.4 indicate that the interaction term of absorptive capability of external technology resources and regional development was not significant for financial performance. \(H9a\) was not supported. In contrast, the interaction term had a significant but negative effect on market performance \((\beta=-0.158, p<0.01)\) and innovation performance \((\beta=-0.154, p<0.01)\). This indicates that the effect of absorptive capability of external technology resources is relatively stronger
when the level of regional economic development is low rather than high. These results were contrary to the predictions in H9b and H9c.

Hypothesis 10 proposed that a firm's product development capability would have a stronger impact on financial performance (H10a), market performance (H10b), and innovation performance (H10c), when the regional economic development is high rather than low. The results supported this prediction. As indicated in Table 7.4, the interaction term for new product innovation capability had a significant and positive effect on financial ($\beta=0.119$, $p<0.01$), market ($\beta=0.175$, $p<0.01$), and innovation performance ($\beta=0.142$, $p<0.01$).

Similarly, Hypothesis 11 predicted that process innovative capability has a stronger impact on financial performance (H11a), market performance (H11b) and innovation performance (H11c) in high economic development regions than that in low economic development regions. As indicated in Table 7.4, the interaction term for process innovative capability was not associated with financial performance. On the other hand, the interaction term was significantly but negatively associated with market performance ($\beta=-0.124$, $p<0.01$) and innovation performance ($\beta=-0.108$, $p<0.01$). Thus, these results did not support for H11a, and they were contrary to H11b and H11c.

Hypothesis 12 and 13 proposed that manufacturing capability and marketing capability have a stronger effect on each performance dimension in high economic development regions. The results shown in Table 7.4 revealed that the interaction terms for manufacturing capability and marketing capability with regional development were not significant with any performance dimensions. Thus, the predictions from Hypothesis 12 and 13 could not be supported.

### 7.3.2 Innovation Policy Support

Hypotheses 14 through to 19 posited that innovation policy support would have a moderating effect on the relationship between innovation capabilities and firm performance. The following regression equation was used to test these hypotheses:
Revealing the Complex Impact of Innovation Capabilities—The Results of Data Analyses

\[ Y_{ij} = \beta_{y0} + \beta_{y1}FSIZE + \beta_{y2}FAGE + \beta_{y3}PScale + \beta_{y4}FSTUK + \beta_{y5}REGDEV + \beta_{y6}INNPSPT + \beta_{y7}INNSPT + \beta_{y8}OWNSHIP + \beta_{y9}PCAPA + \beta_{y10}ABTCAPA + \beta_{y11}PRDCAPA + \beta_{y12}PRCCAPA + \beta_{y13}MNFCAPA + \beta_{y14}MKTCAPA + \sum_{j}^{\text{innovation capabilities}}(\text{INNPSPT}) + \epsilon_{ij} \]  

\( \text{(5)} \)

where \( Y_{ij} \) is performance (\( i=1: \) financial performance, \( i=2: \) market performance, \( i=3: \) innovation performance) in model \( j \), and \( \sum_{j}^{\text{innovation capabilities}}(\text{INNPSPT}) = \)

\[ \beta_{y13}PCAPA \cdot \text{INNPSPT} + \beta_{y14}ABTCAPA \cdot \text{INNPSPT} + \beta_{y17}PRDCAPA \cdot \text{INNPSPT} + \beta_{y18}PRCCAPA \cdot \text{INNPSPT} + \beta_{y19}MNFCAPA \cdot \text{INNPSPT} + \beta_{y20}MKTCAPA \cdot \text{INNPSPT}. \]

The model indices shown in Table 7.4 indicate that the inclusion of interaction terms in financial performance (model 11: adjusted \( R^2 = 0.20 \), \( R^2 \_\text{change} = 0.02 \), \( F \_\text{change} = 13.410 \) at \( p < 0.001 \)), market performance (model 14: adjusted \( R^2 = 0.37 \), \( R^2 \_\text{change} = 0.02 \), \( F \_\text{change} = 9.828 \) at \( p < 0.001 \)) and innovation performance model (model 17: adjusted \( R^2 = 0.28 \), \( R^2 \_\text{change} = 0.02 \), \( F \_\text{change} = 2.122 \) at \( p < 0.05 \)) significantly increased \( R^2 \) from each main effects model (model 2, 5 and 8).

Hypothesis 14 proposed a significant and positive effect of the interaction of R&D capability and innovation policy support on financial performance (H14a), market performance (H14b) and innovation performance (H14c). The test results indicated that the interaction of R&D capability and innovation policy support was significantly and positively associated with financial performance (\( \beta = 0.159, p < 0.001 \)) and innovation performance (\( \beta = 0.148, p < 0.01 \)). On the other hand, the results showed no relationship with market performance. Thus, the results supported H14a and H14c, but did not support H14b.

The partial derivative of financial performance model and market performance model with respect to R&D capability can provide further insight into the interactive effect of R&D capability and innovation policy support. The mathematical task for this is to set the following partial derivative equations equal to zero, and solve for innovation policy support:

\[ \partial \text{FINPFM} / \partial \text{RDCAPA} = 0.372 + 0.159 \text{INNPSPT} = 0, \text{ then } \text{INNPSPT} = -2.340 \]  

\( \text{(a)} \)

\[ \partial \text{INNPFM} / \partial \text{RDCAPA} = 0.132 + 0.148 \text{INNPSPT} = 0, \text{ then } \text{INNPSPT} = -0.892 \]  

\( \text{(b)} \)
Revealing the Complex Impact of Innovation Capabilities: The Results of Data Analyses

where FINPFM = financial performance, INNPFM = innovation performance, RDCAPA = R&D capability, and INNPSPT = innovation policy support.

The result showed that the values of INNPSPT were out of the observed range of innovation policy support (from 1 to 5), when $\partial$FINPFM/$\partial$RDCAPA of financial performance and $\partial$INNPFM/$\partial$RDCAPA of innovation performance equaled to zero. Thus the effect of R&D capability on financial performance and innovation performance is monotonic over the range of innovation policy support. Hypothesis 14 was therefore partially supported.

Hypothesis 15 proposed that the interaction of absorptive capability of external technology resources and innovation policy support would have a significant and positive relationship with financial performance (H15a), market performance (H15b) and innovation performance (H15c). The result with regard to financial performance was not significant, thus H15a was not supported. However, the tests returned a significant and positive result for market performance ($\beta=0.127, p<0.01$) and innovation performance ($\beta=0.114, p<0.01$).

The interpretation of the interaction effect of absorptive capability and innovation policy support was further informed by the following partial derivative equations of market and innovation performance:

$$\partial \text{MKTPFM}/\partial \text{ABTCAPA} = 0.194 + 0.127\text{INNPSPT} = 0, \text{then INNPSPT} = -1.528 \text{ (a)}$$

$$\partial \text{INNPFM}/\partial \text{ABTCAPA} = -0.080 + 0.114\text{INNPSPT} = 0, \text{then INNPSPT} = 0.702 \text{ (b)}$$

where MKTPFM = market performance, INNPFM = innovation performance, ABTCAPA = absorptive capability of external technology resources, and INNPSPT = innovation policy support.

The results of this procedure showed that the values of INNPSPT in both market (equation a) and innovation performance model (equation b) were out of the range of innovation policy support (1 to 5). Thus, absorptive capability has a monotonic and positive relationship with market performance and innovation performance over the range of innovation policy support. These results confirmed H15b and H15c.
Hypothesis 16 predicted that the interaction of product development capability and innovation policy support would have a significant and positive effect on financial performance (H16a), market performance (H16b), and innovation performance (H16c). The results for Hypothesis 16 indicate that the interaction term of product development capability and innovation policy support had a significant and positive relationship with market performance ($\beta=0.102$, $p<0.001$) and innovation performance ($\beta=0.107$, $p<0.01$), but had no association with financial performance. Similarly, the following partial derivative equations were examined:

$$\frac{\partial \text{MKTPFM}}{\partial \text{PRDCAPA}} = 0.130 + 0.102 \text{INNPSPT} = 0, \text{then } \text{INNPSPT} = -1.274 \quad (a)$$

$$\frac{\partial \text{INNPFM}}{\partial \text{PRDCAPA}} = 0.044 + 0.107 \text{INNPSPT} = 0, \text{then } \text{INNPSPT} = -0.411 \quad (b)$$

where MKTPFM = market performance, INNPFM = innovation performance, PRDCAPA = product development capability, and INNPSPT = innovation policy support.

The results indicated that the values of INNPSPT were out of the range of innovation policy support observed in the sample (from 1 to 5) in both equation a and b. Thus, the effects of product development capability on market and innovation performance are monotonically positive over the range of innovation policy support. H16b and H16c were therefore supported.

Hypothesis 17 proposed that the interactive term of process innovative capability and innovation policy support would have a significant and positive relationship with each performance dimension: financial performance (H17a); market performance (H17b); and innovation performance (H17c). The results were significant and had the expected sign in market performance ($\beta=0.112$, $p<0.01$) and innovation performance ($\beta=0.118$, $p<0.01$), but the results were not significant for financial performance.

Further analyses with the following partial derivative equations suggested that process innovative capability has a monotonic impact on market performance and innovation performance:

$$\frac{\partial \text{MKTPFM}}{\partial \text{PRCCAPA}} = 0.197 + 0.112 \text{INNPSPT} = 0, \text{then } \text{INNPSPT} = -1.759 \quad (a)$$

$$\frac{\partial \text{INNPFM}}{\partial \text{PRCCAPA}} = -0.083 + 0.118 \text{INNPSPT} = 0, \text{then } \text{INNPSPT} = 0.703 \quad (b)$$
where MKTPFM = market performance, INNPFM = innovation performance, PRCCAPA = process innovative capability, and INNPSPT = innovation policy support.

When $\partial$MKTPFM/$\partial$PRCCAPA equals to zero, INNPSPT = -1.759. While, when $\partial$INNPFM/$\partial$PRCCAPA equaled to zero, INNPSPT = 0.703. The values of INNPSPT were out of the range of innovation policy support (from 1 to 5). These results provided support for H17b and H17c.

Hypothesis 18 and 19 predicted a significant and positive impact from the interaction of manufacturing capability and innovation policy support or the interaction of marketing capability and innovation policy support on firm performance. These predictions were not confirmed. The test results in the relevant models were not significant, even though the signs were positive in financial and market performance model, as predicted.

### 7.3.3 Industry type

Hypotheses 20 through to 25 predicted that innovation capabilities have stronger effects on firm performance in higher technology-intensive industries compared to firms in lower technology-intensive industries. These hypotheses were tested on the basis of the following equation:

\[
Y_{ij} = \beta_{0j} + \beta_{1j}FSIZE + \beta_{2j}FAGE + \beta_{3j}SCALE + \beta_{4j}STRU + \beta_{5j}REGDEV + \beta_{6j}INNPSPT +
\beta_{7j}INDSTYP + \beta_{8j}OWNSHIP + \beta_{9j}RDCAPA + \beta_{10j}ABTCAPA + \beta_{11j}PRDCAPA +
\beta_{12j}PRCCAPA + \beta_{13j}MNFCAPA + \beta_{14j}MKTCAPA +
\sum \beta_{15j}(Innovation\_capabilities*INDSTYPE) + \epsilon_{ij}
\]

where $Y_{ij}$ is performance ($i=1$: financial performance, $i=2$: market performance, $i=3$: innovation performance) in model $j$, \(\sum \beta_{15j}(Innovation\_capabilities*INDSTYPE) = \)
\(\beta_{15j}RDCAPA*INDSTYPE + \beta_{16j}ABTCAPA*INDSTYPE + \beta_{17j}PRDCAPA*INDSTYPE + \beta_{18j}PRCCAPA*INDSTYPE + \beta_{19j}MNFCAPA*INDSTYPE + \beta_{20j}MKTCAPA*INDSTYPE.

Model 12 (financial performance), model 15 (market performance) and model 18 (innovation performance) in Table 7.4 were used to construct equation 5. The model indices suggested that adding relevant interactive terms for innovation capabilities with industry type
into these three models significantly increased $R^2$ from their main effects models (model 2, 5 and 8): financial performance ($\text{Adjusted } R^2=0.19$, $R^2_{\text{change}}=0.01$, $F$-change=$2.990$ at $p<0.01$); market performance ($\text{Adjusted } R^2=0.36$, $R^2_{\text{change}}=0.01$, $F$-change=$3.443$ at $p<0.05$); and innovation performance ($\text{Adjusted } R^2=0.29$, $R^2_{\text{change}}=0.03$, $F$-change=$2.576$ at $p<0.05$).

Hypothesis 20 predicted that the relationships between R&D capability and financial performance (H20a), market performance (H20b) and innovation performance (H20c) would be stronger among firms in higher technology-intensive industries than those in lower technology-intensive industries. Results in Table 7.4 showed that the interaction term for R&D capability with industry type had a significant but negative effect on financial performance ($\beta=-0.105$, $p<0.01$). On the other hand, the interaction term had a significant and positive relationship with market performance ($\beta=0.097$, $p<0.01$) and innovation performance ($\beta=0.090$, $p<0.01$). In order to know whether the effect of R&D capability on each performance dimension is monotonic or not over the range of industry type, a partial derivative of the each performance model with respect to R&D capability variable was taken. This was achieved by setting the following partial derivative equations equal to zero, and solving for industry type:

$F_{\text{INNPFM}}/ F_{\text{RDCAPA}} = 0.106 + 0.090\text{INDSTYPE} = 0$, then $\text{INDSTYPE} = -1.178$ (c)

where $F_{\text{FINPFM}} = \text{financial performance}$, $F_{\text{MKTPFM}} = \text{market performance}$, $F_{\text{INNPFM}} = \text{innovation performance}$, $F_{\text{RDCAPA}} = \text{R&D capability}$, and $\text{INDSTYPE} = \text{industry type}$.

The results showed that the value of $\text{INDSTYPE}$ in equation a was within the observed range of industry type (from 1 to 5) in the sample. R&D capability had a positive effect on financial performance ($\partial F_{\text{FINPFM}}/ \partial F_{\text{RDCAPA}} > 0$) when the value of industry type was larger than 1 and less than 4.295. This implies that the effect of R&D capability is significantly higher when technology intensity of the industrial sector is high rather than low. In other words, R&D
capability has a stronger positive impact on financial performance in medium-high technology-intensive industries than in low technology-intensive industries. In contrast, R&D capability had a negative effect on financial performance ($\partial \text{FINPFM}/ \partial \text{RDCAPA} < 0$) when the value of industry type was larger than 4.295 and less than 5. This result suggests that in Chinese high technology-intensive industries, higher level of investment in R&D is associated with lower financial performance. This innovation paradox in high technology-intensive industries will be explained in details in the next chapter.

On the other hand, the values of $\text{INDSTYPE}$ at which R&D capability had no effect on market (equation b) and innovation performance (equation c) were negative. Thus, the values were out of the range of industry type in the sample. This result indicates that the effect of R&D capability on market and innovation performance is monotonic over the range of industry type (from 1 to 5). $H20$ was partially supported.

Hypothesis 21 proposed that absorptive capability of external technology resources would have a significant impact on: financial performance ($H21a$); market performance ($H21b$); and innovation performance ($H21c$), and the impact will be stronger among firms in higher technology-intensive industries. The results indicate that the impact of the interaction term of absorptive capability and industry type on financial and market performance was not significant. However, it had a significant but negative impact on innovation performance ($\beta=-0.109$, $p<0.01$). The following partial derivative equation was used to determine whether the effect of absorptive capability is monotonic or not on innovation performance:

$$\partial \text{INNPFM}/ \partial \text{ABTCAPA} = -0.050 - 0.109\text{INDSTYPE} = 0,$$

where INNPFM = innovation performance, ABTCAPA = absorptive capability, and INDSTYPE = industry type.

The results of this procedure indicated that the value of INDSTYPE was out of the range of industry type (from 1 to 5), when $\partial \text{INNPFM}/ \partial \text{ABTCAPA}$ equaled to zero. Absorptive capability had a monotonic and negative relationship with innovation performance. Therefore, the results did not support $H21a$ and $H21b$, and were contrary to the prediction of $H22c$. 189
Hypothesis 22 predicted that the effects of product development capability on each firm performance: financial performance (H22a); market performance (H22b); and innovation performance (H22c), would be stronger among firms in higher technology-intensive industries compared to those in lower technology-intensive industries. The results in Table 7.4 showed that the interaction term of product development capability and industry type had a significant and positive relationship with all three performance dimensions: financial (β=0.096, p<0.05); market (β=0.128, p<0.01); and innovation performance (β=0.126, p<0.01). The following derivative equations were used to further unpack the interactive effect of product development capability and industry type:

\[ \frac{\partial \text{FINPFM}}{\partial \text{PRDCAPA}} = -0.087 + 0.096\text{INDSTYPE} = 0, \text{then INDSTYPE} = 0.906 \] (a)

\[ \frac{\partial \text{MKTPFM}}{\partial \text{PRDCAPA}} = 0.141 + 0.128\text{INDSTYPE} = 0, \text{then INDSTYPE} = -0.102 \] (b)

\[ \frac{\partial \text{INNPFM}}{\partial \text{PRDCAPA}} = 0.050 + 0.126\text{INDSTYPE} = 0, \text{then INDSTYPE} = -0.397 \] (c)

where \( \text{FINPFM} = \) financial performance, \( \text{MKTPFM} = \) market performance, \( \text{INNPFM} = \) innovation performance, \( \text{PRDCAPA} = \) product development capability, and \( \text{INDSTYPE} = \) industry type.

The results confirmed that the effect of product development capability on financial, market and innovation performance was monotonic over the range of industry type (from 1 to 5) in the sample. Because the values of \( \text{INDSTYPE} \) in equation a, b and c were out of the range of industry type, when \( \frac{\partial \text{FINPFM}}{\partial \text{PRDCAPA}}, \frac{\partial \text{MKTPFM}}{\partial \text{PRDCAPA}} \) and \( \frac{\partial \text{INNPFM}}{\partial \text{PRDCAPA}} \) equaled to zero, separately. Therefore, Hypothesis 22 was supported.

Hypothesis 23 proposed that the relationship of process innovative capability with financial performance (H23a), market performance (H23b) and innovation performance (H23c) would be stronger among firms in higher technology-intensive industries than those in lower technology-intensive industries. The results showed that the interactive term of process innovative capability and industry type was significantly but negatively associated with market (β=−0.107, p<0.05) and innovation performance (β=−0.038, p<0.05). It was not significant to
financial performance. The following partial derivative equations were used to determine whether the effects of process innovative capability are monotonic over the range of industry type:

\[ \frac{\partial \text{MKTPFM}}{\partial \text{PRCCAPA}} = 0.105 - 0.107 \text{INDSTYPE} = 0, \text{then INDSTYPE} = 0.981 \] (a)

\[ \frac{\partial \text{INNPFM}}{\partial \text{PRCCAPA}} = -0.087 - 0.038 \text{INDSTYPE} = 0, \text{then INDSTYPE} = -2.289 \] (b)

where MKTPFM = market performance, INNPFM = innovation performance, PRCCAPA = process innovative capability, and INDSTYPE = industry type.

In equation a, the value of INDSTYPE was positive but less than 1 when \( \frac{\partial \text{MKTPFM}}{\partial \text{PRCCAPA}} \) equaled to zero, while in equation b, the value of INDSTYPE was negative when \( \frac{\partial \text{INNPFM}}{\partial \text{PRCCAPA}} \) equaled to zero. They were out of the range of industry type observed in the sample. Thus, process innovative capability was monotonically but negatively associated with market performance and innovation performance. The results were contrary to the predictions of H23b and H23c, and H23a was not supported.

Hypothesis 24 predicted a stronger effect of manufacturing capability on performance dimensions among firms in higher technology-intensive industries rather than those in lower technology-intensive industries. However, the results in Table 7.4 showed that the interaction for manufacturing capability with industry type was not significant for financial, market or innovation performance. Hypothesis 24 was not supported.

Hypothesis 25 proposed that marketing capability has a stronger effect on each performance dimension: financial performance (H15a); market performance (H25b); and innovation performance (H25c) among firms in higher technology-intensive industries. As predicted, the interaction term of marketing capability and industry type was positively and marginally significant to financial \( (\beta=0.054, p<0.05) \) and innovation performance \( (\beta=0.038, p<0.05) \). On the other hand, the interaction term was not significant for market performance. The following partial derivative equations were examined to determine the monotonic effect of market capability on financial and innovation performance:
Revealing the Complex Impact of Innovation Capabilities: The Results of Data Analyses

\[ \frac{\partial \text{FINPFM}}{\partial \text{MKTCAPA}} = -0.033 + 0.054\text{INDSTYPE} = 0, \text{then INDSTYPE} = 0.611 \] (a)

\[ \frac{\partial \text{INNPFM}}{\partial \text{MKTCAPA}} = 0.079 + 0.038\text{INDSTYPE} = 0, \text{then INDSTYPE} = -2.079 \] (b)

where FINPFM = financial performance, INNPFM = innovation performance, MKTCAPA = marketing capability, and INDSTYPE = industry type.

The results showed that the values of INDSTYPE in both equations were less than 1 when \( \frac{\partial \text{FINPFM}}{\partial \text{MKTCAPA}} = 0 \) and \( \frac{\partial \text{INNPFM}}{\partial \text{MKTCAPA}} = 0 \). They were out of the range of industry type (from 1 to 5). Thus, the effect of marketing capability was monotonically positive on financial performance and innovation performance. The results provided support for H25a and H25c, but H25b was not supported.

7.3.4 Ownership: SOEs, non-SOEs and IJVs

Examining the influence of ownership is important since ownership is one of the important determinants of organizational complexity and structure (Kimberly, 1976; Geeraerts, 1984), and is associated with a firm’s internal capabilities and performance. As mentioned in Chapter Six, firms in this sample were grouped into three categories: state-owned enterprises (SOEs); non-state-owned enterprises (non-SOEs); and international joint ventures (IJVs).

As shown in Table 6.2 in Chapter Six, SOEs and non-SOEs cover a larger number of sample firms. In order to make these sub-samples comparable, the analysis related to ownership only covers small and medium-sized enterprises. This is because most of the IJVs covered in the sample are small and medium-sized firms. As mentioned previously, in China, the classification of firm size is traditionally based on production capability rather than the number of employees. In addition, the criteria for the classification differ across industries. In order to simplify the classification and make it consistent with the classification in other countries, in this study, the small and medium-sized enterprises refer to those firms in which the number of employees is less than 500.

Standardized multiple regressions were conducted to test the relationships between innovation capabilities and firm performance. Regression diagnostics in terms of VIF (variance
inflation factor) values in different models also expunged the possibility of multicollinearity among the variables.

As shown in Table 7.5, models from 19 to 24 were related to SOEs. The main effect models of financial performance (model 20: $R^2_{\text{change}}=0.20$, $F$-change$=15.047$ at $p<0.001$), market performance (model 22: $R^2_{\text{change}}=0.09$, $F$-change$=25.047$ at $p<0.001$), and innovation performance (model 24: $R^2_{\text{change}}=0.05$, $F$-change$=3.684$ at $p<0.001$) including all independent and control variables explained firm performance significantly better than model 19 ($p<0.05$), model 21 ($p<0.05$) and model 23 ($p<0.001$), which only included control variables. Specifically, they explained 19% of variance for financial performance, 30% of variance for market performance, and 17% of variance for innovation performance.

For non-SOEs, the main effect models regarding financial performance (model 26: $R^2_{\text{change}}=0.46$, $F$-change$=70.771$ at $p<0.001$), market performance (model 28: $R^2_{\text{change}}=0.32$, $F$-change$=38.904$ at $p<0.001$), and innovation performance (model 30: $R^2_{\text{change}}=0.04$, $F$-change$=3.800$ at $p<0.001$) explained the dependent variables significantly better than relevant baseline models, which just included control variables: model 25 ($p<0.05$); model 27 ($p<0.01$); and model 29 ($p<0.001$). The main effect models explained 47% of variance for financial performance, 33% for market performance, and 17% for innovation performance.

For IJVs, the main effect model of financial performance (model 32: $R^2_{\text{change}}=0.04$, $F$-change$=3.768$ at $p<0.05$) explained the dependent variable (17% of variance) significantly better than model 31 ($p<0.001$), which just included control variables. The main effect model of market performance (model 34: $R^2_{\text{change}}=0.22$, $F$-change$=12.515$ at $p<0.001$) and the main effect model of innovation performance (model 36: $R^2_{\text{change}}=0.04$, $F$-change$=4.790$ at $p<0.05$) were also significantly better than their baseline models of market ($p<0.001$) and innovation performance ($p<0.05$). They explained 25% of variance for market performance, and 11% of variance for innovation performance.
Table 7.5 Split Sample Regression for Small and Medium-Sized SOEs (n=638), non-SOEs (n=831) and IJVs (n=456)

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>SOEs</th>
<th>Non-SOEs</th>
<th>IJVs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 19</td>
<td>Model 20</td>
<td>Model 21</td>
</tr>
<tr>
<td>FSIZE</td>
<td>-0.017</td>
<td>0.178**</td>
<td>-0.122</td>
</tr>
<tr>
<td>FAGE</td>
<td>-0.084</td>
<td>-0.072</td>
<td>-0.040</td>
</tr>
<tr>
<td>PSCHILD</td>
<td>-0.028</td>
<td>-0.030</td>
<td>0.050</td>
</tr>
<tr>
<td>FSTRIUK</td>
<td>-0.023</td>
<td>-0.030</td>
<td>0.026</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>SOEs</th>
<th>Non-SOEs</th>
<th>IJVs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 19</td>
<td>Model 20</td>
<td>Model 21</td>
</tr>
<tr>
<td>RDCA PA</td>
<td>0.455***</td>
<td>0.038</td>
<td>0.112**</td>
</tr>
<tr>
<td>ABTCAPA</td>
<td>-0.035</td>
<td>0.157***</td>
<td>-0.007</td>
</tr>
<tr>
<td>PRDCAPA</td>
<td>0.033</td>
<td>0.138**</td>
<td>0.082</td>
</tr>
<tr>
<td>PRCCAPA</td>
<td>0.072</td>
<td>0.185***</td>
<td>-0.094</td>
</tr>
<tr>
<td>MNFCAPA</td>
<td>0.021</td>
<td>0.151**</td>
<td>0.055</td>
</tr>
<tr>
<td>MKTCAPA</td>
<td>-0.016</td>
<td>0.025</td>
<td>0.027</td>
</tr>
<tr>
<td>Environmental Factors</td>
<td>SOEs</td>
<td>Non-SOEs</td>
<td>IJVs</td>
</tr>
<tr>
<td></td>
<td>Model 19</td>
<td>Model 20</td>
<td>Model 21</td>
</tr>
<tr>
<td>EGDEV</td>
<td>-0.006</td>
<td>0.085*</td>
<td>-0.118*</td>
</tr>
<tr>
<td>NPSPPT</td>
<td>0.009</td>
<td>0.123**</td>
<td>0.073</td>
</tr>
<tr>
<td>DSTYPE</td>
<td>-0.058</td>
<td>0.081*</td>
<td>0.049</td>
</tr>
<tr>
<td>ρ indices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>adjusted R²</td>
<td>0.002*</td>
<td>0.19***</td>
<td>0.02*</td>
</tr>
<tr>
<td>change</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| change                 | 15.047*** | 25.047*** | 3.684*** | 70.771*** | 38.904*** | 3.800*** | 3.768* | 12.515*** | 4.790* | Note: *P<0.05; **P<0.01; ***P<0.001.
The above results indicate that all main effect models for SOEs, non-SOEs and IJVs are statistically significant and better for explaining the relationship between innovation capabilities and firm performance. The comparisons based on these main effect models therefore are reasonable.

Hypothesis 26 proposed that R&D capability would have a stronger impact on financial performance (H26a), market performance (H26b) and innovation performance (H26c) among non-SOEs or IJVs rather than among SOEs. For all groups of SOEs, non-SOEs and IJVs, R&D capability was a significant contributor to financial performance. In the meantime, R&D capability among non-SOEs had a positive and stronger effect on financial performance ($\beta=0.697$, $p<0.001$) than it did among SOEs ($\beta=0.455$, $p<0.001$). However, the effect of R&D capability on financial performance among IJVs ($\beta=0.137$, $p<0.05$) was weaker than that among SOEs. R&D capability also contributed to innovation performance in SOEs and non-SOEs, and the effect was stronger among SOEs ($\beta=0.112$, $p<0.01$) than that among non-SOEs ($\beta=0.085$, $p<0.05$). R&D capability had no association with market performance in all three types of firm ownership. Thus, H26a was partially supported, H26b was not supported, and the results were partially contrary to H26c.

Hypothesis 27 predicted that the effect of absorptive capability of external technology resources on financial performance (H27a), market performance (H27b) and innovation performance (H27c) should be stronger among non-SOEs or IJVs rather than among SOEs. The results in Table 7.5 indicated that absorptive capability had no relationship with financial performance and innovation performance in all three groups. H27a and H27c were therefore not supported. On the other hand, absorptive capability was significant and had a stronger impact on market performance among IJVs ($\beta=0.179$, $p<0.01$) than among SOEs ($\beta=0.157$, $p<0.001$) and non-SOEs ($\beta=0.157$, $p<0.01$). H27b was therefore partially supported.

Hypothesis 28 proposed that product development capability would be more influential on financial performance (H28a), market performance (H28b), and innovation performance (H28c) among non-SOEs or IJVs rather than among SOEs. The results showed that product
development capability had no association with financial performance in SOEs, non-SOEs and IJVs. H28a was not supported. The effect of product development capability on market performance was significant for all firms, but was stronger among IJVs ($\beta=0.150, p<0.01$) compared to it among SOEs ($\beta=0.138, p<0.01$) or non-SOEs ($\beta=0.139, p<0.001$). Product development capability was also related to innovation performance ($\beta=0.112, p<0.05$) among IJVs, a similar relationship could not be found for SOEs or non-SOEs. Thus, H28b and H28c were only partially supported.

Hypothesis 29 similarly proposed that process innovative capability would have a stronger effect on financial performance (H29a), market performance (H29b), and innovation performance (H29c) among non-SOEs or IJVs rather than among SOEs. As shown in Table 7.5, process innovative capability was not associated with financial performance and innovation performance across all three groups. H29a and H29c therefore could not be supported. On the other hand, process innovative capability had a significant and positive effect on market performance among SOEs, non-SOEs or IJVs. However, the effects in both non-SOEs ($\beta=0.177, p<0.001$) and IJVs ($\beta=0.137, p<0.01$) were weaker than such effect among SOEs ($\beta=0.185, p<0.001$). Thus, the results were contrary to the prediction of H29b.

Hypothesis 30 predicted that the effect of manufacturing capability on financial performance (H30a), market performance (H30b) and innovation performance (H30c) would be stronger among non-SOEs or IJVs rather than among SOEs. The coefficients for the relationship between manufacturing capability and performance dimensions showed that manufacturing capability had no relationship with financial and innovation performance across all three groups of firm. However, manufacturing capability presented a significantly positive relationship with market performance across SOEs, non-SOEs and IJVs. The relationship among SOEs ($\beta=0.151, p<0.01$) was stronger than that among non-SOEs ($\beta=0.141, p<0.001$) and IJVs ($\beta=0.112, p<0.05$). Thus, H30a and H30c were not supported, and the results were contrary to the prediction of H30b.
The last hypothesis (Hypothesis 31) suggested that marketing capability would have a stronger impact on financial (H31a), market (H31b) and innovation performance (H31c) among non-SOEs or JVs than such effect among SOEs. However, the results showed that the relationships between marketing capability and firm performance dimensions were not significant across all three groups of firms. Hypothesis 31 was therefore not supported.

7.4 Chapter Summary

This chapter took an initial step toward empirically testing the impact of innovation capabilities on firm performance among a large sample of Chinese industrial firms. Overall, the results of this study show that innovation capabilities have an important but complicated set of effects on firm performance. The findings also confirm the usefulness of the resource-based view of the firm in examining the impact of internal specific innovation capabilities on firm performance in a transitional economy. This section summarizes the hypotheses testing results in Table 7.6 on page 201, and some of the most interesting findings of this study.

First, the results of data analyses in section 7.1 provided support for the general assumption that innovation capabilities are important determinants of firm performance in Chinese industrial firms. Furthermore, among the separate dimensions of innovation capabilities used in this study, R&D capability and marketing capability are related to three performance dimensions. In contrast, manufacturing capability is only associated with market performance. Absorptive capability of external technology resources is important for achieving market performance. However, the results also suggest that an overemphasis on external technology might reduce innovation performance. Product development capability and process innovative capability are more effective for Chinese firms in improving market and innovation performance than improving financial performance.

Section 7.2 demonstrated an interactive effect of R&D capability and marketing capability on firm performance. As expected, the results show that R&D capability and marketing capability jointly influence both financial performance and innovation performance. Moreover, the interaction term has a monotonically positive effect on innovation performance. However,
when firms are primarily oriented to the development of global markets, R&D capability has a negative relationship with financial performance. The results also show that the influence of the interaction term of R&D capability and marketing capability on market performance is not significant.

Third, the results presented in section 7.3.1 suggested that the interactive terms for R&D capability, absorptive capability, product development capability and process innovative capability with regional development, are the important determinants of firm performance. Specifically, the interactive terms for R&D capability and for product development capability are associated with financial performance and they have a stronger impact in high economic development regions rather than in low economic development regions. Three interaction terms for absorptive capability, product development capability and process innovative capability with regional development are related to market performance. These results suggest that product development capability has a stronger relationship with market performance in high economic development regions than in low economic development regions, while the impacts of absorptive capability and process innovative capability are stronger in low economic development regions than in high economic development regions. All of the above interactive terms are associated with innovation performance. Among these, R&D capability and product development capability have a stronger impact on innovation performance in high economic development regions than in low economic development regions. In contrast, absorptive capability and process innovative capability have a stronger influence on innovation performance in low economic development regions than in high economic development regions.

Fourth, the results in section 7.3.2 indicate that innovation capabilities and innovation policy support interactively influence firm performance. Specifically, when innovation policy support is stronger, R&D capability has a stronger effect on financial and innovation performance. It is also not surprising that innovation policy has a more significant moderating effect on the relationship of innovation capabilities with innovation performance, and the relationship with market performance. When innovation policy support is stronger, firms tend to
achieve their market and innovation performance through strengthening absorptive capability, product development capability and process innovative capability. The interactive terms for manufacturing and marketing capability with innovation policy support does not appear to be significant for firm performance.

Fifth, the results in section 7.3.3 suggest that R&D capability and product development capability, which are likely to be associated with more complex technologies (Lall 1994), tend to have a stronger effect on financial, market and innovation performance among firms in higher technology-intensive industries rather than among firms in low technology-intensive industries. However, when the technology intensity of industries is extremely high, larger input in R&D might reduce the short-term financial performance. In contrast, the impact of absorptive capability of external technology resources and process innovative capability on innovation performance and the influence of process innovation capability on market performance are stronger in lower technology-intensive industries than in higher technology-intensive industries. Compared with the above four capability dimensions, the interactive term for marketing capability only has a weak effect on financial and innovation performance, and the impact of marketing capability is stronger in higher technology-intensive industries than in lower technology-intensive industries. The difference of the manufacturing capability effect on firm performance is not significant across higher and lower technology-intensive industries.

Sixth, the results regarding the different impact of innovation capabilities among SOEs, non-SOEs and IJVs suggest that irrespective of firm ownership, firm financial performance appears to be supported by its internal R&D. This is especially true for the effect of R&D capability on financial performance among domestic entrepreneurial firms (non-SOEs). Stronger R&D capability in SOEs and non-SOEs also leads to better innovation performance. Absorptive capability of external technology resources, product development capability, process innovative capability and manufacturing capability are important contributors to market performance among SOEs, non-SOEs and IJVs. Specifically, process innovative capability and manufacturing capability have stronger effects on market performance among domestic firms.
(SOEs and non-SOEs) than among IJVs, while absorptive capability and product development capability are more effective on market performance among IJVs than among SOEs or non-SOEs. Notably, product development capability is also an important determinant of innovation performance in IJVs. Marketing capability has no effects on firm performance across SOEs, non-SOEs or IJVs.

In conclusion, the models developed and tested in this study appear to perform reasonably well in explaining the impact of innovation capabilities on firm performance in Chinese industrial firms. The next chapter will discuss these major findings, and offer some interpretations, implications and conclusions of the results.
Table 7.6 Summaries of Hypotheses Testing

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Sign</th>
<th>Regression Coefficient</th>
<th>Testing Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: R&amp;D capability among Chinese industrial firms will be significantly and positively associated with firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>.454</td>
<td>Supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.048</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.108</td>
<td>Not supported</td>
</tr>
<tr>
<td>H2: Absorptive capability of external technology resources among Chinese industrial firms will be significantly and positively associated with firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.202</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>.096</td>
<td>Refuted</td>
</tr>
<tr>
<td>H3: Product development capability among Chinese industrial firms will be significantly and positively associated with firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.140</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.151</td>
<td>Supported</td>
</tr>
<tr>
<td>H4: Process innovative capability among Chinese industrial firms will be significantly and positively associated with firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.217</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.187</td>
<td>Supported</td>
</tr>
<tr>
<td>H5: Manufacturing capability among Chinese industrial firms will be significantly and positively associated with firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.136</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H6: Marketing capability among Chinese industrial firms will be significantly and positively associated with firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>-</td>
<td>.085</td>
<td>Refuted</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.096</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.88</td>
<td>Supported</td>
</tr>
<tr>
<td>H7: The interaction of R&amp;D capability and Marketing capability among Chinese industrial firms will be significantly and positively associated with firm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>-</td>
<td>.355</td>
<td>Refuted</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.063</td>
<td>Supported</td>
</tr>
</tbody>
</table>
Table 7.6 (Continued)

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Sign</th>
<th>Regression Coefficient</th>
<th>Testing Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H8: The impact of R&amp;D capability on firm performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>.152</td>
<td>Supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.168</td>
<td>Supported</td>
</tr>
<tr>
<td>H9: The impact of absorptive capability of external technology resources on firm performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>-</td>
<td>.158</td>
<td>Refuted</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>.154</td>
<td>Refuted</td>
</tr>
<tr>
<td>H10: The impact of product development capability on firm performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>.119</td>
<td>Supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.175</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.142</td>
<td>Supported</td>
</tr>
<tr>
<td>H11: The impact of process innovative capability on firm performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>-</td>
<td>.124</td>
<td>Refuted</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>.108</td>
<td>Refuted</td>
</tr>
<tr>
<td>H12: The impact of manufacturing capability on firm performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H13: The impact of marketing capability on firm performance is likely to be significantly higher in Chinese industrial firms located in high economic development regions than those in low economic development regions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
</tbody>
</table>
Table 7.6 (Continued)

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Sign</th>
<th>Regression Coefficient</th>
<th>Testing Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>H14: The impact of R&amp;D capability on firm performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>.159</td>
<td>Supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.148</td>
<td>Supported</td>
</tr>
<tr>
<td>H15: The impact of absorptive capability of external technology resources on firm performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.127</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.114</td>
<td>Supported</td>
</tr>
<tr>
<td>H16: The impact of product development capability on firm performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.102</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.107</td>
<td>Supported</td>
</tr>
<tr>
<td>H17: The impact of process innovative capability on firm performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.112</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.118</td>
<td>Supported</td>
</tr>
<tr>
<td>H18: The impact of manufacturing capability on firm performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>H19: The impact of marketing capability on firm performance in Chinese industrial firms is likely to be significantly higher when innovation policy support is strong than it is weak.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
</tbody>
</table>
### Table 7.6 (Continued)

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Sign</th>
<th>Regression Coefficient</th>
<th>Testing Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H20:</strong> The impact of R&amp;D capability on firm performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>-</td>
<td>.105</td>
<td>Refuted</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.097</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.090</td>
<td>Supported</td>
</tr>
<tr>
<td><strong>H21:</strong> The impact of absorptive capability of external technology resources on firm performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>.109</td>
<td>Refuted</td>
</tr>
<tr>
<td><strong>H22:</strong> The impact of product development capability on firm performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>.096</td>
<td>Supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>.128</td>
<td>Supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.126</td>
<td>Supported</td>
</tr>
<tr>
<td><strong>H23:</strong> The impact of process innovative capability on firm performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>-</td>
<td>.107</td>
<td>Refuted</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>-</td>
<td>.038</td>
<td>Refuted</td>
</tr>
<tr>
<td><strong>H24:</strong> The impact of manufacturing capability on firm performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td><strong>H25:</strong> The impact of marketing capability on firm performance is likely to be significantly higher in Chinese industrial firms of high technology-intensive industries than it is in firms of low technology-intensive industries.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>+</td>
<td>.054</td>
<td>Supported</td>
</tr>
<tr>
<td>b. market performance</td>
<td>+</td>
<td>n.s.</td>
<td>Not supported</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>+</td>
<td>.038</td>
<td>Supported</td>
</tr>
</tbody>
</table>
Table 7.6 (Continued)

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Regression coefficient</th>
<th>Testing result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SOEs</td>
<td>Non-SOEs</td>
</tr>
<tr>
<td>H26: The impact of R&amp;D capability on firm performance is likely to be higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is SOEs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>.455</td>
<td>.697</td>
</tr>
<tr>
<td>b. market performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>.112</td>
<td>.085</td>
</tr>
<tr>
<td>H27: The impact of absorptive capability of external technology resources on firm performance is likely to be higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is SOEs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>b. market performance</td>
<td>.157</td>
<td>.157</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>H28: The impact of product development capability on firm performance is likely to be higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is SOEs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>b. market performance</td>
<td>.138</td>
<td>.139</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>H29: The impact of process innovative capability on firm performance is likely to be higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is SOEs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>b. market performance</td>
<td>.185</td>
<td>.177</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>H30: The impact of manufacturing capability on firm performance is likely to be higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is SOEs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>b. market performance</td>
<td>.151</td>
<td>.141</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>H31: The impact of marketing capability on firm performance is likely to be higher in Chinese entrepreneurial industrial firms in terms of non-SOEs and IJVs than it is SOEs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. financial performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>b. market performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>c. innovation performance</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>
CHAPTER EIGHT
DISCUSSION AND CONCLUSIONS

As discussed in preceding chapters, innovation capability is one of the most important engines for driving firm performance. Prior research, however, while clearly emphasizing the impact of a firm’s capabilities and resources has not focused on whether and how a firm’s internal capabilities associated with technological innovation effectively influence firm performance, especially in transitional economies. This is in part because innovation in a firm is an extremely complex process and associated with the fluidity of tacit knowledge (OECD, 1997), and it is difficult to identify idiosyncratic and valuable capabilities and resources (McEvily and Chakravarthy, 2002). In order to address this issue, the present study has applied the resource-based view of the firm (RBV) and assessed its framework to inform the study of the relationship between innovation and firm performance in a transitional economy. This was achieved by developing a framework for estimating the effects of firm-specific innovation capabilities on firm performance in Chinese industrial firms during a period of economic transition. The RBV provides a valuable theoretical framework for understanding that internal idiosyncratic capabilities are likely to contribute to firm superior performance and sustained competitive advantage.

The hypotheses developed in this thesis propose that innovation capabilities are important determinants of firm performance, and individual innovation capabilities associated with different stages of innovation process have different impacts on different performance objectives in Chinese industrial firms. Meanwhile, the relationship between innovation capabilities and firm performance is influenced by specific environmental and organizational factors characterized by China’s transitional economy. This is particularly important for Chinese firms because, in the present transition to market economy, firms must develop their internal idiosyncratic and valuable capabilities in order to improve their competitiveness and performance.
Overall, the findings of this study have provided support for the proposition that innovation capabilities have significant effects on firm performance. Using data from 3843 Chinese industrial firms, the findings offer additional evidence to support the theoretical assumption of the RBV within which innovation capabilities yield a firm’s valuable, scarce, imperfectly imitated and imperfectly substitutable resources that define firm performance (Barney, 1991; Wernerfelt, 1984). The findings of this study, therefore, provide strong support for the use of the RBV as a foundation to explore the impact of innovation capabilities on firm performance in a transitional economy.

Specifically, this thesis has examined the impact of innovation capabilities on firm performance in three ways. First, the study tested the independent impact of innovation capabilities on firm performance simultaneously using different dimensions of innovation capabilities and firm performance. The results reveal that innovation capabilities in terms of R&D capability, absorptive capability of external technology resources, product development capability, process innovative capability, manufacturing capability and market capability are an important but complicated set of prerequisites for achieving different firm performance objectives among Chinese industrial firms. Second, the study examined the interactive impact of innovation capabilities on firm performance using one of the most important interactions: the interaction between R&D capability and marketing capability. The results show that the interaction between R&D capability and marketing capability has a significant and positive effect on innovation performance but a negative effect on financial performance. Finally, the study examined the relationship between innovation capabilities and firm performance considering the moderating effects of some environmental and organizational factors. The results suggest that innovation capabilities carry different implications for firm performance according to regional environments and innovation policy support structures as well as for different types of industry and forms of ownership. These findings also reinforce the argument developed in this thesis that it is the interactions between innovation factors rather than separate capabilities alone that are more important in enhancing firm performance.
This chapter discusses some of the more interesting findings and draws conclusions and implications for future research, as well as for firm managers and policy makers. This is organized into five sections. Section 8.1 focuses on a discussion of the findings presented in Chapter Seven and offers some explanations for the major observations. Section 8.2 presents the general contribution of this study to the RBV literature, and highlights theoretical implications of the study. Section 8.3 discusses the potential managerial and policy implications of the results in light of the research questions and framework presented in Chapter One and Chapter Four. Section 8.4 addresses the limitations of this study and offers some observations and suggestions for future research. Finally, a summary of this study is presented in section 8.5.

8.1 The Complex Impact of Innovation Capabilities among Chinese Firms

Earlier studies found the significantly independent; interactive and moderated impacts of innovation capabilities on firm performance by using one or a few selected dimensions of innovation capabilities. The following sub-sections discuss some specific findings of the impact of innovation capabilities on firm performance in this study. They replicate and extend several previous empirical studies.

8.1.1 The Different Impact of Individual Innovation Capability Dimensions on Firm Performance

At a general level, the results of the present study show that different dimensions of innovation capability, in quite different ways, influence firm performance. Moreover, not all dimensions of innovation capability have a significant or direct effect on a particular firm performance dimension.

The results presented in Chapter Seven show, for example, that R&D capability positively contributes to firm financial, market and innovation performance by providing the firm with effective investment and human resources needed for successful innovation. This result is consistent with some earlier studies, which suggest the positive relationship between R&D capability and firm performance (e.g., Ettlie, 1998; Patterson, 1998). Although, firms with relatively weaker R&D capability may gain short-term market and innovation performance by
engaging in innovation from another starting point such as extend product range and improve production flexibility, the finding in this study suggests that a strategic focus on R&D capability is important for Chinese industrial firms in seeking to achieve superior performance. The implication is that strengthening internal R&D capability through the development of internal R&D financial and human resources increases organizational technological capacities rather than simply R&D outcomes that lead to enhanced firm performance. This impact suggests action for strategic priorities for firm managers.

The results of the present study also show that absorptive capability is important for Chinese firms to enhance short-term market performance. In other words, absorptive capability enables the firm to draw on new or existing technologies and products in order to achieve short-term market success. However, the results also show that absorptive capability of external technology is significantly but negatively related to innovation performance. This implies that if a firm just relies on external technology resources, it will not necessarily lead to successful and independent new product development. The results reinforce Zahra and Nielsen's (2002) finding that reliance on external technology resources can lead firms to losing firm-specific and proprietary knowledge and technology necessary for innovation. This is because a reliance on external resources can adversely influence the development of internalized tacit knowledge (Zahra and Nielsen, 2002). It takes time to convert external technologies into firm-specific resources required to create tacit knowledge and develop new products through the firm's effective learning. Thus the firm must not only build the capacity to absorb but build on the absorptive process to create internal creating and development ability. In essence, this means absorbing and embedding other capabilities such as human resources capability rather than simply the technology itself. Moreover, absorptive capability in this study refers to a firm's ability to acquire new technology from outside technology resources especially from universities and public R&D institutes. The results of the negative relationship between absorptive capability and innovation performance presented in Table 7.3 also provide some
Discussion and Conclusions

evidence that Chinese firms cannot only rely on their traditional technology resources located in universities or government technology institutions to develop new products.

The analysis of the independent impact of innovation capabilities presented in Chapter Seven also showed that it is not surprising that product development capability and process innovative capability have a positive effect on market and innovation performance. The results of this study suggest that innovation and market success can be achieved through both product and process innovation. On the other hand, the data also indicate that product development capability and process innovative capability are not related to short-term financial performance. This result suggests that the proactiveness of technological innovation may not enhance short-term financial performance, though product and process innovation capability may lead to new products. Transforming these innovation advantages into profit-making resources also takes time to occur. Generating an effective return on technological innovation is likely to require strategic decisions that align product and process innovation with appropriate timeframes for anticipating return on innovation.

Improving manufacturing methods and technologies through advanced technology and equipment introduction is clearly defined as a policy target for Chinese industrial firms. However, the data from the present study indicate that manufacturing capability has a relatively weak relationship with market performance, and is not related to innovation and financial performance. There are two plausible explanations for this finding. First, one of the important ways for Chinese firms to improve manufacturing capability is to introduce and adopt advanced manufacturing equipment and technologies mainly provided by foreign organizations. However, to a larger extent, Chinese firms may not obtain the most advanced technologies and equipment from their foreign counterparts, since sometimes they just provide and transfer established or mature technologies to Chinese firms. Thus, even if Chinese firms have invested a large amount of the money in their manufacturing equipment and technology improvement, these technologies and resources may not impart competitive value because they can easily be
duplicated by other firms. Manufacturing capability based on these non-valuable and easily imitated technologies and resources are less likely to contribute effectively to firm performance.

Second, effective equipment and technology transfer requires other relevant capabilities and resources in a firm such as relevant information, skilled and professional personnel and financial support. As others have argued, firms in a transitional economy typically lack these capabilities and resources. The lack of technology information may lead Chinese firms to an incorrect assessment on the levels of technology from outside firms and the demands of their production. Advanced equipment and technologies introduced by Chinese firms may not fit with their production demands and conditions associated with new product production. Therefore, a large investment in advanced technologies and production methods might help the firm maintain or increase its market share in the short term, but it may not lead to successful innovation and better financial performance in the longer term, if these technologies and methods cannot fit with a firm’s overall production capability. Integrating introduced new technologies and equipment with effective manufacturing resources related to new product production should be carefully considered.

The results presented in Chapter Seven provide weak support for the positive effect of marketing capability on market and innovation performance. The results to some extent reinforce the view that a broader marketing network/channel provides greater market information and ideas from customers. Such information and ideas may help the firm produce new products in response to a better understanding of customers’ needs. On the other hand, the data also show that marketing capability is negatively associated with financial performance. In other words, marketing capability in terms of the breadth of marketing networks/channels development is necessary but not sufficient to lead to superior financial performance. Developing broader marketing networks/channels may allow a firm to bring current products into markets through these networks/channels. However, it also enlarges the firm’s innovation cost, leading to a lower financial return in the short term.
The weak relationship between marketing capability and firm performance further suggests that although Chinese firms began to emphasize the development of their own marketing capability, markets and relevant strategies are still under development. Firms have to make greater efforts on explicitly understanding customer awareness, as well as linking existing marketing network with other internal developed marketing resources such as advertising effort, trade loyalty and good relationship with customers. Moreover, to a large extent, many marketing resources are controlled by the government, and Chinese firms are still dependent on government intervention. This also suggests that policy interventions should seek a balance between allowing market forces to steer firms to develop their marketing capabilities and maintenance of government policies to control the market environment.

8.1.2 The Interaction between R&D Capability and Marketing Capability

The results of the data analyses in Chapter Seven not only underscore the separate effect of each innovation capability on firm performance, but also the argument developed in this thesis concerning the importance of the interactive impact of R&D capability and marketing capability.

The results show that the interaction between R&D capability and marketing capability has a positive effect on innovation performance in Chinese industrial firms. Internal R&D investments based on sound market information should be expected to lead to successful new product development. This view is consistent with Dutta, Narasimhan and Rajiv's (1999) recommendation that marketing is one of the most important sources of ideas for innovation. This suggests that the development of marketing capability should be involved from the beginning of innovation.

The findings from the present study also reinforce the observation of the interactive impact of R&D and marketing capability on financial performance, but introduce some deeper insights. These are discussed below. The results produce a surprising and special finding that the interaction between R&D capability and marketing capability has a negative relationship with financial performance. However, this relationship is not monotonic over the range of
marketing capability. Since marketing capability was measured as the orientation and breadth of the marketing networks/channels development, this result reveals that R&D capability has a stronger impact on financial performance when firms emphasize the development of local markets. When firms focus on the development of broader marketing networks such as global markets, extensive development of R&D capability appears to reduce the short-term financial performance. There are several possible explanations for this finding.

First, from a network perspective, inter-firm networking around the broader relationship with buyers and suppliers is more critical for Chinese internationally market-oriented firms (Hsieh, 1994; Li and Ogunmokun, 2001). This is because although, internal technology resources and capabilities are important for developing unique products, Chinese firms tend to lack of internal technology resources. Therefore, unlike their counterparts in market economies, Chinese firms directed toward international markets tend to develop stronger inter-firm relational networks rather than technology in order to achieve their market success. The emphasis on relational networks might lull firms into failing to develop internal R&D capability and reduce the direct impact of internal R&D capability on firm performance in global markets.

Meanwhile, more extensive inter-firm networks or stronger relational capabilities can be converted to lower cost advantages in global markets (Bharadwaj, Varadarajan and Fahy, 1993; Kogut, 1988; Varadarajan and Cunningham, 1995). Thus, for Chinese firms, given their limited internal financing resources, the networking emphasis is on maintaining a low-cost-based competitive advantage to compete in global markets rather than a technologically innovative market niche. Broader marketing networks may help Chinese firms bring their products into foreign markets at a relatively lower level of cost. However, it may also reduce the impact of internal R&D capability on short-term financial performance. This is because the development of internal R&D capability may increase the operating costs of Chinese firms to serve international markets. Data from the technological innovation survey show that internal R&D capability is not related to a firm’s export performance in terms of the percentage of export sales
to total sales. On the other hand, broader marketing networks and relational capabilities may help the firm obtain relative R&D resources that lie with other firms. Thus, to compensate for a lack of internally developed R&D resources and capabilities, the firm might improve its performance by drawing on its partners' R&D resources and capabilities.

A second point to note in this discussion is that Chinese firms, especially those targeted toward global markets tend to orient their innovation activities to less R&D-intensive markets. Data in Table 8.1 show that in domestic technology markets, the sales of internal R&D-based products and technologies accounted for over 30 percent of total new product and technology sales in the mid of 1990s. While for global markets, the exports of R&D-intensive products namely high-tech products only accounted for around 5 per cent of total product exports. The data from the technological innovation survey that underpins this thesis also indicate that the amount of new product exports from Chinese industrial firms accounts for about 10 per cent of their total product exports (see Table 6.3 in Chapter Six). The less R&D-intensive orientation may also reduce the effectiveness of internal R&D capability development, when the firm targets global markets.

Table 8.1 Technology Trade in Domestic Technology Markets and High-Tech Product Exports (100 Million Yuan)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total value of technology trade in domestic markets</strong></td>
<td>207.6</td>
<td>228.9</td>
<td>268.3</td>
<td>300.2</td>
<td>351.4</td>
</tr>
<tr>
<td>Of which: technology development</td>
<td>71.0</td>
<td>71.5</td>
<td>81.0</td>
<td>92.7</td>
<td>116.2</td>
</tr>
<tr>
<td>Ratio to total technology trade (%)</td>
<td>34.2</td>
<td>31.2</td>
<td>30.2</td>
<td>30.9</td>
<td>33.1</td>
</tr>
<tr>
<td><strong>Total value of product exports (USD 100 Million)</strong></td>
<td>917.4</td>
<td>1210.1</td>
<td>1487.7</td>
<td>1510.5</td>
<td>1827.0</td>
</tr>
<tr>
<td>Of which: high-tech product exports</td>
<td>46.8</td>
<td>63.4</td>
<td>100.9</td>
<td>76.8</td>
<td>96.9</td>
</tr>
<tr>
<td>Ratio to total product exports (%)</td>
<td>5.1</td>
<td>5.2</td>
<td>6.8</td>
<td>5.1</td>
<td>5.3</td>
</tr>
</tbody>
</table>

*Data source: China Science and Technology Indicators (1998).*
Finally, this explanation remains consistent with the RBV in China. From this perspective, Chinese firms tend to lack internally complementary assets and managerial skills in R&D and marketing activities. Therefore, they are more likely to be slow in transferring and commercializing their R&D outcomes to more competitive markets such as global markets.

8.1.3 The Influence of Regional Development on the Relationship between Innovation Capabilities and Firm Performance

The data analyses presented in Chapter Seven confirm that regional development is an important factor influencing the impact of innovation capabilities on firm performance. Regions vary greatly in terms of the level and pace of economic development. This variance implies an asymmetrical different distribution of resources and different levels of market competition. These differences in resource distribution and market competition lead to different experiences in building innovation capabilities. In general, the results described in Chapter Seven reinforce some previous findings that the difference of regional development in terms of the level of economic development, environmental munificence, market environment heterogeneity, and technology opportunity difference is definitely associated with firm innovation and performance (e.g., Chryssochoidis and Wong, 1998; Davies, 2001; Kotha and Nair, 1995).

The results of this study suggest that the effect of R&D capability and new product development capability, which tend to be associated with complex technologies (Lall, 1994) on firm performance are stronger, when regions are at a higher level of economic development and competition in terms of the level of annual growth rate of per capita GDP. This result is consistent with the research framework that firms in rapidly growing economic regions with more competitive environments are likely to follow a path of developing internal R&D capability and promoting internal product development to achieve superior performance. Under more competitive environments, firms are driven to pay more attention to market pressures. In many cases, this can lead them to build up their internal technology development capabilities in order to develop new products for gaining monopoly positions in new and existing markets. Product development capability constitutes both technology development and application assets.
Discussion and Conclusions

These assets differ from the scientific research and knowledge/technology accumulation capabilities, which include the creation of new knowledge and present the routine part of innovation (Christensen, 1995). Product innovation is more likely to be linked to the commercialization of technology and products during a relatively short period. To a large extent, superior financial performance results from the firm's monopoly positions through the introduction of valuable new products to the markets (Roberts, 1999).

It is not surprising, therefore, that absorptive capability of external technology resources and process innovative capability are found to have relatively stronger effects on firm performance in regions with a lower level of economic development and competition. As discussed in Chapter Two, R&D and new product development are high-risk and high-cost activities. Under less competitive environments, Chinese firms tend to obtain their temporary positions in the markets through incremental product and process innovation with less complex and low cost technologies, given the lower level of risk taking and the lack of internal R&D resources and valuable product innovation.

Moreover, in regions with a lower level of economic development, technology resources are relatively richer outside the firm. In the lower development regions discussed in this study, the traditional allocation of science and technology resources is concentrated in public research institutes and universities rather than firms. This offers firms more opportunities access these outside technology resources, especially R&D resources from some research institutes. Therefore, firms in lower development regions tend to rely on their absorptive capability to acquire R&D resources and new products from outside in order to reduce the level of risk of internal product development and enhance the short-term performance in local markets. It might reduce firms' incentive to develop their internal R&D and product innovation capability.

The explanation is reinforced through observations of patterns of R&D resource distribution: R&D expenditures and R&D personnel in different regions. As shown in Table 8.2, R&D expenditure in the relatively lower economic development regions discussed in this study accounts for 29.4% of total national R&D expenditure, while R&D expenditure of higher
economic development regions accounts for 25.0%. However, R&D expenditure in lower development regions is mainly located in R&D institutions and universities. As Table 8.2 shows, 67.0% of total R&D expenditure in lower development regions is spent in R&D institutions, 13.0% in universities, and 20.0% in industrial firms. In contrast, industrial firms are the major performers of R&D activities in higher development regions. Industrial R&D expenditure in higher development regions accounts for 35.6% of national total industrial R&D expenditures, industrial R&D expenditure of lower development regions only accounts for 14.6%. More importantly, 57.3% of R&D expenditure in rapid development regions is accounted for by industrial firms, 32.2% by R&D institutions and 10.4% by universities.

Similarly, as shown in Table 8.3, in higher development regions, there are more R&D personnel in industrial firms compared with universities and research institutions (industrial firms: 48.3%; R&D institutions: 25.6%; Universities: 26.1%). In contrast, in lower development regions, R&D institutions (44.9%) and universities (21.4%) have more R&D personnel than industrial firms (20.3%).

This does not mean that internal R&D capability and product development capability are not important for those firms in lower development regions. Rather this simply suggests that absorptive capability and process innovative capability are likely to be more aligned with them. As Cohen and Levinthal (1990) point out, internal technology development and external technology resources are complementary to one another. Assimilating and utilizing external technology resources are determined by the stock of internal prior knowledge and accumulation such as R&D. On the other hand, transforming a firm from imitation to innovation requires considerable learning by doing (Zahra and Nielsen, 2002). Therefore, firms in lower development regions seeking to enhance their long-term performance should strengthen their internal R&D capability and product development capability associated with more complex technologies, in addition to developing less complex technologies.
### Table 8.2 Distribution of R&D Expenditures in Six Surveyed Provinces and Cities (1998, in million yuan)

<table>
<thead>
<tr>
<th>Region</th>
<th>R&amp;D expenditures</th>
<th>% R&amp;D exp. by Region</th>
<th>% Regional R&amp;D exp.</th>
<th>R&amp;D exp. of R&amp;D institutes</th>
<th>% R&amp;D exp. of R&amp;D institution by Region</th>
<th>% Regional R&amp;D exp. of R&amp;D institutions</th>
<th>R&amp;D exp. of Industrial firms</th>
<th>% R&amp;D exp. of Industrial firms by Region</th>
<th>% Regional R&amp;D exp. in firms</th>
<th>R&amp;D exp. of Univ.</th>
<th>% R&amp;D exp. of Univ. by region</th>
<th>% Regional R&amp;D exp. in Univ.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>48887.3</td>
<td>100.0</td>
<td>100.0</td>
<td>23453.2</td>
<td>100.0</td>
<td>48.0</td>
<td>19709.2</td>
<td>100.0</td>
<td>40.3</td>
<td>5725.0</td>
<td>100.0</td>
<td>11.7</td>
</tr>
<tr>
<td><strong>Lower development</strong></td>
<td>14349.2</td>
<td>29.4</td>
<td>100.0</td>
<td>9610.3</td>
<td>41.0</td>
<td>67.0</td>
<td>2876.3</td>
<td>14.6</td>
<td>20.0</td>
<td>1862.6</td>
<td>32.5</td>
<td>13.0</td>
</tr>
<tr>
<td>Beijing</td>
<td>10334.7</td>
<td>21.1</td>
<td>100.0</td>
<td>8367.1</td>
<td>35.7</td>
<td>81.0</td>
<td>8369.6</td>
<td>4.2</td>
<td>8.1</td>
<td>1130.6</td>
<td>19.7</td>
<td>10.9</td>
</tr>
<tr>
<td>Liaoning</td>
<td>2626.6</td>
<td>5.4</td>
<td>100.0</td>
<td>932.0</td>
<td>4.0</td>
<td>35.5</td>
<td>1312.8</td>
<td>6.7</td>
<td>50.0</td>
<td>381.8</td>
<td>6.7</td>
<td>14.5</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>1387.9</td>
<td>2.8</td>
<td>100.0</td>
<td>311.2</td>
<td>1.3</td>
<td>22.4</td>
<td>726.6</td>
<td>3.7</td>
<td>52.4</td>
<td>350.2</td>
<td>6.1</td>
<td>25.2</td>
</tr>
<tr>
<td><strong>Higher development</strong></td>
<td>12226.0</td>
<td>25.0</td>
<td>100.0</td>
<td>3938.1</td>
<td>16.8</td>
<td>32.2</td>
<td>7011.1</td>
<td>35.6</td>
<td>57.3</td>
<td>1276.8</td>
<td>22.3</td>
<td>10.4</td>
</tr>
<tr>
<td>Shanghai</td>
<td>4528.1</td>
<td>9.3</td>
<td>100.0</td>
<td>1899.6</td>
<td>8.1</td>
<td>42.0</td>
<td>1974.2</td>
<td>10.0</td>
<td>43.6</td>
<td>654.3</td>
<td>11.4</td>
<td>14.4</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>3605.0</td>
<td>7.4</td>
<td>100.0</td>
<td>1222.0</td>
<td>5.2</td>
<td>33.9</td>
<td>1902.7</td>
<td>9.7</td>
<td>52.8</td>
<td>480.3</td>
<td>8.4</td>
<td>13.3</td>
</tr>
<tr>
<td>Guangdong</td>
<td>4092.9</td>
<td>8.4</td>
<td>100.0</td>
<td>816.5</td>
<td>3.5</td>
<td>19.9</td>
<td>3134.2</td>
<td>15.9</td>
<td>76.6</td>
<td>142.2</td>
<td>2.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Source: China Statistical Yearbook on Science and Technology 1999.

### Table 8.3 Distribution of R&D Personnel in Six Surveyed Provinces and Cities (1998, in Person)

<table>
<thead>
<tr>
<th>Region</th>
<th>R&amp;D personnel</th>
<th>% R&amp;D personnel by Region</th>
<th>% Regional R&amp;D personnel</th>
<th>R&amp;D personnel of R&amp;D institutions % R&amp;D personnel of R&amp;D institutions by Region</th>
<th>% Regional R&amp;D personnel of R&amp;D institutions</th>
<th>R&amp;D personnel of Industrial firms</th>
<th>% R&amp;D personnel of Industrial firms by Region</th>
<th>% Regional R&amp;D personnel in firms</th>
<th>R&amp;D personnel of Univ.</th>
<th>% R&amp;D personnel of Univ. by region</th>
<th>% Regional R&amp;D personnel in Univ.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>666863</td>
<td>100.0</td>
<td>100.0</td>
<td>227803</td>
<td>100.0</td>
<td>270300</td>
<td>100.0</td>
<td>40.5</td>
<td>168760</td>
<td>100.0</td>
<td>25.3</td>
</tr>
<tr>
<td><strong>Lower development</strong></td>
<td>160094</td>
<td>24.0</td>
<td>100.0</td>
<td>71809.0</td>
<td>31.5</td>
<td>44.9</td>
<td>54048.0</td>
<td>20.0</td>
<td>34246</td>
<td>20.3</td>
<td>21.4</td>
</tr>
<tr>
<td>Beijing</td>
<td>87004</td>
<td>13.0</td>
<td>100.0</td>
<td>57449.0</td>
<td>25.2</td>
<td>66.0</td>
<td>11643.0</td>
<td>4.3</td>
<td>17921</td>
<td>10.6</td>
<td>20.6</td>
</tr>
<tr>
<td>Liaoning</td>
<td>47098</td>
<td>7.1</td>
<td>100.0</td>
<td>9203.0</td>
<td>4.0</td>
<td>19.5</td>
<td>25737.0</td>
<td>10.6</td>
<td>9158</td>
<td>5.4</td>
<td>19.4</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>25992</td>
<td>3.9</td>
<td>100.0</td>
<td>5157.0</td>
<td>2.3</td>
<td>19.8</td>
<td>13668.0</td>
<td>5.1</td>
<td>7167</td>
<td>4.2</td>
<td>27.6</td>
</tr>
<tr>
<td><strong>Higher development</strong></td>
<td>127680</td>
<td>19.1</td>
<td>100.0</td>
<td>32646.0</td>
<td>14.3</td>
<td>25.6</td>
<td>61662.0</td>
<td>22.8</td>
<td>33373</td>
<td>19.8</td>
<td>26.1</td>
</tr>
<tr>
<td>Shanghai</td>
<td>40666</td>
<td>6.1</td>
<td>100.0</td>
<td>14445.0</td>
<td>6.3</td>
<td>35.6</td>
<td>15798.0</td>
<td>5.8</td>
<td>10364</td>
<td>6.1</td>
<td>25.5</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>49218</td>
<td>7.4</td>
<td>100.0</td>
<td>11043.0</td>
<td>4.8</td>
<td>22.4</td>
<td>24816.0</td>
<td>9.2</td>
<td>13359</td>
<td>7.9</td>
<td>27.1</td>
</tr>
<tr>
<td>Guangdong</td>
<td>37856</td>
<td>5.7</td>
<td>100.0</td>
<td>7158.0</td>
<td>3.1</td>
<td>18.9</td>
<td>21048.0</td>
<td>7.8</td>
<td>9650</td>
<td>5.7</td>
<td>25.5</td>
</tr>
</tbody>
</table>

Source: China Statistical Yearbook on Science and Technology 1999.
8.1.4 The Influence of Innovation Policy Support on the Relationship between Innovation Capabilities and Firm Performance

This study advances an understanding of the influence of innovation support policies on the relationship between innovation capabilities and firm performance. The results presented in Chapter Seven reveal that government support for innovation through innovation policies has a significant effect on the relationship between innovation capabilities and firm performance in China. Government innovation support in China is provided through industrial policies. The finding that is concerning with the moderating effect of innovation policy support suggest that innovation policy support provides an important stimulus for Chinese firms to obtain more resources and to conduct innovation. This may be rather different from the process that dominates in the more industrially advanced economies. For example, Chinese firms especially SOEs, are found to be particularly subject to hierarchical interdependent relationships with the State. These firms invariably prefer to work with government-supported research institutes, universities and familiar firm partners with proven technology strength. Thus, the relationship between internal innovation capabilities and firm performance becomes quite complex.

Specifically, the results of this study reveal several significant interaction effects of innovation capabilities and innovation policy support on firm performance. For instance, the data analyses showed that the interaction of R&D capability and innovation policy support has a positive relationship with financial and innovation performance. This suggests that firms can utilize their R&D capability to enhance financial performance and innovation performance where there is a strong support of innovation policies. It is not surprising that innovation policy has a significant moderating effect on the relationship between innovation capabilities and innovation performance as well as the relationship between innovation capabilities and market performance. This implies that when innovation policy support is stronger, firms tend to improve their performance by strengthening internal technological innovation capabilities such as R&D and effectively developing more effective/marketable new products and process.
However, the implications of these findings are also more complicated than they first appear. The results also show the influence of government innovation support on several relationships between innovation capabilities and performance to be weak and not all interactions of policy support and innovation capabilities are significantly effective on firm performance. For example, somewhat surprisingly, the interaction of innovation policy support and manufacturing capability showed no relationship with any of the three firm performance dimensions. This was in spite of the fact that Chinese government has been encouraging firms to improve their production abilities through a range of relevant policy interventions including technology and equipment introduction and improvement incentives. This may be because government agencies have little incentive to evaluate firms' production capabilities and levels before providing firms with investment or development support for improving manufacturing technologies. This is, in part, because the public commitment to provision of resources to firms is not substantial (Lee, Lee and Pennings, 2001). The lack of strong incentives makes such effect of policy support weak.

On the other hand, as noted above, Chinese firms tend to lack abilities to obtain effective technology information and resources. The results of less significant impact of manufacturing capability and its interaction with policy support presented in Table 7.3 and Table 7.4 suggest that ineffective improvement of production such as blindly pursuing an introduction of excessively advanced equipment and technologies makes Chinese firms not benefit from relevant policies, even the innovation policy support is strong.

The results also imply that Chinese firms, especially domestic firms do not get enough qualified technology support from government resources alone to build their internal innovation capabilities. Government policies can stimulate Chinese firms to adopt technology alliance strategies and acquisitions (White, 2000). However, as Li and Atuahene-Gima (2001a) have argued, alliances in China tend to be artificially established based on a push from governmental agencies and partners' desire for rent-seeking via opportunism. This can lead a technology alliance and potential performance in the longer-term failure. On the other hand, the results
from the present study show a relative weakness in internal innovation capabilities, which can hinder firms from winning sufficient government resources for innovation. This in turn limits their access to valuable technology resources such as talented human capital.

8.1.5 The Influence of Industry Type on the Relationship between Innovation Capabilities and Firm Performance

The results presented in Chapter Seven show that the effects of R&D capability, product development capability and marketing capability on financial performance are moderated by industry type in terms of technology intensity of an industry. More importantly, R&D capability may be a necessary, but not sufficient determinant of short-term financial performance among firms in high technology-intensive industries. This is shown as the negative relationship between the interaction for R&D capability and financial performance. According to the classification of high technology-intensive industry, firms in high technology-intensive industries tend to have high rates of R&D investment. Higher R&D investments are synonymous with higher costs of products and processes. As many researchers have argued extensive R&D investment with an objective of more advanced innovations in high technology-intensive industries requires more than three years producing a positive impact on financial performance (e.g., Zif and Mccarthy, 1997). Further, the higher costs may reduce short-term performance.

On the other hand, the high magnitude of R&D requires extensive commitment of resources (Gopalakrishnan, 2000). In a transitional economy, high technology-intensive industries are new and growing sectors, and high technology firms tend to lack complementary resources or assets. The ability to accept higher levels of risk among these firms is weak. The lack of these complementary resources to R&D and radical product development limited the impact of innovation capabilities on financial performance. This finding provides some insights for improving the effectiveness of R&D according to industry type. For example, in medium technology-intensive industries, there is the potential for improvement in short-term financial performance by increasing investment in R&D. While in high technology-intensive industries,
increasing R&D might not lead to short-term financial performance, but might well lead to longer term performance. The difference is important for more accurately evaluating the impact of government R&D investment incentives.

This does not mean that R&D capability in high technology-intensive industries is less important. In fact, the results also show that the effect of R&D capability on market and innovation performance is stronger in high technology-intensive industries than in low technology industries. The findings indicate that firms in higher technology-intensive industries need to maintain a stronger R&D capability as necessary resources in order to achieve market and innovation success because of the more competitive environments in high technology markets, even if short-term financial performance is negatively influenced. This further supports the argument that innovation capabilities are not necessary directly nor independently influential in enhancing firm financial performance. Understanding the contradiction between maintaining high levels of R&D investment and experiencing negative financial performance in the short term at the same time is an important strategic issue in high technology-intensive industries.

The results also suggest that new product development capability and process innovative capability are important determinants of market and innovation performance over the range of industry types. Considering this from the perspective of an innovation-performance model, new product development capability, which is likely to involve more complex technologies (Lall 1994), tends to have a stronger effect on market and innovation performance among firms in higher technology-intensive industries. In contrast, process innovative capability, which is likely to involve less complex technologies, has a greater impact on market and innovation performance among firms in lower technology-intensive industries. On the other hand, the negative sign in front of the interaction term for absorptive capability of external technology resources indicates that external technology resources are more important for firms in lower technology-intensive industries in achieving innovation success. This is generally because of the lack of internal technology resources among those firms. These findings reinforce the claim that
competition in high technology industries is based upon a firm’s high level of innovation and tacit knowledge creation. Radical innovation is a critical determinant of competitive advantage among firms in high technology industries (Hitt, Hoskisson, Johnson and Moesel, 1996), while firms in lower technology-intensive industries have less pressure on innovation in enhancing their performance (Hill and Snell, 1988). Therefore, it is quite important for high technology-intensive firms to strengthen internal R&D and to constantly engage in product innovation with the objective of creating radically new products (Dutta, Narasimhan and Rajiv, 1999).

8.1.6 The Difference of Innovation Capability-Performance Relationship in Different Ownership Firms

Few studies have discussed innovation capability-performance relationships by comparing different forms of firm ownership. The findings of this study provide empirical evidence that the influence of innovation capabilities on firm performance in SOEs is different from the growing number of non-SOEs and IJVs.

The analysis that emerged from testing hypothesis 26 indicated that R&D capability enables Chinese small and medium-sized firms including SOEs, non-SOEs and IJVs to achieve better financial performance.

However, it should be noted that R&D capability among IJVs has a relatively weak effect on financial performance, compared with domestic SOEs and non-SOEs. This finding indicates that IJVs in China tend to conduct little R&D, and it is facilitated through IJVs as technological accumulation or technology transfer. Some IJVs in China just obtain new technology and products solely through their foreign parents firms and use these technologies in production with little or no modification or adaptation. For the Chinese partners, this inhibits technology learning from foreign partners. IJVs in transitional economies present a style of collaboration that transfers, accumulates and applies knowledge and technology of foreign parents to local market by using joint ventures (Grant and Baden-Fuller, 1995; Lane, Salk and Lyles, 2001). The result of the present study indirectly confirms an assumption in previous studies that IJVs or multinational companies are less likely to conduct effective R&D in transitional economies or
Discussion and Conclusions

developing countries generally. For example, Amsden, Tschang and Goto (2001) conclude that foreign companies tend to contribute little R&D in developing countries; and R&D undertaken by foreign companies does not deliver effective resources that significantly enhance economic development in developing countries.

On the other hand, the results also suggest that Chinese firms regard absorptive, product development, process innovative capability and manufacturing capability as very important assets for achieving their market success. Specifically, domestic firms including SOEs and non-SOEs are more likely to use process innovative capability as an appropriate asset for enhancing market performance. According to the definition of innovation capabilities used in this study, to some extent, process innovative capability refers to the skills and knowledge required to use technologies already developed by others. Other innovation capabilities, for example R&D capability and product development capability are related to more complex capabilities, as they refer to the ability to understand the principles of technology and to create new products and technology (Costa, 2001). Some researchers argue that the transition from less complex capabilities toward more complex ones within a firm operating in an emerging market requires a qualitative leap, which is possible through more technology accumulation and effective acquisition of technology resources (e.g., Lall, 1994).

Compared with IJVs, domestic firms lack the necessary advanced technology accumulation and exercise little technology and market development in uncertain or emerging markets. Given this background, improving process innovative capability in terms of incremental process improvement and structural change of management appears to be an effective strategy for increasing market share and making technological innovation successful while coping with China’s complex and uncertain market. Moreover, compared with IJVs, the production in domestic firms is relatively experience-based and labor-intensive. The results provide some empirical evidence to further inform Christensen’s (1995) discussion that for less technology-intensive production, process innovative resources/capabilities may have a more critical impact on firm performance.
In contrast, most IJVs demonstrate the benefit of absorptive capability and product development capability in enhancing market performance. In this study, absorptive capability refers to the ability to acquire external technology and the ability to accumulate technology resources. IJVs’ stronger absorptive capability and internal product development capability implies that small and medium-sized IJVs operating in China are more effective in establishing relations with other technology actors and gaining access to technology resources, and to derive benefit from these resources. On the one hand, stronger absorptive capability and product development capability help IJVs acquire relevant technology from their foreign parents to develop new products, which are highly related with their foreign parents’ products. When the level of technology relatedness to foreign parent is high, an IJV can benefit from using capabilities and resources committed by its foreign parents (Luo, 2002). On the other hand, given the relationship with local parents, these capabilities also imply that an IJV can effectively access local technology resources or local markets and benefit from these resources and channels established by its local parents at a relatively lower level of costs.

Finally, it should also be noted that contrary to predictions, the effects of innovation capabilities on innovation performance are not highly significant in small and medium-sized entrepreneurial firms. This may imply that innovation capabilities in small and medium-sized non-SOEs and IJVs in China will not necessarily ensure more effective innovation outcomes, and may not result in more spillovers to local markets. Moreover, it may also imply that innovation capabilities are not the only important factor driving innovation success in emerging markets like China’s markets. Other factors such as environmental uncertainty, local partner selection and resource complementarity may be more important for innovation performance, since emerging markets are characterized by market potential derived from dynamics of economic transition and institutional instability (Luo, 2002).

Further studies and policy making should consider how these entrepreneurial firms especially IJVs could be induced to develop more complex technologies and how the spillovers of these capabilities and activities could be maximized to the local markets. Nevertheless, these
findings support the main contention in this thesis that ownership influences a firm’s innovation behavior and performance (Damanpour, 1991), and it is an important moderating factor influencing the relationship between innovation capabilities and firm performance.

8.2 Contributions and Theoretical Implications

This study makes several contributions to theoretical, methodological and managerial practice. From a theoretical standpoint, the RBV perspective has begun to provide a general understanding of the importance of firm internal specific capabilities/resources for firm superior performance. This study contributes additional insight to this perspective in a variety of ways. These are discussed in the following sub-sections.

8.2.1 The Implication of the RBV in Transition Economies

This study provides a better understanding of the role of the RBV in explaining firm performance by examining the impact of internal innovation capabilities in a transitional economy. This study is one of the first attempts to apply and empirically test the RBV perspective of innovation capabilities in China’s transitional economy. The extant research on the relationship between capability and performance or innovation and performance has been carried out mainly in market driven economies. It is not clear whether the research findings from these studies in market economies would also apply in transitional economies. The results of this study in China highlight the differing ways in which individual innovation capability dimensions contribute to different firm performance objectives. Importantly, the analysis reinforces the RBV proposition that the impact of particular capabilities and resources on firm performance relies on specific market conditions under which different capabilities are and are not valuable (Barney, 2001a). It is the innovation capabilities, which are idiosyncratic and cannot be easily duplicated by other firms that contribute most to firm performance. Therefore, one of the general findings of this study is that the RBV provides an appropriate theoretical framework for examining the relationship between innovation capabilities and firm performance in transitional economies.
8.2.2 Unpacking Innovation Capabilities

This study has provided new insights into the more specific factors that make up innovation capabilities and their relative contribution to different performance objectives. For example, for Chinese firms, market performance does not so much depend on whether a firm has strong R&D capability, but whether the firm’s absorptive capability, product development capability, process innovative capability and manufacturing capability are strong and in which environmental context. This implies that in order to enhance market performance in the short-term, Chinese firms competing in local markets, need to focus more on developing and acquiring technological resources which directly lead to new product development, rather than focusing on R&D itself. This result is consistent with but sheds further light on Danneels and Kleinschmidt’s (2001) findings on the relationship between product innovativeness and performance. Their study suggests that market success do not depend on whether the innovation requires a new technology, but rather whether the firm can acquire new technology through its internal technological skill-base. The result is also consistent with Quadros and his colleagues’ (2001) findings on technological innovation in Brazil. Their research revealed that market success among industrial firms in a transitional economy has generally relied more on sources of information rather than R&D especially internal R&D activities. The further insight provided through this thesis is that there are various and different capabilities associated with different stages of the innovation process that a firm can particularly emphasize when it seeks to achieve different performance objectives. They inform future theory development on the effectiveness of different innovation capability development.

8.2.3 Interactions between Innovation Capabilities

This study also explored the interaction between input-oriented and output-oriented innovation capabilities in terms of the interaction of R&D capability and marketing capability. This extends earlier research, which has tended to focus mainly on high-tech industries (Dutta, Narasimhan and Rajiv, 1999; Moorman and Slotegraar, 1999) and to generalize the findings to firms in high technology-intensive as well as low technology-intensive industries. The findings
of the present study provide evidence to show the importance of the interaction between R&D and marketing capabilities in enhancing firms' financial performance across a wider range of technology business environments. They reinforce the proposition of the chain-link model of innovation that interaction between marketing and invention stages of the innovation process is critical for innovation success (Kline and Rosenberg, 1986; OECD, 1997). The results of this study further show that the development of R&D capability among this sample of Chinese industrial firms is driven by competition in local markets rather than international markets. This is perhaps a unique feature of China's large domestic market and internal economic growth rate. However, it implies in the China context that firms need to excel in their capability to develop new technology and products for local markets competition. While, firms also need to improve their capacity to develop new technology and products respond to consumer demands in global markets. The ways in which this is being achieved is quite different.

For example, the research findings of this study reveal that marketing capability alone has weak impact on firm performance. But, marketing capability may be used to facilitate the complementary of input-oriented innovation capabilities in local markets. These results help to explain why many Chinese firms fail to improve their performance even they have a considerable existing distribution channels and networks to deliver their products. Thus, building and developing extensive product distribution channels and networks may not be justified by as a means to directly enhance firm performance, but rather, it appears this can be achieved by using channels and networks as a mechanism to facilitate the introduction of new technology, which in turn, and in time, contributes to firm superior performance.

8.2.4 The Role of Environmental and Organizational Factors

This study also presents a contingency model of innovation capability – performance that explicitly accounts for the influence of several environmental and organizational factors. Chinese industrial firms face a different range of barriers and challenges in dealing with competitive environments, organizational structures and acquiring resources for competition and performance compared to their counterparts in market economies. Some earlier studies have
Discussion and Conclusions

suggested that the impact of capabilities and resources on performance is contingent on environmental and organizational factors, such as the external information of environments including product competition level (Moorman and Slotegraaf, 1999), organizational ownership (Ramaswamy, 2001), and geographic location of the firm (Deeds, CeCarolis and Coombs, 1999). These studies are fruitful as a first step toward understanding the role of capabilities related to innovation on firm performance. The present study has added further to these previous findings by taking their assumptions and propositions into a very different economic environment.

The results of the present study of Chinese industrial firms suggest that the impact of innovation capabilities on firm performance in this context is conditional, and that both environmental and organizational factors are relevant in understanding the relationship between innovation capabilities and firm performance. The study revealed that the level of regional economic development, innovation policy environment, and the level of technology intensity in industry are particularly important for both innovation and firm performance. This study also considered factors that might be unique to transitional economies such as ownership in terms of state-owned, non-state-owned firms and international joint ventures. Overall, the results indicate that the development of the RBV should consider the efficiency of the interactions between firm internal and external resources in terms of their influence on firm performance.

8.2.5 Methodological Implications

From a methodological perspective, the results of this study offer four main insights. First, this study contributes to the debate on how to define and measure innovation capabilities. Both the RBV and innovation literature have emphasized the critical role of innovation on firm performance. However, few studies have defined and sought to measure the separate elements that make up innovation capabilities (Christensen, 1995). Empirically, previous studies have discussed several possible measures such as R&D capability, absorptive capability, technological capability and new product development. They may be appropriate for one or more aspects of innovation, but ignored the simultaneous and interactive impacts of other
Discussion and Conclusions

factors. This study provides a richer understanding of the relationships between innovation capabilities and firm performance objectives by simultaneously examining different dimensions of innovation capabilities associated with different stages of innovation process. These include R&D capability, absorptive capability of external technology resources, product development capability, process innovative capability, manufacturing capability and marketing capability.

This multi-dimensional approach for investigating innovation capabilities in this study elaborates a rationale for the use of different measures, and contributes toward bridging the analysis between innovation studies and the RBV. On the other hand, the approach to measuring innovation capabilities has important ramifications for future attempts to measure other types of capabilities. If an activity needs to be supported by a number of capabilities and resources, multiple indicators should be used to capture these capabilities. More importantly, the measures exhibit acceptable properties and could therefore provide valid approaches for future studies.

Second, a methodological insight emerges from the fact that the present study links innovation capabilities to three different dimensions of firm performance. Studies on firm performance tend to analyze capabilities or other factors in relation to one type of performance metric, such as financial performance. Alternatively, they create a composite measure of performance by pooling several different types of indicators together like financial and market performance. This study develops an analytical framework that allows evidence to emerge about the impact of different innovation capabilities on each of financial, market, and innovation performance dimensions. The results of this analytical emphasis on the multi-dimensions of firm performance rather than a single dimension can help to construct a set of choices about innovation resources, which could advance the positive impact of innovation on different performance objectives. While Murphy, Trailer and Hill (1996) argued that the effect of a given independent variable on performance may also depend on the performance measures, the present study has moved some steps toward operationalizing such measures for the study of innovation.
Third, the sample used in this study covers all industrial sectors defined at a 4-digit CSICs level in six provinces and cities of China rather than from some selected sectors. The sample was large and included a broad representation of the population of Chinese industrial sectors. This provides the possibility to understand the different characteristics of capability-performance relationship between industries especially between industrial sectors with high technology intensity and low technology intensity. Many previous studies on the relationship between innovation and performance have not controlled for the difference between these different industries. The approach taken in this study can help us to clarify which innovation resources are more effective on helping the firm achieve superior performance in different industries.

Fourth, this study measures innovation capabilities and firm performance by using both subjective (qualitative) and objective (quantitative) indicators. A common problem in social science research is that the perspective of an informant often differs from another one even in the same firm (McDaniel and Kolari, 1987). The current literature has indicated several ways of using either quantitative or qualitative data to measure capabilities and firm performance. Built on these studies, this study presents an additional set of measures of both quantitative indicators and qualitative constructs of innovation capabilities and firm performance. The results empirically confirm the reliability and validity of quantitative measures for R&D capability, financial performance and innovation performance, as well as qualitative measures for absorptive capability, product development capability, process innovative capability, manufacturing capability, marketing capability and market performance constructs. To some extent, the combination of subjective and objective data could avoid some biases raised from relying solely on quantitative and qualitative constructs.

8.3 Managerial and Policy Implications

Firms are not independent entities operating in an unchanging environment. Managers have to make managerial decisions concerning investments in resources, and policy makers make decisions about government incentive regulations. The present study into innovation and
firm performance raises issues about such decisions. On the other hand, this study also offers a number of managerial and policy implications.

8.3.1 Managerial Implications

The significant impact of valuable capabilities and resources on firm performance has gained wide recognition among researchers. This study concludes that a firm’s internal innovation capabilities generally contribute to firm performance in Chinese industrial firms. The lesson for firm managers to note is that they should identify somewhat ways to construct their own innovation capabilities in order to achieve superior performance. For Chinese firms with limited resources, the effective development of innovation capabilities can help them gain competitive advantage at least in local markets.

The results of this study also suggest that firms should assess their own strengths and weaknesses, and appraise innovation capabilities when they seek to achieve different performance objectives, since different innovation capabilities have asserted a different influence on different types of firm performance. In other words, firm managers should consider which capabilities should be emphasized in order to achieve specific performance objectives, as well as examine which necessary capabilities are already in place and which remain to be built. For example, this study highlights the importance of R&D capability along three performance dimensions. Therefore, the patient, long-lasting and effective investments in R&D to create new knowledge and products and upgrade existing ones should be a strategic consideration. While absorptive capability, product development and process innovative capabilities are more likely to be associated with market and innovation performance in Chinese industrial firms. Understanding the nature and role of various types of innovation capability allows deeper insights into the specific impact associated with different performance objectives. These insights can serve to better organizational links between innovation capability building and firm performance. For example, firm managers should combine and coordinate the use of different innovation resources and encourage the co-operations between different departments within the firm by using cross-functional task forces.
Another lesson for managers is that the relationship between innovation capabilities and firm performance is influenced by several environmental and organizational factors. This implies that in order to achieve superior performance, firms should develop and accumulate internal firm innovation capabilities and simultaneously examine internal and external environments under which performance implications are more effective. If a firm pays most attention to developing internal capabilities or imitating competitive firms in its innovation capability development, but ignores the current or evolving environmental conditions under which the firm is operating, it is less likely to succeed in achieving superior performance.

8.3.2 Policy implications

The results of this study show that both input-oriented and output-oriented innovation capabilities are important determinants of superior performance in Chinese industrial firms. However, the study also reveals no single policy measure is likely to significantly promote increased firm performance. Government policy should be aimed at the whole range of measures that help the firm to bridge the gap between market competitive advantage and various intra-reactive innovation resources, rather than focus on the development of a specific resource such as technology development or technology transfer policy.

On the other hand, China has promulgated a large number of policies embodied in industry and finance policies since embarking on the transition from centrally planned to market-oriented economy. However, the results in this study indicate not all interactions of policy support and innovation capabilities are significantly effective for enhancing firm performance. For example, Chinese government has attempted to formulate technology introduction and improvement intensives to stimulate firms to improve their manufacturing capability. However, manufacturing capability based on the introduction of advanced technology and equipment discussed in this study is less likely to be effective on firm performance. Policy-makers should, in particular, consider the effectiveness of relevant policies and the practical implication of these policies in different regional and industrial environments.
8.4 Limitations and Future Research Directions

As with most studies, this study has some limitations. These should be taken into account before generating from the results. On the other hand, the limitations of this study also suggest several possible avenues for future research.

First of all, the research framework of this study is based on an assumption that innovation capabilities discussed in this study are idiosyncratic in a firm. It did not measure how these innovation capabilities emerge and become embedded as firm valuable and rare resources.

The RBV theory points out that a firm’s valuable, rare and imperfectly imitable/substitutable resources and capabilities generate superior performance and competitive advantage (Barney, 1991). Typically, it is difficult to identify idiosyncratic innovation capabilities and resources in Chinese firms, since Chinese firms are generally perceived as lacking innovation resources and weak in innovation capabilities, particularly during economic transition. With respect to the RBV, future research is needed to address the issue of how to adequately identify and measure the valuableness, rareness, imitability and substitutability of firm internal capabilities during economic transition.

Second, the present study represents a preliminary attempt to explore the performance contribution of innovation capabilities by using six dimensions of innovation capabilities. However, these dimensions are still incomplete in reflecting the full chain of events and processes in innovation. Future research should incorporate more aspects of innovation capabilities, and benefit from specifying core definition of innovation capabilities and generating more appropriate and broader range of measurements for each innovation capability dimension discussed in this study. Moreover, additional measures for each performance dimension discussed in this study might also be useful to establish the robustness of findings of the research and specify more fine-grained relationships between innovation capabilities and firm performance.

Third, this study did not examine the relationship between input-oriented and output-oriented innovation capabilities. Instead, the study focused on the level of importance of each
innovation capability dimension for different firm performance dimensions. A longitudinal study into the relationship between innovation capabilities and firm performance should be considered in order to further build on the study presented in this thesis. In other words, the specific links between different dimensions of innovation capabilities could be explored in future studies. Research on this issue could capture the interactiveness and complementarities of innovation capabilities. For example, since innovation outcomes may be a function of innovation input, additional research should explore how input-oriented innovation capabilities influence output-oriented innovation capabilities, which in turn affect firm performance.

Fourth, this study examined one interaction of innovation capabilities in terms of R&D-marketing interaction. However, innovation in a firm is conceptualized as various interactions among the firm's knowledge-based resources, capabilities and market opportunities (OECD, 1997). Additional research is needed to identify other effective interactions of innovation capabilities, and examine how these interactions maintain effective links to firm performance. For example, although the interaction between R&D and marketing is central importance in innovation (Kline and Rosenberg, 1986; OECD, 1997), R&D is also linked to other innovation stages such as detailed design and test and production, since R&D is also a form of problem solving to be called upon at any stages of innovation process (Kline and Rosenberg, 1986). Research on interactions among different innovation resources and capabilities will provide new insights into the combination of innovation resources within a firm. Future research also needs to examine whether firm performance is conditional upon these combinations of innovation resources. It helps us better understand how firms integrate innovation resources and link them to firm performance.

Fifth, the inclusion of environmental and organizational factors such as regional development, innovation policy support, industry type and ownership is still insufficient in capturing the full nature and nuances of complex environments in China, given the limitation of data source of this study. Future research could identify broader fine-grained environment factors related to innovation such as environmental munificence, uncertainty, market
Discussion and Conclusions

competition, institutional environment and technology change to investigate their moderating and interactive effects. These factors have been shown to influence firm performance (Chryssochoidis and Wong, 1998, Kotha and Nair, 1995). This may enhance our understanding of the influence of complex environments on both innovation capabilities and firm performance in China’s transitional economy.

Sixth, one limitation of this study emerges from the use of the technological innovation survey data. First, this survey focused on technological innovation activities rather than capabilities and resources. As Sakakibara (1997) argued, the subjective nature of data especially qualitative data leads to limitations of results. Using existing data may limit in the extent to which it could have more appropriate dimensions of innovation capabilities. Nevertheless, this study has made an important first step for better understanding the impact of innovation capabilities by identifying different dimensions of innovation capabilities related to different stages of innovation process and highlighting relationships between these capabilities and firm performance. The findings derived from the present study should be regarded as exploratory and should be replicated and developed further in future research. Moreover, in this study, the collection of innovation data was for 1993 to 1995 with performance data collected for 1995. With respect to effectiveness of innovation, it seems that the time frame for performance data may not have been long enough to have allowed some impacts to occur. Collection of performance data for a longer period would result in potentially a better insight into the impact of innovation on performance (Irwin, Hoffman and Lamont, 1998).

Finally, this study used data from firms in six provinces and cities of China. As a result, generalizability of the results to other region settings in China or other country settings needs further research based on other kinds of settings. Future research should replicate samples from other transitional economies in order to improve the validity of major findings based in China. Although, the influence of national environments may not be significant compared to other industrial environments (Luo, 2002), the replications of such research will provide better
understanding of the performance effects of firm internal innovation capabilities in transitional economies.

8.5 Conclusions

In summary, despite the importance of innovation to firm performance in strategic management, empirical research has devoted less attention to the conceptualization of innovation capabilities and the specific impact of innovation capabilities on firm performance, especially in transitional economies. This study takes an empirical step to develop more comprehensive dimensions of innovation capabilities and attempts to shed light on an important but un-addressed aspect. That is, the impact of innovation capabilities on firm performance in industrial firms in a transitional economy. Industrial firms in China proved the empirical base while the combination of the resource-based view of the firm and the chain-link model of innovation provides the theoretical building block for this study. The findings in this study indicate that it is a necessary and exploratory study to help better understand the complexity of innovation capabilities and their impacts on firm performance and competitive advantage in the context of a transitional economy. The results of this study also suggest how future research can apply more exact definitions and measures of innovation capabilities for such as longitudinal studies into the relationship between innovation capabilities and firm performance, the parameterization of capability value, and the interactive and distinctive impact of firm internal and external resources. The present study can therefore also serve as a reference point for further studies concerned with building on the resource-based theory as a building block for understanding the relationship between innovation capabilities and firm performance in a transitional economy.
References


References


References


References


References


Yan, Y. and Zhang, J. (2001). 'Contextual analysis on technological development between domestic and international companies in China: Ownership-based Learning', Working Paper, No. MKT01-3-0. Department of Marketing, City University of Hong Kong.


Appendix A

Questionnaire of The Technological Innovation Survey
Statistics Law of the People's Republic of China stipulates that state organs, public organizations, enterprises, institutions, and self-employed industrialists and businessmen that are under statistical investigation shall, in accordance with the provisions of this Law and State regulations, provide truthful statistical data. They may not make false entries or conceal statistical data, and they may not refuse to submit statistical reports or statistical data belatedly. Falsification of or tampering with statistical data shall be prohibited. Autonomous mass organizations at the grass-roots level and citizens shall have the duty to provide truthful information needed for State statistical investigations.

TECHNOLOGICAL INNOVATION SURVEY IN FIRMS

Purpose of Collection
The purpose of this survey is to collect data on innovation activities, innovation capabilities and impact of innovation at firm level. This survey will be used to improve firm’s innovation capabilities and China’s international competitiveness by facilitating the development of government policies to support future innovation activities in Chinese firms.

Confidentiality

Corporation Code: ________________________________

Name of Enterprise: _____________________________________________

Postal Address: ________________________________________________

Person we should contact if any queries arise regarding this form

<table>
<thead>
<tr>
<th>Name</th>
<th>Telephone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Facsimile Number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signature</th>
<th>Zip Code</th>
<th>Date</th>
</tr>
</thead>
</table>

State Science and Technology Commission of China
National Bureau of Statistics of China
March, 1996
## I. General Information about Your Firm

### I - 1 General Information about Your Firm

<table>
<thead>
<tr>
<th>Region code</th>
<th>Please refer to “The List of Regional Code”.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry classification</td>
<td>Please refer to “Standard Industry Classification (SIC)” (GB/T4154-94)</td>
</tr>
<tr>
<td>Industry:</td>
<td></td>
</tr>
</tbody>
</table>
| Administrative subordination | 1. under the control of central government 
2. under the jurisdiction of provinces or municipality directly 
3. under the central government 
4. under the region 
5. under the county administration 
6. under the neighborhood committee 
7. town factory 
8. village factory 
9. others |
| Year of establishment | |
| Firm Size | 1. megacorporation 
2. large firm 
3. medium-sized firm 
4. small firm |
| Ownership | 10 state-owned-enterprises 
20 collective-owned 
30 private 
50 joint owned 
60 share holding 
71 joint ventures 
72 joint cooperation 
73 international joint ventures 
81 joint ventures with HK, Macao and Taiwan 
82 joint cooperation firm with HK, Macao, and Taiwan 
83 HK, Macao and Taiwan firm 
90 others |
| Independence of Your Firm | Does your firm serve as a part of the industrial group? 
1 yes 
2 no 
If yes, it is: 
1 administrative department in the group 
2 key firm in the group 
3 member of the group 
9 others 
Please specify the name of group: |
| Establishment of Internal R&D institute or department | Did your firm establish any internal R&D institute? 
1 Yes 
2 No 
If yes, it is: 
1 involved in engineering and technical work during production 
2 involved in R&D activities, not in production or marketing activities 
3 involved in R&D activities, and participating in production or marketing activities. 
9 others |
<table>
<thead>
<tr>
<th>Capacity of production</th>
<th>Does your firm have the capacity of production?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Yes  2 No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Right of autonomous import and export</th>
<th>Does your firm have the right of autonomous import or export?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Yes  2 No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distribution and marketing networks</th>
<th>Does your firm orient to the development of:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 overseas distribution and marketing networks</td>
</tr>
<tr>
<td></td>
<td>2 distribution and marketing networks in China</td>
</tr>
<tr>
<td></td>
<td>3 regional distribution and marketing networks across provinces</td>
</tr>
<tr>
<td></td>
<td>4 distribution and marketing networks within your province</td>
</tr>
<tr>
<td></td>
<td>5 less distribution and marketing networks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Well-known brand name</th>
<th>Does your firm have well-known brand name?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Yes  2 No</td>
</tr>
<tr>
<td>If yes, please specify the name:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality standard</th>
<th>Are there any products in your firm which obtain:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 ISO9000 certification</td>
</tr>
<tr>
<td></td>
<td>2 GB/T19000 certification</td>
</tr>
<tr>
<td></td>
<td>3 other international certification</td>
</tr>
<tr>
<td></td>
<td>4 other national certification</td>
</tr>
<tr>
<td></td>
<td>5 certification within your industry</td>
</tr>
<tr>
<td></td>
<td>6 others</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main products life cycle</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. less than 6 months</td>
</tr>
<tr>
<td></td>
<td>2. 6 months or more, but less than one and a half year</td>
</tr>
<tr>
<td></td>
<td>3. one and a half year or more, but less than 3 years</td>
</tr>
<tr>
<td></td>
<td>4. 3 years or more, but less than 5 years</td>
</tr>
<tr>
<td></td>
<td>5. 5 years or more</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Certification of high and new technology firm</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Your firm has been entitled as a high and new technology firm by provincial or autonomous regional Science and Technology Committee</td>
</tr>
<tr>
<td></td>
<td>2. Your firm is not a high and new technology firm.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Entry into high and new technology development zones</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. entry into national high and new technology development zones</td>
</tr>
<tr>
<td></td>
<td>2. entry into local high and new technology development zones</td>
</tr>
<tr>
<td></td>
<td>9. no entry into high and new technology development zones</td>
</tr>
</tbody>
</table>
## I - 1 General Information about Your Firm (Continued)

<table>
<thead>
<tr>
<th>1. Number of employees in 1995</th>
<th>(person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual average number of employees</td>
<td></td>
</tr>
<tr>
<td>Number of employees at the end of 1995</td>
<td></td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
</tr>
<tr>
<td>With college and higher educational background</td>
<td></td>
</tr>
<tr>
<td>Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>Full-time sales personnel</td>
<td></td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
</tr>
<tr>
<td>With college and higher educational background</td>
<td></td>
</tr>
<tr>
<td>Number of employees involved in development of products or processes (in full-time equivalents)</td>
<td></td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
</tr>
<tr>
<td>With college and higher educational background</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Expenditures on employees’ professional training programs between 1993 and 1995</th>
<th>(in 1000 Yuan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Main economics indicators in 1995</td>
<td></td>
</tr>
<tr>
<td>Gross industrial output value (current price, new definition)</td>
<td></td>
</tr>
<tr>
<td>Industrial medium input</td>
<td></td>
</tr>
<tr>
<td>Total tax profits</td>
<td></td>
</tr>
<tr>
<td>Annual average balance of circulating funds</td>
<td></td>
</tr>
<tr>
<td>Average balance of net value of fixed assets</td>
<td></td>
</tr>
<tr>
<td>Total assets (year – end)</td>
<td></td>
</tr>
<tr>
<td>Total liabilities (year – end)</td>
<td></td>
</tr>
<tr>
<td>Total income of technology production and trade (only filled in by firms in high and new technology development zones)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Technological level of main equipment of industrial production (by year – end equipment value)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>At domestic backward level (Poor)</td>
<td></td>
</tr>
<tr>
<td>At domestic average level (Fair)</td>
<td></td>
</tr>
<tr>
<td>At domestic advanced level (Advance)</td>
<td></td>
</tr>
<tr>
<td>At international level (International)</td>
<td></td>
</tr>
</tbody>
</table>

## I - 2 High Technology Products and Processes

Please indicate three main high-tech products produced by your firm in 1995. (in 1000 Yuan)

<table>
<thead>
<tr>
<th>High-tech product</th>
<th>unit</th>
<th>Annual output</th>
<th>Total sales</th>
<th>Code number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: refer to the Appendix Two *Classification of High Technology Products* to fill in the product code number.

If your firm used high technology during the production of some products in 1995, Please indicate these products (choose three main products). (in 1000 Yuan)

<table>
<thead>
<tr>
<th>High-tech product</th>
<th>unit</th>
<th>Annual output</th>
<th>Total sales</th>
<th>Code number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The field of high technology includes:

- 01 biotechnology
- 02 life science
- 03 computers and telecommunication
- 04 opto-electronics
- 05 electronics
- 06 computer integrated manufacturing
- 07 new materials design
- 08 aerospace
- 09 weapons
- 10 nuclear technology.

## I - 3 Participation in technological innovative activities

1. Did your firm develop, introduce or produce any new or technologically improved products between 1993 and 1995?  
   1. Yes 2. No

2. Did your firm develop, introduce or produce any new or technologically improved processes between 1993 and 1995?  
   1. Yes 2. No
II. Technological Innovation

**Definitions**

Technological innovation activity covers a wide spectrum of technological and economic behaviors. Technological innovation activity includes any activity undertaken by your firm which aims to introduce or develop new or technologically improved product onto the market or which intends to implement a new or technologically improved process in production. For example, the technological innovation activities may include such as the creation of new ideas, research and development (R&D), engineering work, mass production, and commercialization, etc. Technological innovation mainly includes product innovation or process innovation.

**Product innovation** is any new or technologically improved product, which has been commercialized. In this survey, product innovation is divided into major product innovation and incremental product innovation.

**Major product innovation** is a product whose intended use, performance characteristics, attributes, design properties or use of materials and components differs significantly compared with previously manufactured products. Such innovations can be radically new technologies, or can be based on combining existing technologies in new uses.

**Incremental product innovation** is an existing product whose performance has been significantly enhanced or upgraded. Incremental product innovation can take two forms: a simple product and a complex product. Simple product may be improved (in terms of improved performance or lower cost) though use of higher performance components or materials, or a complex product which consists of a number of integrated technical subsystems, may be improved by partial changes to one of the subsystems.

**Process innovation** is any new or technologically improved process used for the production of products. It includes the adoption of new or significantly improved production methods. These methods may involve changes in equipment or production organization or both. The methods may be intended to produce new or improved products, which can be produced using conventional plants or production methods, or essentially to increase the production efficiency of existing products.

<table>
<thead>
<tr>
<th>II – 1 Number of Innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product innovations</strong> are those, which should be completed between 1993 and 1995 and still be sold in 1995. Process innovations are processes, which should be completed between 1993 and 1995 and still be used during in 1995.</td>
</tr>
<tr>
<td><strong>(Item)</strong></td>
</tr>
<tr>
<td><strong>Total number of products sold in 1995</strong></td>
</tr>
<tr>
<td>Of which:</td>
</tr>
<tr>
<td><strong>Product innovations completed between 1993 and 1995</strong></td>
</tr>
<tr>
<td>Of which:</td>
</tr>
<tr>
<td><strong>Major product innovations</strong></td>
</tr>
<tr>
<td><strong>Incremental product innovations</strong></td>
</tr>
<tr>
<td><strong>Process innovations between 1993 and 1995</strong></td>
</tr>
<tr>
<td><strong>Total Number of innovations</strong></td>
</tr>
</tbody>
</table>
II – 2 Type of Innovations

<table>
<thead>
<tr>
<th>Total number of innovations</th>
<th>(items)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The way of technological innovation</td>
<td></td>
</tr>
<tr>
<td>Independently pursued new technology development and produced by your firm</td>
<td></td>
</tr>
<tr>
<td>Developed new products or processes based on foreign technology and produced by your firm</td>
<td></td>
</tr>
<tr>
<td>Developed new products or processes based on domestic technology and produced by your firm</td>
<td></td>
</tr>
<tr>
<td>Produced directly by using foreign production facilities, not developed by your firm</td>
<td></td>
</tr>
<tr>
<td>Of which: purchased foreign facilities to produce directly</td>
<td></td>
</tr>
<tr>
<td>Produced directly by using domestic mature technologies</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>The way of cooperation in R&amp;D activities</td>
<td></td>
</tr>
<tr>
<td>Your firm was not involved in R&amp;D activities</td>
<td></td>
</tr>
<tr>
<td>Your firm was involved in R&amp;D activities</td>
<td></td>
</tr>
<tr>
<td>Of Which:</td>
<td></td>
</tr>
<tr>
<td>Undertook joint R&amp;D with universities/R&amp;D institutions</td>
<td></td>
</tr>
<tr>
<td>Contracted R&amp;D to other domestic universities/institutions</td>
<td></td>
</tr>
<tr>
<td>Employed part-time researchers</td>
<td></td>
</tr>
<tr>
<td>Contracted R&amp;D to foreign universities or institutions</td>
<td></td>
</tr>
<tr>
<td>Novelty</td>
<td></td>
</tr>
<tr>
<td>New to your firm</td>
<td></td>
</tr>
<tr>
<td>New to the industry within province</td>
<td></td>
</tr>
<tr>
<td>New to the industry in China</td>
<td></td>
</tr>
<tr>
<td>New to the industry in the world</td>
<td></td>
</tr>
</tbody>
</table>

II – 3 Government support on innovation activity

Your firm's innovations were:
- supported by government funds
- supported by government loans
- supported by tax incentives policy
- supported directly by other policies
- not supported by government

III. Acquisition and transfer of technology

<table>
<thead>
<tr>
<th>Type of technology</th>
<th>Acquisition of technology</th>
<th>Transfer of technology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Domestic</td>
<td>HK, Macao or Taiwan</td>
</tr>
<tr>
<td>Rights or license of inventions from other organizations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Results of R&amp;D contracted out</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology consultants service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology improvements together with other organizations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plans and drawings, technical specifications or software with a new technological (or process) content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key machinery and equipment with a technological (process) content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete sets of equipment with a new technological (process) content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training related technicians</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## IV. Costs of innovation

Please estimate the expenditures on innovation-related activities in 1995. (in 1000 Yuan)

<table>
<thead>
<tr>
<th>Total expenditure on innovation activity</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By type of expenditure</strong></td>
<td></td>
</tr>
<tr>
<td>R&amp;D expenditures</td>
<td></td>
</tr>
<tr>
<td>Of which: cooperated with external R&amp;D institutes</td>
<td></td>
</tr>
<tr>
<td>Acquisition of technology developed by others (e.g. patents, licenses, trademarks, know-how, etc.)</td>
<td></td>
</tr>
<tr>
<td>Expenditures on purchasing machinery and equipment related to new products (processes)</td>
<td></td>
</tr>
<tr>
<td>Expenditures on industrial engineering and trial production related to new products (processes)</td>
<td></td>
</tr>
<tr>
<td>Training programs related to new products (processes)</td>
<td></td>
</tr>
<tr>
<td>costs of new products sales</td>
<td></td>
</tr>
<tr>
<td><em>Include:</em></td>
<td></td>
</tr>
<tr>
<td>Expenditure associated with the launch of a new or changed product, e.g. preliminary market research, market tests and launch advertising</td>
<td></td>
</tr>
<tr>
<td><em>Exclude:</em></td>
<td></td>
</tr>
<tr>
<td>Expenditure for the building of distribution networks</td>
<td></td>
</tr>
<tr>
<td><strong>By sources of funds</strong></td>
<td></td>
</tr>
<tr>
<td>Government funds</td>
<td></td>
</tr>
<tr>
<td>Loans</td>
<td></td>
</tr>
<tr>
<td>Of which: Special S&amp;T loans (include loans for technology improvement, introduction and development, etc.)</td>
<td></td>
</tr>
<tr>
<td>Funds raised by your firm</td>
<td></td>
</tr>
<tr>
<td>Of which: Stocks and bonds</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Of which: Foreign funds</td>
<td></td>
</tr>
</tbody>
</table>

## V. Impact of innovation activities

Please indicate the impact of innovation activities by related indicators in 1995.

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sales of products</td>
<td>in 1000 yuan</td>
</tr>
<tr>
<td>Of which: new products sales</td>
<td>in 1000 yuan</td>
</tr>
<tr>
<td>Of which: new to your firm</td>
<td>%</td>
</tr>
<tr>
<td>new to the industry within province</td>
<td>%</td>
</tr>
<tr>
<td>new to the industry in China</td>
<td>%</td>
</tr>
<tr>
<td>new to the industry in the world</td>
<td>%</td>
</tr>
<tr>
<td>Total profits</td>
<td>in 1000 yuan</td>
</tr>
<tr>
<td>Of which: new products profits</td>
<td>in 1000 yuan</td>
</tr>
<tr>
<td>Total export sales of products</td>
<td>in US$1,000</td>
</tr>
<tr>
<td>Of which: new products export sales</td>
<td>in US$1,000</td>
</tr>
<tr>
<td>Income of technology transfer</td>
<td>in 1000 yuan</td>
</tr>
<tr>
<td>Number of patents purchased by your firm between 1993 and 1995</td>
<td>item</td>
</tr>
<tr>
<td>Of which: invention patents</td>
<td>item</td>
</tr>
<tr>
<td>Number of patents applied by your firm between 1993-1995</td>
<td>item</td>
</tr>
<tr>
<td>Of which: invention patents</td>
<td>item</td>
</tr>
</tbody>
</table>

268
VI. Factors of stopping or suspending innovation (case study)

Stopping innovation refers to failure or suspension at a stage of innovation activity. If your firm has a case about stopping product or process innovation, please indicate it.

The following questions relate only to the suspended innovation and not the overall innovative activities of your firm.

Title of the aborted innovation: ________________________________

Factors suspending the innovation (please choose three main items and rank them according to the importance):

1. technology potential insufficient
2. lack of skilled personnel
3. no need to innovate due to new or better technology (or products)
4. lack of appropriate sources of finance during the industrial engineering
5. lack of appropriate new technology for the current firm's production ability
6. lack of distribution channels or services
7. lack of marketing analysis or information on markets
8. competition with copied or exported products
9. legislation, regulations, standards, etc
10. others

At which stage did this innovation aborted?
1. R&D
2. industrial engineering and trial production
3. production
4. marketing

VII. Case study of a significant innovation

This section is concerned with one of your firm's most significant or radical innovation that was commercialized during the period 1 January 1993 to 12 December 1995. If you could not identify your significant or radical innovation, please select one innovation which with the best economic benefits.

The following questions relate only to this significant innovation and not the overall innovative activities of your firm.

Name of this innovation: ________________________________

1. Type of the innovation
   (1) product innovation
   (2) process innovation

2. Type of novelty of this innovation
   (1) new to your firm
   (2) new to the industry in the province
   (3) new to the industry in China
   (4) new to the industry in the world

3. Compared with old products or processes in your firm, what were the mainly technological or functional improvements of this innovation? (Please specify within 120 words)
4. The field of the dominant technology embodied in this innovation
For a product innovation, if the product is entitled as a high-tech product, please indicate its code according to appendix two List of High Technology Product, if not, please fill in the blank with "999999".

For a process innovation, please indicate the field of technology embodied in this process.
Field of high technology includes:
01 biotechnology 02 life science 03 computers and telecommunication
04 opto-electronics 05 electronics 06 computer integrated manufacturing
07 new materials design 08 aerospace 09 weapons 10 nuclear technology

5. Start-stop time of this innovation
How long has it taken for this innovation form beginning to commercialization phase?
Beginning: ________ (month) ________ (year)
Distribution: ________ (month) ________ (year)

At which stage did the innovation activity begin to be carried out?
(1) R&D activity
(2) industrial engineering and trial production
(3) production

6. Total costs of this innovation
The total cost of this innovation includes expenditure on R&D, acquisition of patent, license, technology or information, and processes, tooling-up, industrial engineering, manufacturing start-up and marketing of new product.
(1) Less than 10 million yuan
(2) 10 to 20 million yuan
(3) 20 to 30 million yuan
(4) 30 to 40 million yuan
(5) 40 to 50 million yuan
(6) 50 to 100 million yuan
(7) 100 to 500 million yuan
(8) 500 to 1000 million yuan
(9) Greater than 1000 million yuan

If the cost is greater than RMB100 million, please specify: ______________________

7. Pay back period of this innovation
How long the "pay back" period was expected?
(1) Less than 6 months
(2) 6 months or more, but less than 1 year
(3) 1 year or more, but less than 2 years
(4) 2 years or more, but less than 5 years
(5) 5 years or more
(6) not able to estimate

8. The impact of this innovation on your firm (please choose at most three items and range them by importance)
This innovation activity:
(1) developed radically new products
(2) replaced products being phased out
(3) increased or maintained market share
(4) opened up new markets
(5) reduced production cost
(6) reduced environmental damage
(7) improved product quality
(9) other
9. Government's support on this innovation

Was this innovation in government S&T programs?  (1) Yes  (2) No

If yes, please indicate:
11 National Torch Program
12 National Spark Program
13 National Extension Programs of Key S&T Achievements
14 National Industrial Experiment Program
15 National Programs of Key Projects
16 National High Technology R&D Program ("863" Program)
17 National Technological Development Program
18 Other National Programs
21 Local Torch Program
22 Local Spark Program
23 Local Programs of Key Projects
24 Other Local Programs

This innovation was supported by government funds with ___________ (in 1000 yuan)
This innovation was supported by government loans with ___________ (in 1000 yuan)

Did this innovation obtain other direct government support?  (1) Yes  (2) No

If yes, please specify: ________________________________________________________________

10. Main economics indicators of this innovation (which is a product innovation) (in 1000 yuan)

<table>
<thead>
<tr>
<th></th>
<th>1993 - 1995</th>
<th>1995</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross industrial output value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(current price, new definition)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total tax profits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax payable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of preferential tax</td>
<td></td>
<td></td>
</tr>
<tr>
<td>treatment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you very much for your time! Please continue the qualitative part questions!
Technological Innovation Survey (Qualitative Part)

1. When did you know the concept of technological innovation? (please choose one item)
   1) through this survey
   2) after 1995
   3) 1990 to 1994
   4) 1980s

2. Which statement on technological innovation activity is correct?
   The technological innovation activity is to:
   1) develop or introduce new products or processes
   2) improve functions, designs or structures of products, etc.
   3) change decoration
   4) develop or introduce new products or processes and placing them into market

3. Did your firm develop or introduce any substantially and technologically changed products (processes) during the period 1993 to 1995?
   1) Yes 2) No (If no, go to question 6)

4. How do you assess innovation capabilities of your firm compared with other competitors?
   1) Very poor
   2) poor
   3) strong
   4) excellent

5. How does your firm obtain ideas and information for developing or introducing new products (processes)? (Please choose 3 items at most and rank them according to the importance)
   1) from internal R&D department
   2) from other departments within your firm
   3) from other firms of the group
   4) customers
   5) government programs or information
   6) patent disclosures
   7) professional journals, fairs/exhibitions
   8) universities/academic institutions
   9) technological markets or consultant agencies
   10) products from other firms within your industry
   11) others (please specify)

6. Please indicate which of the following factors were important barriers to the innovation activities in your firm? (Please choose 3 items at most and rank them according to the importance)
   1) lack of information on technology or market
   2) lack of skilled personnel
   3) lack of technology accumulation
   4) excessive perceived risk
   5) innovation costs too high
   6) lack of sources of finance
   7) lack of distribution channels or networks of marketing
   8) more competitors or exported products
   9) legislation, regulations, standards, taxation
   10) uncertainty in ownership of patent right or technology
   11) decision-makers' mistake
   12) lack of opportunities for cooperating with other firms or institutions
   13) others (please specify)
7. Please indicate which of the following financial factors prevented your firm from innovation activities? (Please choose 3 items at most and rank them according to the importance)

1) not setting up special R&D funds in your firm
2) costs of raising funds too high
3) lack of information of financial resources
4) no right for applying loans
5) lack of government funds
6) debts too high to applying loans
7) lack of investors because of the uncertainty in new products (processes) market potential
8) others (please specify)

8. At what stage in innovation activity was most difficult to obtain financial support?

1) R&D
2) Industrial engineering or trail production
3) Mass production
4) Marketing

9. According to the current situation of your firm, what strategy will you take during the period of ninth-year programs? (please choose one most important item)

1) maintain the status of innovative leader in your products field
2) follow up advanced firms, maintain technology advantage and try to develop more advanced products (technology)
3) imitate activities of advanced firms or imitate new products and processes (technology)
4) maintain current technology level, production and operation
5) innovate on the basis of introducing and absorbing technology
6) others (please specify)

10. How strong or important are your firm's capabilities and resources related to undertaking technological innovation activities? (Please tick one box in each row)

1=not at all  2=less strong  3=strong  4=very strong  5=crucial

<table>
<thead>
<tr>
<th>Capability and Resource</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal product and technology development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancement of technology acquisition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancement of technology improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancement of transfer and absorption of foreign technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External co-operative product and technology development with universities/institutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development and access to new knowledge and resources of new products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managerial restructuring of production based on the introduction of foreign advanced technology and equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adoption of advanced production advanced technology and equipment introduced from foreign organizations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhancement of workers' skills through implementing staff training programs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of materials consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of energy consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement of work conditions and environments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of product costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
11. Please indicate how has your firm performed with respect to the following objectives during the period of 1993-1995. (Please tick one box in each row)

1 very poor  2 poor  3 good  4 very good  5 excellent

<table>
<thead>
<tr>
<th>Objective</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed new radical products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduced products which are appropriate for your firm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replaced products being phased out</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintained desired market share</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased market share and sales growth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entered/opened up new domestic or overseas markets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved product quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved current technology in order to replace imported foreign equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. Did your firm have any cooperation with universities or R&D institutions during the period of 1993 to 1995?

1) no cooperation
2) Introduced S&T results from universities or R&D institutions
3) Jointly developed S&T projects
4) Contracted R&D to universities/R&D institutions
5) Jointly established new R&D institutions with universities or institutions
6) Invited S&T personnel from universities/R&D institutions
7) cooperated with universities or institutions to undertake government projects
8) others (please specify)

13. Which of the following factors prevented your firm from acquisition of S&T results from universities or R&D institutions?

(Please choose 3 items at most and rank them according to the importance)

1) lack of information on S&T results made by universities or R&D institutions
2) unreasonable fees on technology transfer
3) technology being not mature
4) S&T results being too difficult to be commercialized
5) Insufficient intermediary services
6) Unclear ownership of S&T results
7) No advantages in comparison with similar foreign technology
8) Uncertainty in market prospects
9) Others (please specify)
14. Please indicate which of the following policies were important incentives to stimulate your firm's innovation activities?

1 Not applicable  2 Not important  3 important  4 very Important  5 Crucial

<table>
<thead>
<tr>
<th>Policy</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialized technology development loans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inclusion of technology development expenditures into costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pricing policy: prices determined by firms themselves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specialized human resources policy: S&amp;T personnel rewarding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial incentives for technology development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax incentives policy (reduction or remission of taxes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial policy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology policy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection of intellectual property rights</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tariff protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. In your opinions, what should government do to stimulate firms' innovation activities? (Please choose 3 items at most and rank them according to the importance)

1) Support technological innovation activities with funds
2) Improve access to technology and market information
3) List industrial technological innovation projects into government programs
4) Support cooperation between firms and universities/R&D institutions
5) Provide opportunities for cooperating with foreign partners
6) Grant license to export and import
7) Reduce administrative interference
8) Other (please specify)

Please provide your comments
1) on any of the information you have supplied on the form
2) on any questions or items which caused problems
3) on any suggestions to improve the form

Thank you very much for completing this form!
# Appendix B

OECD's Classifications of Manufacturing Industries (ISIC Revision 2)

<table>
<thead>
<tr>
<th>High-technology</th>
<th>CITI Revision 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aerospace</td>
<td>3845</td>
</tr>
<tr>
<td>2. Computers, office machinery</td>
<td>3825</td>
</tr>
<tr>
<td>3. Electronics-communications</td>
<td>3832</td>
</tr>
<tr>
<td>4. Pharmaceuticals</td>
<td>3522</td>
</tr>
</tbody>
</table>

### Medium-high-technology

| 5. Scientific instruments              | 385             |
| 6. Motor vehicles                      | 3843            |
| 7. Electrical machinery                | 383-3832        |
| 8. Chemicals                           | 351+352+3522    |
| 9. Other transport equipment           | 3842+3844+3849  |
| 10. Non-electrical machinery           | 382-3825        |

### Medium-low-technology

| 11. Rubber and plastic products        | 355+356         |
| 12. Shipbuilding                       | 3841            |
| 13. Other manufacturing                | 39              |
| 14. Non-ferrous metals                 | 372             |
| 15. Non-metallic mineral products      | 36              |
| 16. Fabricated metal products          | 381             |
| 17. Petroleum refining                 | 351+354         |
| 18. Ferrous metals                     | 371             |

### Low-technology

| 19. Paper printing                     | 34              |
| 20. Textile and clothing               | 32              |
| 21. Food, beverages, and tabacco       | 31              |
| 22. Wood and furniture                 | 33              |