**MOTIVE, FORM AND FUNCTION OF INTERNATIONAL R&D ALLIANCES
IN THE INFORMATION TECHNOLOGY INDUSTRY IN CHINA**

by
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in partial fulfillment of the requirements for the degree of
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MOTIVE, FORM AND FUNCTION OF INTERNATIONAL R&D ALLIANCES IN THE INFORMATION TECHNOLOGY INDUSTRY IN CHINA

ABSTRACT

Multinational corporations have been actively forming R&D alliances with Chinese organizations for the last decade. The objective of this thesis is to explore the connections between the forms of these alliances, their function (i.e., the R&D activities undertaken) and the declared motives of the participants. Particular attention is paid to the significant changes in Chinese public policy with respect to international R&D alliances during the study period. A sample of 80 international R&D alliances between multinational corporations and Chinese organizations (both public and private) in the information technology (including telecommunications) industry in China formed during the period from 1997 to 2003 is used in the research. Hypotheses derived from theories of resource dependency, transaction costs, and strategic choice, are tested and the results show that the motives of multinational corporations are significantly associated with the choice of forms and R&D activities.

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TABLE OF CONTENTS

Abstract	iii
Acknowledgements.....	iv
Table of Contents.....	v
List of Tables	vii
List of Figures	viii
List of Appendices	ix
1 Introduction.....	1
2 The Growth Trend of Foreign R&D in China and Government Policy	6
3 Literature Review.....	11
3.1 Definition of international R&D alliances.....	11
3.2 Theoretical perspectives on the rationale of strategic alliances.....	12
3.2.1 Transaction cost economics (TCE).....	12
3.2.2 Resource dependency.....	13
3.2.3 Strategic choice	14
4 Hypothesis Development.....	17
4.1 Motives of R&D alliances	17
4.2 Forms of R&D alliances	24
4.3 Functions of R&D alliances.....	26
4.4 Hypotheses development	27
4.4.1 Relationships between motive and form.....	27
4.4.2 Relationships between motive and function	32
4.4.3 Relationships between form and function.....	33
5 Research Strategy and Method Used	36
5.1 Data collection	36
5.2 Variables and measurements.....	40
5.3 Data analysis and results.....	47
5.3.1 General growth patterns of the R&D alliances in China	48
5.3.2 Hypotheses testing	49
5.3.2.1 Method of data analysis	49
5.3.2.2 Descriptive statistics of motive, form and function	50
5.3.2.3 Chi-Square tests for Hypothesis 1.....	51

5.3.2.4	Chi-square tests for Hypothesis 2	55
5.3.2.5	Chi-square tests for Hypothesis 3	58
5.3.2.6	Testing with control variable	60
5.3.3	Summary of results	60
6	Discussion and Conclusions	63
6.1	Key findings.....	63
6.1.1	Motives for R&D alliances	63
6.1.2	Preference on form and the relationships between form and motive... 64	
6.1.3	The relationships between function and motive	66
6.1.4	The relationships between form and function.....	66
6.2	Conclusions.....	67
6.3	Contributions.....	68
6.4	Limitations and future research	70
	References.....	72

LIST OF TABLES

Table 1 Key Words for the Categorization of Motive, Form and Function	44
Table 2 Coding Scheme	45
Table 3 Example of Coding	46
Table 4 Descriptive Statistics for Motive, Form and Function.....	50
Table 5 First Chi-square Test for H1	52
Table 6 Second Chi-square Test for H1	54
Table 7 First Chi-square Test for H2	55
Table 8 Second Chi-square Test for H2.....	57
Table 9 Chi-square Test for H3	59
Table 10 Crosstab for Origin of MNC and Form	60

LIST OF FIGURES

Figure 1 Summary of Hypotheses.....	35
Figure 2 Procedures of Data Collection.....	39
Figure 3 The Growth of International R&D Alliances in China	48

LIST OF APPENDICES

Appendix: Database for International R&D Alliances in Information Technology Industry in China	79
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MOTIVE, FORM AND FUNCTION OF INTERNATIONAL R&D ALLIANCES IN THE INFORMATION TECHNOLOGY INDUSTRY IN CHINA

1 INTRODUCTION

China is the largest emerging economy in the world; it has maintained a rapid rate of economic growth since its *Open Door* policy was implemented in the 1980s. China's huge domestic market and low cost/highly skilled labor force attracted a soaring inflow of foreign direct investment (FDI) in the past decade. For much of the decade of the 1990s China was the world's second largest recipient of foreign direct investment, following only the United States. By 2002 it ranked first with over \$50 billion inflow foreign investment (UNCTAD, 2003)¹. China has become a major manufacturing center and market for multinational corporations (MNC) accounting for 12.7% of the world GDP, second only to the US (IMF, 2003)². In recent years, consistent with a national long-term development policy for science and technology, China has been making efforts to attract foreign investment in R&D with the aim of enhancing the technology capabilities of Chinese firms. China has made significant efforts to increase protection for intellectual property and it is offering other incentives including tax exemption for foreign R&D. Many MNCs have set up R&D centers in China and have formed substantial R&D alliances with Chinese companies, universities, and government

¹ UNCTAD Handbook of Statistics 2003, http://www.unctad.org/en/docs/tdstat28_enfr.pdf

² IMF, World Economic Outlook, September 2003 – Statistical Appendix, <http://www.imf.org/external/pubs/ft/weo/2003/02/pdf/appendix.pdf>

agencies in various forms, including: cooperation in research projects, joint product development, R&D joint ventures, and R&D consortia (Li and Zhong, 2003). R&D strategic alliances have enabled multinational corporations to leverage resources and capabilities from local partners and adapt products to the local market, respond to the market quickly, and to take advantage of scientific inputs for their global R&D strategy.

Strategic alliances have become one of the most important organizational forms to emerge in the past decade, providing a critical source of competitive advantage because of their value creation potential (Das and Teng, 2000). R&D alliances have been widely used to create a competitive position for high-tech companies (Ball, 1999). However, evidence from past research shows that many strategic alliances fail and the failure rates are even higher for alliances between firms with home bases in different countries (Hitt, Dacin, Levitas, Arregle, and Borza, 2000). Therefore, the decision to form an international alliance is a critical one, especially in an emerging market like China which has a very specific business environment. China is still in the course of transition from a state/centrally planned economy to a market economy, and its governments (national and local) still exert great influence on business activities. It is very important for multinational companies wishing to carry out R&D in China to have a good understanding of the growth of R&D activities in China and the government policy towards foreign invested R&D. When entering into an R&D alliance with local partners, MNCs also need to have a clear understanding of their strategic motives, and choose forms and R&D activities that support their strategic motives. My thesis explores the following research questions:

- How is the growth of foreign R&D in China related to the government policies towards foreign invested R&D?
- What are the strategic motives of MNCs to form R&D alliances in China?
- What are the connections between MNC's strategic motives and the choices of forms and R&D activities of their R&D alliances in China?

To study the proposed research questions, it is necessary to study international R&D alliances in technology-intensive industries. This thesis draws samples from the information technology (IT) industry (including telecommunications), an emerging industrial sector in China that has been involved in a large amount of international R&D collaborations in the past decade. Because of the absence of any comprehensive government or industry-collected data, the chosen means of identifying international R&D alliances in China was to review press releases, corporate websites, and similar public sources. My sample includes 80 international R&D alliances between MNCs from North America, Europe, Japan and South Korea and Chinese organizations. The empirical testing was conducted by collecting data from the above mentioned public sources, mainly press releases issued by foreign partners of the sample alliances.

The results of my research reveal that major strategic motives of MNCs to form R&D alliances with Chinese partners include:

- gaining local market access and market share;
- seeking local government relationships;

- obtaining human resources;
- creating vertical linkages;
- transferring complementary technology; and
- achieving economies of scale.

Establishing vertical linkage and obtaining human resources were the two most frequent motives in the research sample.

A firm's strategic motives affect its choices of the form and function of the R&D alliances.

- Alliances formed by MNCs to seek market access and market share or government relationship are more likely to be in the form of equity based joint venture than alliances formed to seek human resources, vertical linkage, complementary technology, or economies of scale.
- Alliances formed by MNCs to seek human resources are more likely to undertake research-oriented R&D activities than alliances formed for market access and market share or government relationship, vertical linkage, complementary technology, or economies of scale.
- Equity-based joint ventures are more likely involved with development-oriented R&D activities than non-equity based cooperative agreements.

The rest of the thesis is organized as follows:

- Section 2 is an investigation on the growth of foreign R&D activities in China related to government policies towards foreign R&D;

- Section 3 is a literature review concerning the formation of strategic alliances;
- In Section 4, I examine the motives of the international R&D alliance formation from the perspective of foreign partners and the connection among motive, form and function of R&D alliances and propose the hypotheses to be tested.
- Section 5 explains the research strategy, method used, and the results.
- Section 6 closes with a review of the main conclusions and contributions to knowledge and managerial practice.

2 THE GROWTH TREND OF FOREIGN R&D IN CHINA AND GOVERNMENT POLICY

Science and technology development has long been a priority in Chinese policy planning. The Chinese government plays an active role in attracting R&D-related foreign direct investment because R&D investments can have positive spillover effects to other parts of the national economy and to Chinese society at large.

Technology transfer, as an early form for foreign R&D investment, started in the mid-1980s. China implemented a policy of '*Technology Transfer from Opening Domestic Markets*' (TTODM) to attract foreign direct investments and obtain spillover effects for the domestic economy in the mid-1980s (Zhao and Sun, 2003). This TTODM strategy has successfully attracted huge foreign investment. MNCs, especially those of the Fortune 500, have been an important source of foreign R&D investment in China. The Chinese government believes that MNCs can promote technology transfer. By the mid-1990s R&D investment was required by official or unofficial policies regarding the establishment of Sino-foreign joint ventures. However, as many of these early joint venture-based R&D programs were products of government pressure, they rarely involved much advanced research and development work (Walsh, 2003). Rather, technology collaborations in this period commonly comprised simple equipment or fund donations for training or education in China, often in connection with universities and research centers. Particularly, in the information technology industry, many multinational

corporations, like HP, Motorola, Microsoft, IBM, etc. established a number of joint ‘labs’ at leading Chinese universities (e.g., Tsinghua, Peking, and Fudan Universities).

Foreign invested R&D began to grow and expand in China in the mid-1990s. Encouraged by the Chinese policy of ‘*Going West*’, many foreign investors moved into the less developed inland provinces in China and established R&D centers and manufacturing bases there, partly to take advantage of the preferential policies. In addition, the expectation of China’s near-term accession to the WTO and the growing competition among foreign investors, also contributed to the rapid growth of foreign invested R&D centers (mostly joint ventures) in China during this period (Walsh, 2003).

During this period, in the telecom and information technology sector, China started to implement so called ‘*Golden Projects*’, to establish national fiber-optic communications networks.³ This program includes three key projects: the Golden Bridge Project (The State Public Economic Information Network Project), the Golden Cards Project (an electronic currency project to realize computerized finances), and the Golden Customs Project (an information network project specially designed for foreign trade). This extremely ambitious series of projects, which have been compared to the 19th Century American railroad system development program, provided enormous business opportunities to both domestic and foreign companies. Multinational corporations rushed to partner with Chinese firms for market access, especially the opportunities these projects offered.

³ The Three ‘Golden’ Projects, <http://www.chinagate.com.cn/english/147.htm>

China imposes severe restrictions to foreign investment in the telecommunications sector. Foreign investors are not permitted to establish wholly-owned enterprises (WFOE) in the telecom sector. Despite this restriction, US computer and telecommunications companies such as Motorola, IBM, Cisco, Sun Microsystems, and Hughes assisted China's Ministry of Posts and Telecommunications (now the Ministry of Information Industry) in establishing the various '*Golden Projects*' networks (Defense Market Research Report, 1999). Foreign companies also participated in various projects for communication terminals and other related equipment. Lucent established several alliances with Chinese telecom equipment suppliers, e.g. Eastcom, Konka, and AmoiSonic, to develop and produce a new generation wireless handhelds. Fujitsu and Changzhou Guoguang General Electronic were involved in the joint development of financial point-of-sale terminals for the '*Golden Card*' project. The '*Golden Projects*' have led to a boom of technology transfer and R&D collaboration in the telecom and IT industry. R&D activities undertaken in these alliances often involved product localization, customization, and system integration for the Chinese market.

Since the late 1990's, in part due to WTO-related reforms, foreign companies are no longer required to have Chinese partners to invest in most high-tech industries. The MOFTEC (Ministry of Foreign Trade and Economic Cooperation) issued relevant regulation on foreign invested R&D centers in 2000, *Circular Concerning Issues Related to Foreign Investment in the Establishment of Research and Development Centers* (MOFTEC, 2000). The provincial governments now have the authority to approve the

application to establish R&D center in the form of Equity Joint Venture (EJV), Cooperative Joint Venture (CJV), or Wholly Foreign Owned Enterprise (WFOE), which has enabled the application process to be much faster and more convenient. Major city governments, specifically, Beijing and Shanghai, issued special measures on R&D center investment in June 1999 (revised in August 2002) and July 2000, respectively. These municipal policies offer many preferential features to encourage establishment of international R&D alliances and foreign-owned R&D centers. For example, foreign R&D centers can import certain equipment duty free. As a result, the world's leading companies, particularly high-tech multinationals, are establishing growing numbers of R&D centers, programs, and labs in China.

Since the change of policy requirement for Chinese partners, many foreign investors have set up wholly foreign owned and managed R&D facilities. According to a recent report on foreign high tech R&D in China, more than 200 foreign invested R&D centers, programs, or laboratories in the computer and telecommunications sectors were established during the period from 1990 to 2002 (Walsh, 2003). Although many of the foreign invested R&D centers are wholly foreign-owned subsidiaries, many of these R&D centers are still part of joint ventures between MNCs and Chinese partners.

Since the late 1990s, Chinese companies in the IT and Telecom sectors have made rapid progress in advanced technology development. Chinese companies, such as Huawei, Datang, and Legend, have been involved in active R&D partnerships with multinational corporations. The R&D cooperation began to involve more sophisticated development

and research work. Datang, for example, has been cooperating with Siemens IC Mobile on developing technologies for third generation mobile radio since 1998. Their cooperation achieved great success, when the jointly developed TD-SCDMA (Time Division – Synchronous Code Division Multiple Access) radio transmission system was adopted by the International Telecommunication Union (ITU) for the IMT-2000 family of 3G standards in 2000, and was also adopted by the Third Generation Partnership Project (3GPP) – an initiative of large international telecommunications standardizing bodies as a global 3G/UMTS standard in 2001. In order to promote the standard, China has allocated 155MHz of valuable radio frequency spectrum for TD-SCDMA. Seeking the potential of huge business opportunities, foreign companies are establishing many cooperative R&D projects with Chinese partners on the commercialization of this technology. UK-based Thales Instruments Ltd signed an agreement with Datang to jointly develop test equipment of TD-SCDMA system for the third generation (3G) mobile network shortly after the adaptation of TD-SCDMA by 3GPP in 2001. In October 2003, Nortel Networks and Datang opened a laboratory in Beijing in a move to explore the commercialization of the TD-SCDMA technology in China.

Despite the rapid growth trend of foreign invested R&D programs in China, they have received only limited scholarly attention to date (Walsh, 2003). The objective of this study is to explore the strategic motives of MNCs to form R&D alliances in China and the connections between MNC's motives and the choices of forms and R&D activities of their alliances.

3 LITERATURE REVIEW

3.1 Definition of international R&D alliances

Previous research has proposed many definitions of strategic alliances. The differences between the definitions are more on the scope of the definition than the general concept. A broad definition of strategic alliances is given by Yoshino and Rangan (1995) that emphasizes three characteristics of alliances:

- 1) Two or more firms unite to pursue a set of agreed upon goals while remaining independent subsequent to the formation of the alliance.
- 2) The partner share the benefits of the alliance and control over the performance of assigned tasks, perhaps the most distinctive characteristic of alliances and the one that makes them so difficult to manage.
- 3) The partner firms contribute on a continuing basis in one or more key strategic areas, for example, technology and products.

In accordance with this broad definition, strategic alliances constitute a subset of various collaborative activities, e.g. R&D, marketing, manufacturing, etc. This study focuses on one subset of strategic alliances: R&D alliances, which are also called research partnership or strategic technology partnering by some researchers (Hagedoorn, Link, and Vonortas, 2000; Hagedoorn and Narula, 1996). Hagedoorn, et al (2000) defines a research partnership as an innovation-based relationship that involves, at least partly, a

significant effort in research and development. For the purpose of this study, international R&D alliances are defined as a collaborative relationship between firms with home bases in different countries that involve, at least partly, a significant effort in research and development.

3.2 Theoretical perspectives on the rationale of strategic alliances

There are several different schools of thought and methodological approaches developed in prior research on strategic alliances (Barringer and Harrison, 2000; Hagedoorn, et al, 2000; Kogut, 1988). These include: transaction cost economics (Williamson, 1985 and 1991; Hennart, 1988), social networks (Gulati, 1995; Ahuja, 2000), resource dependency (Pfeffer and Salancik, 1978), strategic choice (Porter, 1980 and 1986), and organizational learning (Khanna, Gulati, and Nohria, 1998; Mowery, Oxley, and Silverman, 1996). Each of these theoretical regimes offers a unique perspective on the formation of alliances.

This study reviews three widely used theoretical paradigms that explain alliance formation, including transaction cost economics, resource dependence theory, and strategic choice theory.

3.2.1 Transaction cost economics (TCE)

TCE focuses on how an organization chooses governance structure in terms of the characteristics of transactions so as to minimize its production and transaction costs.

Governance structure choices range from discrete market exchange at the one extreme, to

centralized, hierarchical organization at the other, with hybrid or intermediate modes in between (Williamson, 1985). TCE proposes the match of governance structures with transactions in terms of asset specificity, frequency, and uncertainty. With the increase in asset specificity, recurrence frequency, and uncertainty involved in a transaction, internal organization will be more likely to take place of market arrangement.

From a TCE perspective, R&D alliances are one type of inter-firm relationships found in between standard market transactions of unrelated companies and integration by means of mergers and acquisitions (Hagedoorn, 2002). Alliances are preferred when transaction costs associated with a specific exchange are too high for an arm's-length market exchange but not high enough to justify vertical integration (Hennart, 1988).

3.2.2 Resource dependency

Resource dependence theory is rooted in an open system framework, which argues that organizations must engage in exchanges with their environment to obtain resources (Scott, 2002). Resource dependence theory examines the formation of strategic alliances as a result of underlying resource dependence (Pfeffer and Nowak, 1976). From the resource dependence perspective, 'no organization is completely self-contained' (Pfeffer and Salancik, 1978). An organization must transact with others to acquire resources to survive. Interdependence thus exists between the organization and others who control resources it needs. Firms seek resources that they lack and that are essential to achieving competitive advantage. Strategic interdependence between organizations describes a situation in

which one organization has resources or capabilities beneficial to but not possessed by the other (Gulati, 1995).

Resource dependence theory suggests that one common reason for the formation of strategic alliances is to take advantage of complementary assets (Barringer and Harrison, 2000; Chung, Singh and Lee, 2000). The benefits of joint R&D are based on the pooling of complementary resources provided by partners, such as technological skills and assets, financing, and access to the large domestic or international markets (Hladik, 1988).

3.2.3 Strategic choice

The strategic choice theory focuses on the competitive environment of an organization (Porter, 1980). From a strategic choice perspective, strategic alliances are a mechanism for firms to enhance their competitive positioning or market power (Porter, 1986; Kogut, 1988). Alliances are a natural consequence of globalization and the need for an integrated global strategy (Porter, 1986). According to Porter (1986), a strategic alliance can be a transitional state in the adjustment of firms to globalization, used to accelerate the process of foreign market entry.

The motivations to alliances for strategic reasons are numerous (Kogut, 1988). Strategic alliances are used to gain access to market, shape competition, facilitate international expansion, increase speed to market, gain fast access to new technologies, benefit from

economies of scale, reduce costs, share risks, and increase market power (Porter, 1986; Glaister and Buckley, 1996; Barringer and Harrison, 2000; Powell, 1990).

Despite the amount of research in strategic alliances formation, few studies have looked at the characteristics of the alliances formed for the collaboration of R&D activities.

There is yet incomplete theoretical perspective on R&D collaboration (Osborn and Hagedoorn, 1997). The few prior studies on R&D alliances focus on the alliance between partners both from developed countries, mainly in the triad countries (North America, Europe, and Japan), and examine the characteristics of alliances at the industry level (Hagedoorn and Narula, 1996; Hagedoorn, et al. 2000; Bayona, Garcia-Marco and Huerta, 2001).

As R&D alliances have become a key source of competitive advantage, many multinational corporations have adopted global R&D strategies and established extensive R&D alliances with local partners in emerging markets. While the choices of the form and function are important aspects of international R&D alliance strategies, little research explored the choice of form and function in line with the underlying motive.

My thesis focuses on the R&D alliances formed between partners from developed markets and from emerging economies. Instead of studying many industries with different technology intensiveness, my thesis examines the characteristics of the alliances in a selected sector, information technology (including telecommunications), at the firm level for an in depth study. This study provides some insights on the motives of the

MNCs in forming international R&D strategic alliances in an emerging economy like China and how different motives of R&D alliances affect the choice of alliance forms and R&D activities.

4 HYPOTHESIS DEVELOPMENT

4.1 Motives of R&D alliances

As different theories can be used to explain the formation of strategic alliance, a comprehensive perspective integrating different theories should provide us with better understanding of the formation of international R&D alliances in China. This study draws on three widely used theories, i.e. transaction cost, resource dependency, and strategic choice theories, to examine the international R&D alliances in China. Using this integrated perspective, we set out a number of key strategic motives that drive MNCs to form international R&D strategic alliance in an emerging economy like China.

Market access and market share

In an international context, entry into foreign markets is a well-known rationale for firms to enter into alliances with local partners (Contractor and Lorange, 1988; Hladik, 1988). The selection of a particular local partner may be a strictly strategic decision, based on how the partner can enhance the firm's long-term competitiveness in a foreign market, rather than on specific resource dependency needs or transaction costs considerations (Barringer and Harrison, 2000).

To examine the motives behind international R&D alliances in China, we should draw much attention to the lure of a huge domestic market to foreign partners. Although China is currently undertaking a series of aggressive reform measures to transform the centrally

planned economic system into a market-oriented economic system, state-owned enterprises still dominate its economy and national and local government often place strict control over market operations (Calantone and Zhao, 2001; Lee, Chen, and Kao, 2003). Under such circumstances, alliances with local partners may be the only way to enter the domestic market. For instance, due to the implementation of the policy of '*Technology Transfer from Opening Domestic Markets*' (Zhao and Sun, 2003), access to the local market can occur only if the foreign company transfers technology to a local partner to meet the government policy requirements. This government pressure is very common in technology intensive industries such as the emerging information technology industry. Foreign firms in these industries who wish to sell products in the Chinese market may form R&D strategic alliances with local firms to commit to technology transfer so as to get access to the market.

In those industrial areas where foreign firms are allowed to enter the domestic market, China's business environment and volatile market are still major challenges to MNCs. Targeting this unfamiliar market, MNCs will wish to obtain market knowledge and enhance market share through partnering with local firms who have strong market position. The Chinese partners' existing sales and support network in China is of great help for MNCs to promote their technology and products to the vast Chinese market.

The localization of R&D through alliances also enables multinational corporations to move product development and resources closer to the customers and respond more quickly to domestic market requirements. This can enhance a firm's competitive

advantage and market share. MNCs may also use R&D alliances to increase recognition and credibility of their technology and products in the new market.

Government relationships

China is converting from a state/centrally planned economy to a market economy; however, the government retains great influence in the Chinese market. Land and other important resources are under government control. Firms that have better relationships with various governmental institutions are expected to have greater problem-solving capacity (Luo, 1999). Forming strategic alliance with local partners who have strong government relationships is an efficient means for MNCs to overcome barriers in the local market.

Government relationships also provide firms with legitimacy for its products, especially in industries where the prevalence or dominance of a technical standard determines the subsequent competitive performance of firms. As the Chinese government often plays a key role in determining the adoption of a specific technological standard in many industries, it is very important for MNCs to ally with the appropriate firms that have key influence on standards issues in the local market so as to ensure the successful development and commercialization of technology. Taking a recent example (Einhorn, 2004), the Chinese government implemented a new policy requiring all wireless network equipment to comply with a new, Chinese-made encryption standard, but it will not give any foreign companies access to the standard due to national-security concerns. Thus, companies like Intel that want to sell Wi-Fi products in China have to become partners

with two dozen or so Chinese concerns designated by the government, despite much debate over this policy among many MNCs.

Human resources

China's human resources are a key factor attracting MNCs to undertake R&D activities in China (Li and Zhong, 2003). China has a large pool of well trained scientists, engineers and technicians who are capable of performing quality basic and applied research and who do so at a relatively low cost. According to China Social Statistics (2000), there were 2.4 million people engaged in scientific and technological activities in 1999, including 1.4 million scientists and engineers. MNCs have been taking advantage of the vast high quality/low cost human resource pool to carry out R&D activities for their global strategy.

Vertical linkages

Establishing vertical linkages is one of the traditional motives for firms to form strategic alliances. In a vertical linkage, each partner contributes one or more different element in a value chain (Contractor and Lorange, 1988).

Strategic alliances as a vertical coordination mechanism are well explained by TCE as an intermediary form between vertical integration and spot market transactions (Sporleder, 1992). Specific assets are the principal focus of TCE. Asset specificity is ubiquitous on both sides of R&D alliances as formed vertical linkages, due to the contribution of both sides of specialized knowledge and technology. When faced with asset specificity, firms

become aware of the potential for a partner's opportunistic behavior. Open market procurement may not sufficiently guard the firm against opportunism. Vertical integration would be a better choice of governance form for recurrent transactions when distinguished by asset specificity (Williamson, 1985). However, vertical integration has significant drawbacks. Economies of scope and scale from pooling multiple demands are lost and companies are forced into activities for which they lack competence (Bensaou and Anderson, 1999). Strategic alliances, as an intermediate form between open market and integration, contain characteristics that help avoid the problems of both markets and hierarchies. Strategic alliances can provide safeguards against the hazards of opportunism while at the same time avoiding the need for a firm to internalize an activity which may not be aligned with its distinctive competencies or may be difficult and costly to manage (Barringer and Harrison, 2000).

Although previous research on strategic alliances has focused on horizontal strategic alliances between competitors within the same industry, creating vertical linkage has been one of the key motives for MNCs to form R&D alliances with Chinese partners. In high tech sectors like the information technology industry, Chinese firms often have to purchase core components and technology from MNCs. Chinese firms often undertake system integration and develop features for the final product for the consumer market. Attracted by the market potential in China, MNCs may wish to establish long-term relationships with their Chinese customers. R&D alliances not only provide MNCs the opportunity to establish stable relationship with their Chinese customers but also enable

them to adapt their technology to meet the local market demand with the collaboration of Chinese partners who have better knowledge of the local market requirements.

Transfer of complementary technology

From a resource perspective, R&D strategic alliances, like other types of strategic alliances, can facilitate access to external complementary skills and resources to better exploit existing resources and develop sustained competitive advantage (Hagedoorn, et al. 2000; Yang and Taylor, 1999). Technological capabilities are critical resources for carrying out R&D projects. Complex R&D projects in high tech sectors often require technological capabilities in multiple areas. Since one company may not have technical expertise in every area, firms often need to obtain complementary technology from outside. Transfer of complementary technology or exchange of patents is one of the major strategic motives for international R&D alliance formation.

From a TCE perspective, R&D alliances offer an efficient way for technology transfer between partners. Transactions of intangible assets, including the transfer of technology (for example, implicit know-how or explicit patents), are a primary cause of incomplete contracts and lead to high market transaction costs (Hagedoorn, et al. 2000; Hennart, 1988). Narula (1999) suggests that alliances may be more efficient than hierarchical arrangements, particularly in volatile circumstances in which the activities undertaken are governed by uncertainty and a high degree of tacitness. R&D strategic alliances can be used as a hybrid form of organization between the market and the hierarchy to facilitate the transfer of technology.

Despite the fact that the technological gap between MNCs and Chinese firms is still large, China has achieved remarkable progress in science and technology development in recent years. Many Chinese firms have developed self sustaining technological capabilities in some of the advanced technology areas, partly through learning from the West. Most Chinese firms have undergone a process of importing, digesting and absorbing advanced technologies from western countries to developing technology with their own property rights. MNCs may enter into R&D collaboration with Chinese partners who have the needed complementary technology or expertise.

Economies of scale

The benefit of economies of scale from joint research can be one of the strategic reasons for alliance formation (Powell, 1990; Hagedoorn, et al. 2000). In an R&D alliance driven by economies of scale, both partners may have similar technological capabilities to undertake the project independently, but they can make more efficient use of their combined resources, including capital, facilities/laboratories, and human resources, and lower costs by using comparative advantage of each other (Hladik, 1988). Also, firms join forces to meet the ‘demand for speed’ and share the expense of developing costly products that have short life spans (Powell, 1990).

Given the achievements of Chinese firms in developing technological capabilities in recent years, MNCs may engage in joint R&D with Chinese partners who have similar technological bases for the benefit of economies of scale in R&D.

4.2 Forms of R&D alliances

Strategic alliances include a variety of organizational forms that lie between internal hierarchies at one extreme and market-mediated exchanges at the other (Barringer and Harrison, 2000; Pangarkar and Klein, 2001). Previous research has generally differentiated the strategic alliances by the presence or absence of equity (Gulati and Singh, 1998; Glaister and Buckley, 1996; Gulati, 1995; Osborn and Baughn, 1990; Reid, Bussiere and Greenaway, 2001; Tallman and Shenkar, 1994). Equity alliances include any exchange agreement in which the partners share or exchange equity. These include agreements in which partners create a new entity in which they share equity as well as those in which one partner takes an equity interest in the other (Gulati and Singh, 1998; Zollo, Reuer and Singh, 2002). Equity-based alliances most closely replicate the hierarchical control features of organizations, while non-equity-based alliances with no sharing of equity have few hierarchical controls built into them (Gulati and Singh, 1998; Osborn and Baughn, 1990; Hagedoorn and Narula, 1996).

Similarly, researchers on R&D alliances also distinguish two types of governance forms by the presence or absence of equity sharing: equity based R&D joint ventures and non-equity-based R&D cooperative agreements (Hagedoorn, 2002; Li and Zhong, 2003). This study adopted this categorization of R&D alliance forms.

An equity-based R&D joint venture (RJV) involves the sharing of equity, which usually involves the formation of a new organization jointly controlled by two or more partners

to engage in R&D activities (Vonortas, 1997; Hagedoorn and Narula, 1996). RJV in China includes R&D center in the form of Equity Joint Venture (EJV) and R&D branch or department of EJV.

A non-equity based R&D cooperative agreement (RCA) does not involve the sharing or exchange of equity. These agreements cover technology and R&D sharing between two or more companies in combination with joint research or joint development projects (Hagedoorn, 2002). Non-equity based alliances usually do not involve the creation of new firms (Glaister and Buckley, 1996). However, a non-equity based R&D cooperative agreement may acquire the status of a legal person in China. According to Chinese laws, an equity-based joint venture (EJV) shall take the form of a limited liability company and the profits, risks and losses of an EJV shall be shared by the parties in proportion to their investment. In contrast, a cooperative joint venture (CJV) is jointly established by partners without equity sharing. The investment or conditions for cooperation, the distribution of earnings or products, and the sharing of risks and losses, and the manners of operation and management, etc. are agreed upon by parties of the CJV as the conditions for the cooperation. A CJV which meets the conditions for being considered a legal person under Chinese law shall acquire the status of a Chinese legal person in accordance with law. RCA in China includes various types of R&D cooperation relationship: joint research projects, joint product development, joint R&D centers or labs in the form of CJV, open R&D center, and research and development cooperation agreements or partnership.

4.3 Functions of R&D alliances

The function of R&D alliances in this study refers to the types of R&D activities carried out in R&D alliances. There have been various classifications of R&D activities in previous research. The most widely accepted definitions for R&D activities are those of the National Science Foundation (NSF, 2002) and the OECD *Frascati Manual 2002* (OECD, 2002). They have been used for practical R&D surveys for several decades in US and OECD countries respectively.

The NSF defines three types of R&D, i.e. basic research, applied research, and development. The *Frascati Manual 2002* recognizes three categories of R&D: basic research, applied research, and experimental development. These two sets of definitions are generally consistent in distinguishing the R&D activities. According to NSF definitions, the objective of basic research is to gain more comprehensive knowledge or understanding of the subject under study without specific applications in mind. Applied research is oriented to discovering new scientific knowledge with specific commercial objectives with respect to products, processes, or services. Development is the systematic use of the knowledge or understanding gained from research directed toward the production of useful materials, devices, systems, or methods.

These classifications, however, have received criticism for practical R&D data collection because of the lack of clear boundaries between basic research and applied research. For this reason, some researchers divide the R&D activities into two groups, i.e. research-

oriented and development-oriented (Li and Zhong, 2003). This study adopts this two-category typology for R&D activities in international R&D alliances: development-oriented activities and research-oriented activities.

Development-oriented activities include: product/material/process adaptation or improvement, and product/system testing and interoperability or compatibility testing for local markets; and system integration, and product/system design and development for local and/or global markets.

Research-oriented activities include both basic research and applied research, which are aimed at gaining new scientific knowledge without or with specific commercial objectives respectively. New scientific knowledge gained from basic research and applied research is converted into commercially viable products and processes in the development stage (Li and Zhong, 2003).

4.4 Hypotheses development

4.4.1 Relationships between motive and form

In the early 1970s according to Hagedoorn, et al. (2000), the majority of research partnerships found in the triad countries were equity-based research corporations, but ‘by the mid-1990s, more than 85 percent of research partnerships did not involve equity

investments.’ This is attributed in large part to the higher degree of organizational flexibility of non-equity agreements.

Previous research, from a resource perspective, has proposed that the types of resources that firms could potentially contribute constitute a key dimension in predicting the partners' structural preferences in the prospective alliance (Das and Teng, 2000). Firms are interested not only in accessing or acquiring their partners' valuable resources, but also in protecting their own valuable resources during the alliance-making process (Das and Teng, 2000). Other research has noticed an underlying tension between ‘trying to learn and trying to protect’ in strategic alliances (Kale, Singh and Perlmutter, 2000). Alliance participants would internalize some complementary capabilities and skills possessed by the partner, and at the same time they would also like to protect some of their own core proprietary capabilities from being unilaterally absorbed or appropriated by the partner. A dilemma arises because conditions that might facilitate the learning process are likely to expose firms to the danger of losing some of their crown jewels to the partner. Governance form should facilitate inter-partner learning while simultaneously protect proprietary knowledge (Kale et al., 2000).

Previous studies show that equity-based joint ventures provide the best opportunities to acquire partners' tacit knowledge and other knowledge-based resources due to the degree that partners were exposed to each other (Mowery, et al. 1996; Kogut, 1988). Equity joint venture is found to be the preference of firms who seek transfer of intangible know-how

and skills; while non-equity based cooperation agreement would be the preference of firms who contribute such tacit skills (Shenkar and Li, 1999; Das and Teng, 2000).

In an international R&D alliance in China, the primary contributions of MNCs are often advanced technologies and skills. MNCs may have great concerns on the possible appropriation of their proprietary knowledge by partner firms and thus will prefer non-equity based cooperative agreement as the governance form of their R&D alliances with Chinese partners. However, the governance form selected by partner firms of an alliance is the result of negotiations. As the primary motive of Chinese firms is most likely to gain access to advanced technology (especially tacit know-how) that MNCs bring to the alliance, Chinese firms may have greater preference of equity-based joint ventures to facilitate technology transfer. A governance form of non-equity based cooperative agreement may be agreed upon when both partners contribute knowledge-based resources and have the same concern about unintended transfer. Therefore the contributions of Chinese partners should be taken into consideration when we examine the choice of governance forms. Because MNCs seek different resources and capabilities from their partners, their motives underlying the alliances can lead to different choice of governance forms. While MNCs may have multiple motives to form R&D alliances with local partners in China, it is necessary to take consideration of the predominant motive in the discussion.

When alliances are formed by MNCs to obtain market access and market share or government relationships from their local partners, Chinese partners may have little

concern on the appropriation of their contributed resources. Instead, Chinese partners may place great emphasis on the transfer of technology from foreign partners and thus may prefer equity-based joint ventures that can facilitate technology transfer. Taking into consideration the special business environment in China, MNCs are likely to enter into equity-based joint ventures in order to conform to the Chinese policy of ‘technology for market’.

When the motive of an MNC is to obtain local human resources, the MNC may wish to take advantage of the scientific inputs from local talents for its global R&D strategy. The primary contribution of MNCs is often property-based resources, such as capital and research equipment, instead of the transfer of technology. Since both partners contribute property-based resources, neither firm will be interested in appropriating partner’s tacit knowledge. A non-equity-based cooperative agreement may serve well for the combination of complementary resources to create new knowledge and share the scientific output.

When the motive of an MNC is to create a vertical linkage, each partner contributes different elements in the value chain. Chinese firms, usually as system integrators, may focus on the development of the final products instead of learning the technology for the components. MNCs may adapt their technology and products through R&D alliances to meet their partner’s requirements and ensure the interfaces of the supplied component work properly for the partner’s integration work. Non-equity based cooperative agreement is likely to be chosen as an efficient governance form.

When the motive of an MNC is to seek complementary technology or economies of scale of R&D, the primary contributions of both partners are technology. Both partners may have the same concern to protect their own core capability and prefer a non-equity based governance form. In this case, non-equity based cooperative agreement is most likely to be chosen for the alliance.

We may propose the following hypotheses regarding the connection between motives of MNCs to form international R&D alliances in China and the choice of governance forms of the alliances:

H1.a. International R&D alliances in China formed by MNCs to seek local market access and market share or government relationships are likely to be in the form of equity based joint ventures.

H1.b. International R&D alliances in China formed by MNCs to obtain human resources, or to establish vertical linkages, or to seek complementary technologies or economies of scale, are likely to be in the form of non-equity based cooperative agreements.

4.4.2 Relationships between motive and function

In international R&D alliances in China, various motives of MNCs may also affect the choice of alliance function in terms of development-oriented or research-oriented activities.

In alliances formed by MNCs to seek market access and market share, or government relationship, the focus of MNCs is on the local market. They are likely to promote existing technologies and products to the local market. Partners may collaborate on the adaptation or improvement of products to meet the local market requirements.

In alliances formed by MNCs to create vertical linkages, partners collaborate on system integration for local and/or global markets.

In alliances formed by MNCs to obtain complementary technology, MNCs may likely take advantage of the partner's complementary technology and unique expertise for the development of new products for local market and so the R&D activities in these alliances will focus on product development targeting local market.

Strategic alliances used to create economies of scale often pool the technological know-how and expertise of different firms in product development (Das and Teng, 2000). Faster time to market of new products may be the key consideration of the partner firms.

The R&D activities in these alliances will be likely involved in product development for local and/or global markets.

In alliances formed to take advantage of local human resources, highly skilled scientists and researchers have the required capabilities to undertake basic and applied research to meet the global strategy of MNCs. Li and Zhong (2003) find that R&D alliances are more likely to be research-oriented when local universities and institutes are alliance partners.

H2.a. International R&D alliances in China formed by MNCs to seek local market access and market share, or government relationships, or to establish vertical linkages, or to seek complementary technology or economies of scale, are likely to undertake development-oriented R&D activities.

H2.b. International R&D alliances in China formed by MNCs to seek human resources are likely to undertake research-oriented R&D activities.

4.4.3 Relationships between form and function

Equity-based joint ventures enable partners closely exposed to each other to have better mutual alignment of incentives than cooperative agreements. Partners are motivated to adapt to changes in the environment because of joint ownership rights and mutual commitment of resources (Kogut, 1988). Development activities, undertaken to meet market needs and confront with high demand uncertainty, need closer interaction between

partners than research activities (Li and Zhong, 2003). Thus development activities may be more likely to be conducted in equity-based R&D joint ventures.

Previous research also noted that equity joint ventures, which usually embody the creation of a new firm, represent a longer-term commitment by the parent organizations than do non-equity agreements, which are often viewed as more temporary organizational modes (Hagedoorn and Narula, 1996; Glaister and Buckley, 1996). It is generally intended that a joint venture be operational for a substantial number of years. There are higher costs to either terminating or fundamentally changing equity alliances than non equity agreements (Pangarkar and Klein, 2001). As MNCs often enter into equity based joint ventures to demonstrate their long-term commitment to the local market, especially in respond to local government pressures, it is likely that equity-based joint ventures may be used for the development-oriented activities aimed at local markets. Hence we hypothesize:

H3. Equity-based joint ventures are more likely involved with development-oriented R&D activities than non-equity based cooperative agreements.

Figure 1 shows the summary of the hypotheses of this study.

Figure 1 Summary of Hypotheses

5 RESEACH STRATEGY AND METHOD USED

5.1 Data collection

Past research shows that most international R&D alliances in China are in technology-related industries such as electronics, computer software, telecommunications and Internet (Li and Zhong, 2003). My thesis draws samples from information technology (including telecommunications) industry, an emerging industry in China, which has attracted great amount of foreign direct investment for R&D. The information technology industry in China is currently under the administration of the Ministry of Information Industry (MII) of China. MII was created in the midst of the bureaucratic reshuffling of March 1998. The former Ministry of Post and Telecommunications, which oversaw network standards and access, and the Ministry of Electronics and Information, which oversaw computers and software, were merged. Responsibility for postal administration and the telecom trunk line network was divested elsewhere. The resulting MII is now a super-agency overseeing telecommunications, multimedia, broadcasting, satellites, and the Internet (Source: China Online). The information technology industry examined in this study covers those industrial sectors under the administration of the MII and enjoying similar local government policies, which include telecommunications, computer electronics, software, and Internet. Through collaboration with foreign partners in R&D, Chinese firms are developing and implementing advanced technologies, especially in these information technology industry sectors.

Although public data on these international business activities are key for science and technology policy analysis and design, their availability varies considerably, even within advanced economies (NSF, 2002). Because no comprehensive database was available in China for identifying international R&D cooperation, a new database was developed for this study, with key sources such as press releases, corporate websites, newspapers (Lexis-Nexis database), journal articles (Business Source Premier database), Internet news, and similar public sources.

As a first step, a list of alliances between MNCs and Chinese firms was obtained using the database of *China Business Review*, a major bimonthly trade magazine published by the US–China Business Council. This database has been widely used by past researchers. However, some alliances could not be identified as R&D alliances because they did not mention the involvement of R&D activities in their cooperation. After efforts of searching further information for these alliances from other sources, mainly corporate websites and press releases, a large number of the alliances in this list could not be identified because of lack of sufficient information. Due to the fast development in the industry studied, many firms were found to have been terminated through merger and acquisition, or even just disappeared without any trace.

As a second option, I turned to other sources and started from the sources of Chinese partners. The membership of China Communications Standards Association (CCSA) was used as the source of Chinese partners, which include major players in information technology industry. As of December 31, 2003, CCSA had 147 members (128 full

members and 19 participating members) that were Chinese companies or joint ventures. From the websites of these CCSA members, it was found that 94 foreign companies, from Europe, North America, and Japan and South Korea, had established various cooperative relationships with these CCSA members in China.

From the information on the websites of these foreign companies, 30 companies from North American, Europe, and Japan and South Korea were found to have established R&D alliances with Chinese partners (government agencies, universities, and firms) in information technology industry during the period from 1994 to 2003. Very few alliances were found established before 1997 and no detailed information was available for these few alliances. Thus no alliance established before 1997 are included in the database. Detailed information for 80 R&D alliances established during the period from 1997 to 2003 was collected from public sources, such as press releases, corporate websites, newspapers in Lexis-Nexis, and journal articles in Business Source Premier. These alliances were used as the sample for data analysis of this study.

Further data search were conducted for some additional MNCs (8 Japanese and 5 South Korean MNCs) which were drawn from the membership lists of the 3rd Generation Partnership Project (3GPP) and the Third Generation Partnership Project 2 (3GPP2). However, no R&D alliances were found between these companies and Chinese partners. This provided evidence that the foreign companies drawn from the CCSA list of partnership included most foreign companies who established alliances with Chinese partners during the study period.

Figure 2 Procedures of Data Collection

The database includes only those inter-firm agreements that contain arrangements for joint R&D. Agreements solely devoted to production and marketing are excluded. The focus of the data gathering is on those forms of cooperation and agreements for which joint R&D activities are at least part of the agreement. The database also excludes those

involving related activities with a scientific and technological basis, e.g. laboratories for education, training centers, education and training programs, equipment donations for R&D labs, technology centers for education or showcasing, and technical support laboratories. Licensing and royalty agreements, cross-licensing, joint stock limited company, R&D consortia, and contract research are also excluded.

The unit of analysis is the alliance. The database counts any agreement made between two or more companies at a particular moment as an alliance. New agreements between the same partners made sequentially in time are considered as individual alliances. The involvement of a new partner to the existing cooperative venture or joint projects under separate agreement is also treated as a new alliance. However, in the case when there are more than two partners involved in the same agreement, it is counted as one alliance. Frequencies reported in this paper therefore refer to the number of individual alliances.

5.2 Variables and measurements

Dependent variables

Form

The form of R&D alliance indicates whether the R&D alliance was formed with equity sharing of partners. A categorical variable is used and coded as: 1 for Non-equity based R&D cooperative agreements (RCA); 2 for Equity-based R&D joint ventures (RJV). Non-equity based R&D cooperative agreements are cooperative relationship without equity sharing of partners. RCAs include the following cooperation forms: a) joint

research and/or development project/program, b) joint R&D center/laboratory in the form of Cooperative Joint Venture (with conditions for cooperation), c) open R&D center, and d) research and/or development cooperation agreement/partnership. Equity-based R&D joint ventures involve equity sharing between partners, and include: a) R&D center in the form of Equity Joint Venture (EJV), and b) R&D activities in EJV.

Function

The function of R&D alliances indicates the types of joint R&D activities, i.e. whether an alliance undertakes development-oriented or research-oriented activities. A categorical variable is used and coded as: 1 for Development-oriented R&D; 2 for Research-oriented R&D.

Development-oriented R&D activities include: a) development, i.e. product/service/process development; b) system integration; c) adaptation, i.e. product/service/process tailoring, localization, customization, improvement; and d) testing, i.e. product/system testing, and interoperability/compatibility testing. Adaptation and testing activities often focus on local markets, while development and system integration may target on local and/or global markets.

Research-oriented R&D includes a) basic research, and b) applied research. Basic research and applied research are undertaken without or with specific commercial objectives respectively.

An indicator of market intention can be used to categorize development-oriented activities and research-oriented activities. Development-oriented activities are undertaken to target local and/or global markets, while normally no specific target market is taken into consideration at the research stage. The output of basic and applied research has to be applied to product development for market application.

Independent variable

Motive

A category variable was defined for the primary motive of the alliance formation and coded as: 1 - seeking government relationships, 2 - obtaining human resources; 3 - creating vertical linkages, 4 - transferring complementary technology; 5 - achieving economies of scale, and 6 - gaining market access and market share. Among them, seeking government relationships is indicated by government requirement, the partner's government background, or government support and endorsement. Achieving economies of scale is indicated by partners with similar technology or the demand for speed of R&D. Gaining market access and market share is indicated by four specific objectives: market access, market share, R&D localization for competitive advantage, and technology recognition.

Control variable

Origin of MNC

The different countries of origin of foreign partners have different culture distances from local partners. Given that this cultural distance may affect objectives, governance form

selection, or alliance function, foreign partner country origin is added as a control variable (Hitt et al. 2000; Kale et al. 2000). Previous research work (Hagedoorn, et al. 2000) revealed that the majority of international R&D alliances are between companies from Europe (the EU and EFTA countries), North America (USA and Canada), and Asia (Japan and South Korea). This study examines the international R&D alliances between Chinese companies and foreign companies from these same three regions: Europe, North America, and Asia. The country of origin of a multinational corporation refers to the region in which the company's head office is located. A category variable is used with the following notation: 1 for North America (USA and Canada); 2 for Europe (the EU and EFTA countries); 3 for Japan and South Korea.

Table 1 illustrates the key words, phrases or cues to determine the categorization of motive, form and function. These key words can be found in public source information such as press releases. Table 2 illustrates the coding scheme. An example of coding using text data contained in the research data base is shown in Table 3.

Table 1 Key Words for the Categorization of Motive, Form and Function

Motive	Key words
1 Government relationships	Ministry of Information Industry, Chinese Government, government plan; Support, encourage, appoint
2 Human resources	Talents, professors, students, staff, personnel, workforce, engineers, researchers
3 Vertical linkages	Based on, products, components, platform, technology; Provider, supplier, vendor, customer
4 Transfer of complementary technology	Technology, expertise, experience, knowledge; Complement, unique, compatible
5 Economies of Scale	Technology, expertise, experience, knowledge, respective [type] technology, early
6 Market access and market share	License, market position, leadership, brand, close to customer, localized R&D, technology recognition
Form	Key words
1 Non-equity based R&D cooperative agreements	Program, project, agreement, alliance, partnership, collaboration, initiative; Responsible for, provide, offer
2 Equity-based R&D joint ventures	joint venture, investment, capital shares, equity stake, majority-owned
Function	Key words
1 Development-oriented R&D	Develop, design, integrate, localize, Chinese version, tailor, enhance, improve, optimize, upgrade, adapt, suit, test, interoperate, compatible; Chinese/local market, export, international/global market, worldwide
2 Research-oriented R&D	Research, technology research, future applications

Table 2 Coding Scheme

Variable	Code	Details
Form	1 Non-equity based R&D cooperative agreements	11 Joint research/development project/program
		12 Joint R&D center/laboratory in the form of Cooperative Joint Venture (with conditions for cooperation)
		13 Open R&D center
		14 Research/development cooperation agreement/partnership
	2 Equity-based R&D joint ventures	21 R&D center in the form of EJV
		22 R&D in EJV
Function	1 Development-oriented R&D	11 Product/service/technology development (for local and/or global markets)
		12 System integration (for local and/or global markets)
		13 Product/service/technology tailoring, localization, customization, adaptation, improvement (for local markets)
		14 Product/system testing, interoperability or compatibility testing (for local markets)
	2 Research-oriented R&D	21 Basic research
		22 Applied research
Motive	1 Government relationships	11 Government requirement
		12 Government background
		13 Government support/endorsement
	2 Human resources	20 Human resource
	3 Vertical linkages	30 Component/product supplier
	4 Transfer of complementary technology	40 Transfer of complementary technology
	5 Economies of Scale	51 Similar technology
		52 Demand for speed of R&D
	6 Market access and market share	61 Market access
		62 Market share
		63 R&D localization for competitive advantage
		64 Technology recognition
Origin of MNC	0 North America (USA and Canada)	
	1 Europe	
	2 Japan and South Korea	

Table 3 Example of Coding

Year of establishment	2000		
MNC	IBM		
Chinese partner	Huawei Technologies Co., Ltd.		
Variables	Code	Details	Text data
Form	1 Non-equity based R&D cooperative agreement	14 Development cooperative agreement	IBM and Huawei Technologies Co., Ltd. today announced a collaborative agreement to accelerate the introduction of Huawei's high performance network communications systems.
Function	1 Development-oriented R&D	12 Product customization, System integration (for local and global markets)	Huawei plans to integrate IBM's PowerNP network processor, Packet Routing Switch technology, PowerPC™ processors and customized ASIC (application specific integrated circuit) chips into its product lines. In addition, the two companies have launched a collaborative research and development effort to make their respective products and technologies work more closely together, allowing customers to incorporate both into their products. "Working with Huawei offers an opportunity to extend the reach of IBM's comprehensive networking technologies into China and the exploding telecommunications marketplace worldwide," said James Northington, vice president of network processing for IBM.
Motive	3 Vertical linkage	30 Component supplier	IBM will be a key technology supplier for Huawei's next-generation IP (Internet Protocol) routers and SDH (Synchronous Digital Hierarchy) optical transmission systems. "Huawei has joined a growing list of customers who have chosen IBM to satisfy their technology and performance requirements with an unparalleled menu of both standard and customized solutions."
Origin of MNC	0	USA	
Source	http://www-3.ibm.com/chips/news/2000/0925_huawei.html IBM and Huawei announce networking technology collaboration		

5.3 Data analysis and results

In the database, each alliance was recorded with the following data: year of establishment, name of partners, country of origin of multinational corporations, motive of multinational corporations, alliance form, and alliance function. Year of establishment and name of partners are used as descriptive data for the sample alliances.

I also coded the performance with ‘success’ for alliances with evidence of objective achievement declared in the public media, e.g. product developed, research project finished, sales achievement, market access gained, etc., and ‘unknown’ for alliances without any information on performance. However, because the cases recorded as ‘unknown’ may include alliances of success, failure, or performance unknown, the records of ‘success’ and ‘unknown’ are not mutually exclusive. Hence the record of this information was not useful for the data analysis.

Considering that in some cases there is more than one motive that drives the formation of the R&D alliances, I coded a Secondary Motive for the alliances in the same way as the primary variable Motive. However, due to the small number of cases with recorded secondary motive, this information was not used in data analysis of this study.

5.3.1 General growth patterns of the R&D alliances in China (in the sample)

The general growth of newly made international R&D alliances in the information technology industry in China for the period from 1997 to 2003 is given in Figure 3.

Figure 3 The Growth of International R&D Alliances in China

The data suggest that in general international R&D alliances in the information technology industry in China started from the mid-late 1990's and had a rapid growth during the late 1990's. The number of new alliances reached a peak in 2000 and then declined in 2001. The number of new alliances maintained a growth at a medium level since 2001, though with some fluctuation.

This general growth pattern provides some evidence for our discussion in Section 2 of this paper. In general international R&D alliances in China began to grow and expand in the mid-late 1990s and the number of newly formed R&D alliances reached a peak in 2000, as a result of the ‘Technology for Market’ policy, ‘*Going West*’ campaign, the implementation of ‘*Golden Projects*’, the expectation for China’s near-term of accession to the WTO, and the growing competition among foreign investors. The number of newly formed R&D alliances declined in 2001 due to the change of policy requirement for local partners with related to China’s accession to WTO. The growth of R&D alliances has stayed at a medium level since 2001 even during the high tech meltdown and despite fewer impediments to wholly owned subsidiaries. An examination on the motives of multinational corporations to form R&D alliances is given in the following section of data analysis, which shows that there are a broad range of motives, besides government policy pressure, that drive MNCs to form R&D alliances.

5.3.2 Hypotheses testing

5.3.2.1 Method of data analysis

Because the variables for testing the hypotheses are independent categorical variables, the descriptive statistics of frequencies and crosstabs were used to summarize data. Chi-square tests were used to examine the hypotheses.

5.3.2.2 Descriptive statistics of motive, form and function

The frequency tables of motive, form, and function of alliances (Table 4) show that:

- 1) The two most frequent motives of MNCs in forming R&D alliances in China are establishing vertical linkage and obtaining human resources;
- 2) The majority of the alliances take the form of non-equity based R&D cooperation agreements; and
- 3) The majority of the alliances perform development-oriented R&D activities.

Table 4 Descriptive Statistics for Motive, Form and Function

Motive					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Government relationships	12	15.0	15.0	15.0
	2 Human resources	19	23.8	23.8	38.8
	3 Vertical linkage	24	30.0	30.0	68.8
	4 Complementary technology	8	10.0	10.0	78.8
	5 Economies of scale	3	3.8	3.8	82.5
	6 Market access and market share	14	17.5	17.5	100.0
	Total	80	100.0	100.0	

Form					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Non-equity based RCA	52	65.0	72.2	72.2
	Equity-based RJV	20	25.0	27.8	100.0
	Total	72	90.0	100.0	
Missing	System	8	10.0		
Total		80	100.0		

		Function			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Development-oriented	65	81.3	81.3	81.3
	Research-oriented	15	18.8	18.8	100.0
	Total	80	100.0	100.0	

5.3.2.3 Chi-Square tests for Hypothesis 1

Hypothesis 1 states that international R&D alliances in China formed by MNCs to seek local market access and market share or government relationships are likely to be in the form of equity based joint venture, while international R&D alliances in China formed by MNCs to obtain human resources, or to establish vertical linkages, or to seek complementary technologies or economies of scale, are likely to be in the form of non-equity based cooperative agreements.

A. All values of Motive included.

The descriptive statistics of crosstab and Chi-square test results for H1 are shown in Table 5.

The crosstab for motive and form shows that MNC has a strong preference for non-equity based cooperative agreements but within that context, there is some evidence for H1.

The two sided Pearson Chi-Square test has significance of 0.118, so there is some evidence for H1. The Likelihood Ratio is very close to the Chi-Square. This is because

the likelihood-ratio chi-square is a statistic very similar to the Pearson Chi-Square and the two statistics are close in value for large sample sizes.

Table 5 First Chi-square Test for H1

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Motive * Form	72	90.0%	8	10.0%	80	100.0%

Motive * Form Crosstabulation

				Form		Total
				Non-equity based RCA	Equity-based RJV	
Motive	1 Government relationships	Count		6	4	10
		Expected Count		7.2	2.8	10.0
		% within Motive		60.0%	40.0%	100.0%
		Residual		-1.2	1.2	
	2 Human resources	Count		16	2	18
		Expected Count		13.0	5.0	18.0
		% within Motive		88.9%	11.1%	100.0%
		Residual		3.0	-3.0	
	3 Vertical linkage	Count		18	4	22
		Expected Count		15.9	6.1	22.0
		% within Motive		81.8%	18.2%	100.0%
		Residual		2.1	-2.1	
	4 Complementary technology	Count		4	2	6
		Expected Count		4.3	1.7	6.0
		% within Motive		66.7%	33.3%	100.0%
		Residual		-.3	.3	
	5 Economies of scale	Count		2	1	3
		Expected Count		2.2	.8	3.0
		% within Motive		66.7%	33.3%	100.0%
		Residual		-.2	.2	
	6 Market access and market share	Count		6	7	13
		Expected Count		9.4	3.6	13.0
		% within Motive		46.2%	53.8%	100.0%
		Residual		-3.4	3.4	
	Total	Count		52	20	72
		Expected Count		52.0	20.0	72.0
		% within Motive		72.2%	27.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.789 ^a	5	.118
Likelihood Ratio	8.799	5	.117
N of Valid Cases	72		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is .83.

Because the minimum expected count in the chi-square tests is 0.83, the observed significance level based on the chi-square distribution may not be correct. The minimum expected count should be more than 5 for the Chi-Square test to work without qualification. To have more solid results, a Chi-square test was conducted with motive values 4 and 5 removed from the data because of the small number of cases for each. The results are given as below.

B. Motive values 4 and 5 removed from the data because of the small number of cases for each

The second Chi-square test results for H1 with Motive values 4 and 5 removed are shown in Table 6. Now the two sided Pearson Chi-Square test has significance of 0.032, so there is stronger evidence for the limited H1 (i.e., with motives 4 and 5 taken out of the data). The number of cells with expected counts less than 5 is much less and the expected minimum count is much great: 2.70 versus 0.83.

Table 6 Second Chi-square Test for H1

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Motive * Form	63	91.3%	6	8.7%	69	100.0%

Motive * Form Crosstabulation

				Form		Total
				Non-equity based RCA	Equity-based RJV	
Motive 1	Government relationships	Count	6	4	10	
		Expected Count	7.3	2.7	10.0	
		% within Motive	60.0%	40.0%	100.0%	
		Residual	-1.3	1.3		
2	Human resources	Count	16	2	18	
		Expected Count	13.1	4.9	18.0	
		% within Motive	88.9%	11.1%	100.0%	
		Residual	2.9	-2.9		
3	Vertical linkage	Count	18	4	22	
		Expected Count	16.1	5.9	22.0	
		% within Motive	81.8%	18.2%	100.0%	
		Residual	1.9	-1.9		
6	Market access and market share	Count	6	7	13	
		Expected Count	9.5	3.5	13.0	
		% within Motive	46.2%	53.8%	100.0%	
		Residual	-3.5	3.5		
Total		Count	46	17	63	
		Expected Count	46.0	17.0	63.0	
		% within Motive	73.0%	27.0%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.788 ^a	3	.032
Likelihood Ratio	8.646	3	.034
N of Valid Cases	63		

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is 2.70.

5.3.2.4 Chi-square tests for Hypothesis 2

Hypothesis 2 states that international R&D alliances in China formed by MNCs to seek local market access and market share, or government relationships, or to establish vertical linkages, or to seek complementary technology or economies of scale are likely to undertake development-oriented R&D activities, while international R&D alliances in China formed by MNCs to seek human resources are likely to undertake research-oriented R&D activities.

A. All values of Motive included.

The descriptive statistics of crosstab and Chi-square test results for H2 are shown in Table 7.

The descriptive statistics of crosstab for motive and function shows strong evidence for H2. The two sided Chi-square test has significance of 0.000, so there is very strong evidence for H2. The Likelihood Ratio is the same as the Chi-Square.

Table 7 First Chi-square Test for H2

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Motive * Function	80	100.0%	0	.0%	80	100.0%

Motive * Function Crosstabulation

				Function		Total
				Developme nt-oriented	Research -oriented	
Motive 1	Government relationships	Count		12	0	12
		Expected Count		9.8	2.3	12.0
		% within Motive		100.0%	.0%	100.0%
		Residual		2.3	-2.3	
2	Human resources	Count		5	14	19
		Expected Count		15.4	3.6	19.0
		% within Motive		26.3%	73.7%	100.0%
		Residual		-10.4	10.4	
3	Vertical linkage	Count		24	0	24
		Expected Count		19.5	4.5	24.0
		% within Motive		100.0%	.0%	100.0%
		Residual		4.5	-4.5	
4	Complementary technology	Count		8	0	8
		Expected Count		6.5	1.5	8.0
		% within Motive		100.0%	.0%	100.0%
		Residual		1.5	-1.5	
5	Economies of scale	Count		2	1	3
		Expected Count		2.4	.6	3.0
		% within Motive		66.7%	33.3%	100.0%
		Residual		-.4	.4	
6	Market access and market share	Count		14	0	14
		Expected Count		11.4	2.6	14.0
		% within Motive		100.0%	.0%	100.0%
		Residual		2.6	-2.6	
Total		Count		65	15	80
		Expected Count		65.0	15.0	80.0
		% within Motive		81.3%	18.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	51.440 ^a	5	.000
Likelihood Ratio	51.493	5	.000
N of Valid Cases	80		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .56.

- B. Motive values 4 and 5 removed from the data because of the small number of cases for each

Now the two sided Pearson Chi-Square test (Table 8) still has significance of 0.000, so there is still strong evidence for the limited H2 (i.e., with motives 4 and 5 taken out of the data). That the number of cells with expected counts less than 5 is less and the expected minimum count is much great: 2.43 versus 0.56.

Table 8 Second Chi-square Test for H2

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Motive * Function	69	100.0%	0	.0%	69	100.0%

Motive * Function Crosstabulation

				Function		Total
				Developme nt-oriented	Research -oriented	
Motive 1	Government relationships	Count	12	0	12	
		Expected Count	9.6	2.4	12.0	
		% within Motive	100.0%	.0%	100.0%	
		Residual	2.4	-2.4		
2	Human resources	Count	5	14	19	
		Expected Count	15.1	3.9	19.0	
		% within Motive	26.3%	73.7%	100.0%	
		Residual	-10.1	10.1		
3	Vertical linkage	Count	24	0	24	
		Expected Count	19.1	4.9	24.0	
		% within Motive	100.0%	.0%	100.0%	
		Residual	4.9	-4.9		
6	Market access and market share	Count	14	0	14	
		Expected Count	11.2	2.8	14.0	
		% within Motive	100.0%	.0%	100.0%	
		Residual	2.8	-2.8		
Total		Count	55	14	69	
		Expected Count	55.0	14.0	69.0	
		% within Motive	79.7%	20.3%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	46.220 ^a	3	.000
Likelihood Ratio	47.706	3	.000
N of Valid Cases	69		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 2.43.

5.3.2.5 Chi-square tests for Hypothesis 3

Hypothesis 3 states that equity-based joint ventures are more likely involved with development-oriented R&D activities than non-equity based cooperative agreements.

The crosstab and Chi-square test results for H3 are shown in Table 9. The crosstab of Form and Function shows that there is a strong preference in the data for non-equity based cooperative agreements but within that context, there is strong evidence for H3.

The two sided Chi-square test has significance of 0.007, so there is very strong evidence for H1. The Fisher exact test (applicable for 2x2 tables) is also very significant at 0.007 (2-sided) and 0.004 (1-sided). The Fisher exact test is a conservative test that works even when the expected value in one or more of the cells is small. The Continuity Correction is a modification of the Pearson Chi-square for two-by-two tables. It also is very significant at 0.018 (2-sided). The expected minimum count, 4.17, is close to 5.

Table 9 Chi-square Test for H3

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Form * Function	72	90.0%	8	10.0%	80	100.0%

Form * Function Crosstabulation

			Function		Total
			Development-oriented	Research-oriented	
Form	Non-equity based RCA	Count	37	15	52
		Expected Count	41.2	10.8	52.0
		% within Form	71.2%	28.8%	100.0%
		Residual	-4.2	4.2	
	Equity-based RJV	Count	20	0	20
		Expected Count	15.8	4.2	20.0
		% within Form	100.0%	.0%	100.0%
		Residual	4.2	-4.2	
Total	Count	57	15	72	
	Expected Count	57.0	15.0	72.0	
	% within Form	79.2%	20.8%	100.0%	

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.287 ^b	1	.007		
Continuity Correction ^a	5.643	1	.018		
Likelihood Ratio	11.211	1	.001		
Fisher's Exact Test				.007	.004
N of Valid Cases	72				

a. Computed only for a 2x2 table

b. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.17.

5.3.2.6 Testing with control variable

A crosstab for origin of MNC and form (Table 10) shows that MNC from Japan and South Korea has a preference of equity-based R&D joint venture, different from the results of the whole sample. This shows that there may be cultural difference in the choice of form. However, the results of Chi-square tests with Origin of MNC as the control variable for the hypotheses were not used because of the very small value of minimum expected count, which means that the chi-square distribution may not be correct. Future research with larger database is needed to provide statistical evidence.

Table 10 Crosstab for Origin of MNC and Form

MNC Origin * Form Crosstabulation				
Count		Form		Total
		Non-equity RCA	Equity RJV	
MNC	North America	45	8	53
Origin	Europe	7	4	11
	Japan and South Korea		8	8
Total		52	20	72

5.3.3 Summary of results

From the tests of the hypotheses, we can summarize the results as follows,

- 1) There is some evidence for the association between an MNC's primary motive and its choice of organization form for an alliance. There is stronger evidence for

the association between an MNC's primary motive and its choice of organization form for an alliance when cases with motive 'transfer of complementary technology' and 'economies of scale' are not taken into account. MNCs have a strong preference in the data for non-equity based cooperative agreements but within that context, there is evidence that international R&D alliances in China formed by MNCs to seek local market access and market share or government relationship are likely to be in the form of equity based joint venture; while international R&D alliances formed by MNCs to seek human resources, to establish vertical linkages, to obtain complementary technologies or economies of scale are likely to be in the form of non-equity based cooperative agreements.

- 2) There is strong evidence that international R&D alliances in China formed by MNCs to seek local market access and market share, government relationship, to establish vertical linkages, to transfer complementary technology, or to capture economies of scale are likely to undertake development-oriented R&D activities, while international R&D alliances in China formed by MNCs to seek human resources are likely to undertake research-oriented R&D activities. There is strong evidence for the association between an MNC's primary motive and the activities undertaken in an alliance.
- 3) There is a strong preference for non-equity based cooperative agreements in the data but within that context, there is strong evidence for the association between the chosen form of R&D alliance and the alliance function. There is strong

evidence that equity-based joint ventures are more likely involved with development-oriented activities than non-equity based cooperative agreements.

6 DISCUSSION AND CONCLUSIONS

The data analysis and major findings of this study provide some insights on the motives of multinational corporations in forming international R&D alliances in China. They also shed light on the connection among the choice of alliance forms, functions undertaken, and declared motives.

6.1 Key findings

6.1.1 Motives for R&D alliances

Past research has noted the wide set of motives for R&D alliances, e.g. market- and technology-mediated motives (Hagedoorn and Narula, 1996). This study proposes a classification of six major motives of multinational corporations in forming R&D alliances in China from an integrated theoretical perspective while taking into consideration of the specific business environment in China. These major motives include market access and market share, government relationships, human resources, vertical linkages, transfer of complementary technology, and economies of scale.

The data show that the two most frequent motives of MNCs when establishing R&D alliances with Chinese organizations are establishing vertical linkage and obtaining human resources. The alliances between partners with vertical linkage may benefit both sides in several ways. The long-term supplier/customer relationship reduces transaction costs, enables partners to take advantage of complementary capabilities, facilitates

product development and system integration for an enhanced market share, and also, meets the policy or unofficial requirements for technology transfer for the market in China. The R&D alliances Lucent established with Chinese telecom equipment manufacturers Konka, Amoisonic, Eastcom, are typical examples of vertical linkages. Cooperating with Lucent, Konka, Amoisonic, and Eastcom developed their own GSM phone based on Lucent's technology for the mobile telecommunications market in China, which has the highest number of cellular phone users in the world.

High quality and low cost human resources in China were also expected to be a key to multinational corporations. Public sources show that more and more multinational corporations are increasing their R&D expenditures in China and hiring more local talents while at the same time cutting R&D jobs in North America and Europe. Many multinational corporations like Lucent Bell Labs, IBM, Microsoft, and Nokia all established extensive R&D alliances in China to take advantage of the local human resources.

6.1.2 Preference on form and the relationships between form and motive

The data show that in general there is a strong preference of non-equity based cooperative agreements. This is in consistent with the findings of past research on the general pattern of international R&D alliances formed between partners from developed markets such as US, EU and Japan (Hagedoorn and Narula, 1996). Harrigan (1985) noted that cooperation was a fundamental structural trait of high technology industries. Informal

cooperation forms such as non-equity based cooperative agreements were more commonplace than joint ventures. In technological intensive areas, firms are likely to be particularly concerned about the protection of proprietary knowledge for competitive advantages (Harrigan, 1985; Hladik, 1988). Contractual agreements are more likely than joint ventures to be the chosen form of governance in multinational alliances with high R&D intensity (Osborn and Baughn, 1990). The findings in this paper of the preference of non-equity based cooperative agreements for international R&D alliances in the information technology in China support these other research findings.

Within the context that there is a strong preference for non-equity based cooperative agreements, the data analysis of this study also provides some evidence for the association between the choice of organizational forms and MNC's primary motive. International R&D alliances in China driven by market access and market share or government relationships are more likely to be in the form of equity based joint venture than those seeking human resources, vertical linkages, complementary technologies or economies of scale. This result is consistent with the suggestions of Hagedoorn and Narula (1996) who point out that technology cooperation characterized by equity sharing are aimed at both market- and technology-mediated objectives rather than merely driven by technology sharing, or exclusively aimed at the creation of innovations. Considering the specific business environment in China, outside pressures like government requirements and growing inter-firm competition may be one of the reasons for the choice of equity-based joint venture as alliance form. As the organizational form of a joint venture facilitates better transferring of embedded knowledge (Kogut, 1988),

Chinese governments prefer this form even when it is no longer officially required in many high tech sectors due to China's accession to WTO. Because government relationships are very important to the success of foreign investors in a market with great impact of the centralized government authority like China, multinational corporations choose the form of joint ventures partly because they have to conform to government requirements or appease Chinese officials.

6.1.3 The relationships between function and motive

Data analysis of this study provides strong evidence for the association between the choice of alliance function and MNC's primary motive. International R&D alliances in China formed to seek human resources are more likely to undertake research-oriented R&D activities than those for market access and market share, government relationship, vertical linkages, transfer of complementary technology, or economies of scale. This is expected because the universities and academies in China offer high quality scientific and technological talents qualified for undertaking research oriented R&D activities, which require more sophisticated understanding of science and technology.

6.1.4 The relationships between form and function

Despite the strong preference for non-equity based cooperative agreements, data analysis in this study provides strong evidence for the association between the chosen form of R&D alliance and the alliance function. Equity-based joint ventures are more likely

involved with development-oriented R&D activities than non-equity based cooperative agreements.

6.2 Conclusions

From the data analysis and the above discussion, we can draw conclusions as follows,

- 1) Major motives driving MNCs to form international R&D alliances with partners from an emerging economy like China include seeking market access and market share, government relationship, human resources, vertical linkages, transfer of complementary technology, and economies of scale. Among them, establishing vertical linkage and obtaining human resources are the two most frequent motives.
- 2) There is a strong preference of non-equity based cooperative agreements in international R&D alliances in China. Within this context, there is significant association between motive of multinational corporations and the choice of form. Alliances formed by MNCs to seek market access and market share or government relationship are more likely to be in the form of equity based joint venture than others.
- 3) There is significant association between motive of multinational corporations and the choice of alliance function. Alliances formed by MNCs to seek human resources are more likely to undertake research-oriented R&D activities than others.

- 4) Equity-based joint ventures are more likely involved with development-oriented R&D activities than non-equity based cooperative agreements.

6.3 Contributions

This study makes five contributions to the academic knowledge of R&D strategic alliances.

- 1) This study constructs a framework of relationships among motive, form and function of international R&D alliances from an integrated theoretical perspective. It also provides empirical support using the firm level data based on a sample of 80 international R&D alliances between MNCs and Chinese partners.
- 2) This study identifies the major motives of MNCs to form international R&D alliances with partners from an emerging economy like China. This complements the academic knowledge on the global R&D strategies, which focuses on alliances between partners from developed countries. The data of this study revealed that seeking to establish vertical linkage and obtain human resources rank the two most frequent motives.
- 3) This study categorizes R&D activities with an indicator of market intention. The development-oriented activities are undertaken targeting local and/or global markets, while normally there is no specific target market for research-oriented activities.

- 4) This study provides a database of international R&D alliances in the information industry in China over the study period based on public information. This effort produces a clear picture of the joint efforts of many companies and makes it possible to study alliances in an emerging economy under the circumstances that there is no comprehensive government or industry collected database. It also enables empirical research which goes beyond case-based studies or experience-based statements.
- 5) The empirical research of this study is based on a database developed from public sources. Unlike survey-based research, the empirical findings of this study are reproducible due to the nature of its data gathering method. Such reproducibility is an essential aspect of most scientific endeavour.

This study also contributes to managerial practices:

- 1) This study presents an overview of the growth of R&D alliances in China and the impact of Chinese government policy on the growth trend with concrete data based on 80 alliances established during the period from 1997 to 2003. This information can help MNCs to understand the specific business environment in China.
- 2) This study provides alliance managers with an understanding on the motives that drive MNCs to form R&D alliances with partners in emerging economies. Its empirical findings provide insights on how a firm's strategic motive affects its choice of governance form and alliance function. This will help alliance managers

to choose proper form and function of the proposed alliances to support the firm's strategic motives.

- 3) This study provides a list of Chinese companies who have valued capabilities to be alliance partners of MNCs in IT and telecom industry. This may help the alliance managers of MNCs who are considering R&D alliances in China to find potential partners in unfamiliar market like China.

6.4 Limitations and future research

There are some limitations of this study and future research is needed in the studied areas.

- 1) There is a limitation of the data gathering method, such as inadequacy of certain sources and low profile of certain companies. Agreements involving small firms and R&D activities in existing manufacturing or marketing alliances are likely to be underrepresented because of the lack of information. The database draws primarily from English and Chinese-language materials. These shortcomings are not likely to be solvable for an individual collection. Hopefully there will be some extensive and large-scale data-collection by government or industry available in the future to facilitate both longitudinal as well as cross-sectional studies.
- 2) This study focuses on the perspective of multinational corporations. Future research is needed to study from the perspective of the local partners of emerging economies or of both partners.

- 3) This study analyzes R&D alliances cross-sectionally. Future studies are needed to look at the dynamic characteristics of alliances within a context, for example, of series of alliances between the same partners.
- 4) This study focuses on alliances in the information technology industry. Future research may include alliances in other industries for a larger size of sample to examine other factors that may affect the choices of alliance form and function, e.g. cultural difference of alliance partners.
- 5) Another research opportunity is to examine how the choices of form and function affect the alliance performance.

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APPENDIX

Database for International R&D Alliances in Information Technology Industry in China

Sources:

- Membership of China Communications Standards Association (CCSA)
- Corporate websites, press releases
- Newspapers in Lexis-Nexis, and journal articles in Business Source Premier.

List of 80 international R&D alliances in information technology industry (including telecommunications) established during the period from 1997 to 2003:

No	Year	MNC	Chinese
1	2002	Agere	Zhongxing
2	2002	Alcatel	MII
3	1998	AT&T	CAS
4	2000	Bell Labs	CAS
5	2001	Bell Labs	Fudan
6	1998	Bell Labs	Peking
7	2000	Bell Labs	Tsinghua
8	2000	Bell Labs	Tsinghua2
9	2000	Bell Labs	Tsinghua3
10	2002	Ciena	CEC-IDN
11	2001	Cisco	AsiaInfo
12	2000	Cisco	China Unicom
13	1999	Compaq	CS&S
14	2000	Compaq	Xi'an Datang
15	1999	Ericsson	BIT
16	2000	Ericsson	CATT
17	1999	Fujitsu	Guoguang
18	1999	Fujitsu	Nanjing
19	2001	HP	China Mobile
20	1997	IBM	Beida Founder
21	1997	IBM	Great Wall

No	Year	MNC	Chinese
22	2000	IBM	Huawei
23	2000	IBM	Peking
24	2000	IBM	Tsinghua
25	2003	Infineon	Huawei
26	2002	Infineon	Huawei
27	2001	Intel	CAS
28	2003	Intel	Legend
29	2001	LGE	Capitel
30	2001	LGE	Langchao
31	2000	Lucent	Amoisonic
32	1999	Lucent	Beijing Optical
33	1999	Lucent	BTEF
34	1999	Lucent	China Telecom
35	2000	Lucent	China Unicom
36	1998	Lucent	Eastcom
37	1999	Lucent	Konka
38	1998	Lucent	Qingdao
39	2002	Microsoft	Centek
40	2003	Microsoft	CS&S
41	2001	Microsoft	CS&S
42	2002	Microsoft	Datasys
43	2000	Microsoft	HIU
44	2000	Microsoft	Tsinghua
45	2000	Microsoft	Zhejiang
46	2002	Microsoft	Shangdong
47	2002	Microsoft	Shanghai Alliance
48	2002	Microsoft	TCL
49	1999	Microsoft	UFsoft
50	2002	Microsoft	UFsoft
51	2003	Microsoft	Vimicro
52	2002	Motorola	Dianji
53	2000	Motorola	Eastcom
54	2002	Motorola	Eastcom
55	2000	Motorola	Nanjing
56	2000	Motorola	CAS
57	2000	Motorola	Neusoft
58	2003	Motorola	Shanghai 3g
59	2000	National Semi	Legend
60	1998	NEC	Huahong
61	2002	NEC	Huawei
62	2003	NEC	SVA
63	2000	Nokia	Beijing Mobile

No	Year	MNC	Chinese
64	1999	Nokia	Cernet
65	2000	Nokia	Neusoft
66	1999	Nokia	RITT
67	2001	Nokia	Zhejiang Gov.
68	2000	Nortel	Datang
69	2003	Nortel	Datang Mobile
70	2002	Oracle	Legend
71	2003	Philips	Datang Mobile
72	2001	Samsung	Shanghai Bell
73	2003	Siemens	Huawei
74	2003	Sun	China Unicom
75	2002	Tektronix	RITT
76	2001	Thales	CATT
77	1999	TI	Great Wall
78	2000	TI	GSTA
79	2002	UTstarcom	Datang Mobile
80	2002	Vodafone	China Mobile