Motive, Form and Function of International R&D Alliances:

Evidence from the Chinese IT Industry

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Abstract

This article adds to the research literature on international R&D alliances by focusing on alliances formed by multinational corporations with Chinese organizations. Using publicly available information, we developed a sample of 80 international R&D alliances between multinational corporations and Chinese organizations in the information technology industry in China formed during the period from 1997 to 2003. We use these data to test hypotheses on the connections between the declared motives, organizational form and R&D activity function of such alliances. Our analysis shows that the two most frequent motives of multinational corporations when establishing R&D alliances with Chinese organizations are establishing vertical linkages and obtaining human resources. Within the context of a strong preference for non-equity based cooperative agreements, our analysis also provides some evidence for an association between the choice of form and motive, strong evidence for an association between function and motive, and strong evidence for an association between the form and function. (154 words)

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1. Introduction

Strategic alliances have emerged as one of the most important organizational forms providing competitive advantage (Das and Teng, 2000), particularly for technology-based 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 that has a very specific business environment.

China has been making efforts in recent years to attract foreign investment in R&D with the aim of enhancing the technology capabilities of Chinese firms. Many multinational corporations (MNCs) have set up R&D centers in China and have formed R&D alliances with Chinese companies, universities, and government agencies in various forms (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.

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. We explore the following research question: What are the connections between MNCs' strategic motives, choices of forms and R&D activities of their R&D alliances in China?

There is a need to better understand the relationships between motive, form and function of international R&D alliances particularly when the home bases of the firms involved are in different countries. As noted, the failure rates for alliances of this sort are very high. This study addresses this need. We theorize about the relationships between motive, form and function of international R&D alliances and find significant support for the resulting hypotheses when tested on a sample of 80 international R&D alliances between MNCs and Chinese partners. We also provide managerially relevant insights into the growth of R&D alliances in China and the impact of Chinese government policy on this growth – information that can assist managers in understanding the business environment in China.

We create a sample from the Chinese information technology (IT) industry (including telecommunications), an emerging industrial sector that has been involved in a large number 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. The sample includes 80 international R&D alliances between MNCs from North America, Europe, Japan and South Korea and Chinese organizations.

The results of our research reveal that major strategic motives of MNCs to form R&D alliances with Chinese partners include: nurturing government relationships; obtaining human resources; creating vertical linkages; transferring complementary technology; achieving economies of scale; and gaining local market access and market share. The two most frequently observed motives were establishing vertical linkage and obtaining human resources.

We also found that alliances formed by MNCs are more frequently non-equity based cooperative agreements. Within this context, alliances formed by MNCs to nurture government relationships or to seek market access and market share 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 other motives. Equity-based joint ventures are more likely formed for development-oriented R&D activities than are non-equity based cooperative agreements. Since evidence for these relationships was developed through testing hypotheses, the reasoning for the hypotheses themselves provides further insight for researchers and managers into motive, form and function of multi-national R&D alliances in China.

2. Chinese Government Policy and the Growth of Foreign R&D

In the mid-1980s, China implemented a policy of '*Technology Transfer from Opening Domestic Markets'* to attract foreign direct investments and obtain spillover effects for the domestic economy (Zhao and Sun, 2003). MNCs became an important source of foreign R&D investment in China. By the mid-1990s R&D investment was required by official or unofficial policies for the establishment of Sino-foreign joint ventures. As many of these early joint venture-based R&D programs were products of government pressure, however, 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.

As foreign invested R&D began to grow and expand in China in the mid-1990s, the Chinese policy of '*Going West'* encouraged foreign investors to move into the less developed inland provinces in China to establish R&D centers and manufacturing bases. In addition, the expectation of China's near-term of 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).

In the telecom and information technology sector, China started to implement the so-called '*Golden Projects*' to establish national fiber-optic communications networks. Multinational corporations rushed to partner with Chinese firms for market access, especially the opportunities these projects offered. Foreign companies also participated in various projects for communication terminals and other related equipment. The

'*Golden Projects'* 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 1990s, in part due to WTO-related reforms, foreign companies are no longer *required* to have Chinese partners to invest in most high-tech industries (MOFTEC, 2000). Major city governments, such as Beijing and Shanghai now offer preferential features to encourage the 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 of these changes, technology-based multinationals have established many R&D centers, programs, and labs in China, in partnership with Chinese companies or in the form of wholly foreign owned enterprises (Walsh, 2003).

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. This R&D cooperation has begun 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.

China's rapid advance in technology-based industries has been aided by a policy of 'technology for market' (Kranhold, 2004). Upon entering the WTO in 2001, China did not sign away its ability to require foreign companies to transfer technology as part of any agreement for doing business 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). This article aims to

reduce this gap by exploring 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. Research Model

3.1 Motive

Numerous motivations for alliances have been identified in the literature (Barringer and Harrison, 2000; Glaister and Buckley, 1996; Kogut, 1988; Porter, 1986; Powell, 1990). We consider six motives for MNCs establishing alliances with Chinese organizations: government relations, human resources, vertical linkages, transfer of complementary technology, economies of scale, and market access and market share.

Government relationships

Government retains great influence in the Chinese market. 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, particularly in IT where the Chinese government plays a key role in determining technical standards. It can be important for MNCs to ally with firms that have influence on these standards.

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 capable of performing quality basic and applied research at a relatively low cost.

Vertical linkages

In a vertical linkage, each partner contributes one or more different element in a value chain (Contractor and Lorange, 1988). Chinese IT firms often purchase core components and technologies from MNCs, and then undertake system integration and develop features for the final product for the consumer market. 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

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). 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.

Economies of scale

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 the 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 for the benefit of economies of scale in R&D.

Market access and market share

Entry into foreign markets is a well-known rationale for firms to enter into alliances with local partners (Contractor and Lorange, 1988; Hladik, 1988). Moreover, in China, as state-owned enterprises dominate its economy and national and local government often place strict control over market operations, alliances with local partners were the only way to enter the domestic market up until the WTO reforms in the late 1990s (Calantone and Zhao, 2001; Lee, Chen, and Kao, 2003). In those industrial areas where foreign firms are allowed to enter the domestic market, MNCs can obtain market knowledge and enhance market share through partnering with local firms who have strong market position. 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.

3.2 Form

Researchers have distinguished two types of R&D alliance 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). We adopt this categorization of R&D alliance forms.

An equity-based R&D joint venture (RJV) involves the sharing of equity in a new organization jointly controlled by two or more partners to engage in R&D activities (Vonortas, 1997; Hagedoorn and Narula, 1996). 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).

3.3 Function

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). The NSF defines three types of R&D, basic research, applied research, and development. The *Frascati Manual 2002* recognizes three categories of R&D: basic research, applied research, and experimental development.

These classifications, however, have received criticism for practical 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, research-oriented and development-oriented (Li and Zhong, 2003). We adopt this two-category typology for R&D activities in international R&D alliances.

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

Research-oriented activities include both basic research and applied research 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).

3.4 Relationship between motive and form

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 noted an underlying tension between 'trying to learn and trying to protect' in strategic alliances (Kale et al., 2000, p. 217). Alliance participants internalize complementary capabilities and skills possessed by the partner and, at the same time, work to protect some of their own core capabilities from being appropriated by the partner. Thus, alliance 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 are exposed to each other (Mowery, et al. 1996; Kogut, 1988). Equity joint ventures are found to be the preference of firms who seek the transfer of intangible know-how and skills, while non-equity based cooperation agreements are 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 prefer non-equity based cooperative agreements 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. 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 seek market access and market share or to nurture government relationships from their local partners, 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 when pursuing these motives 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. A 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. In this case, non-equity based cooperative agreement is most likely to be chosen for the alliance.

We 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 nurture government relationships or to seek local market access and market share 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, to establish vertical linkages, to seek complementary technologies or economies of scale, are likely to be in the form of non-equity based cooperative agreements.

3.5 Relationship 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 nurture government relationships or to seek market access and market share, 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 and so concentrate on development activities.

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 from local universities and institutes 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 nurture government relationships, to seek local market access and market share, to establish vertical linkages,

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.

3.6 Relationship 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 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 response to local government pressures, it is likely that equity-based joint ventures are used for the development-oriented activities aimed at local markets.

Table 1 shows, moreover, that hypotheses 1 and 2 taken together imply that MNCs will establish non-equity based cooperative agreements for research to take advantage of China's human resources but have no motives for establishing equity based joint ventures to carry out research. This implies that equity-based joint ventures are more likely used for development-oriented R&D activities than are non-equity based cooperative agreements.

Table 1: The Connection between Hypotheses 1, 2 and 3

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Hence we hypothesize:

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

4. Research Design

4.1 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). We drew our sample from the information

technology (including telecommunications) industry, an emerging industry in China that has attracted a 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 (China Online, 2004). In this study we examine those industrial sectors under the administration of the MII and enjoying similar local government policies, which include telecommunications, computer electronics, software, and Internet.

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), magazine articles (Business Source Premier database), Internet news, and similar public sources. Many of the newspaper and magazine articles, Internet news and similar public sources originate as company written news releases.

The membership of China Communications Standards Association (CCSA) was used as the source of Chinese partners. It includes major players in the 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 the information technology industry during the period from 1994 to 2003. Very few alliances were established before 1997 and no detailed information was available for these few alliances. Thus no alliance established before 1997 is 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) that were drawn from the membership lists of the 3rd Generation Partnership Project (3GPP) and the Third Generation Partnership Project 2 (3GPP2). However, no additional 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.

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

Figure 1: Procedures of Data Collection

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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 were considered as individual alliances. The involvement of a new partner to the existing cooperative venture or joint projects under separate agreement was also treated as a new alliance. When more than two partners were involved in the same agreement, it was counted as one alliance. Frequencies reported, therefore, refer to the number of individual alliances.

4.2. Variables and measurements

Form

The categorization of the form of R&D alliances was based on equity participation: non-equity based R&D cooperative agreements (RCAs) and equity-based R&D joint ventures (RJVs). 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 projects/programs, b) joint R&D centers/laboratories in the form of a Cooperative Joint Venture (with conditions for cooperation), c) open R&D centers, and d) research and/or development cooperation

agreements/partnerships. Equity-based R&D joint ventures involve equity sharing between partners, and include: a) R&D centers in the form of Equity Joint Ventures (EJVs), and b) R&D activities in the form of EJVs.

Function

The categorization of the function of R&D alliances was based on whether an alliance undertakes development-oriented or research-oriented activities. 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 and with specific commercial objectives, respectively.

An indicator of market intention was 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 had to be applied to product development for market application.

Motive

A category variable was defined for the primary motive of the alliance formation: nurturing government relationships, obtaining human resources; creating vertical linkages,

transferring complementary technology; achieving economies of scale, and gaining market access and market share. Among these motives, nurturing government relationships was indicated by government requirement, the partner's government background, or government support and endorsement. Achieving economies of scale was indicated by partners with similar technology or the demand for speed of R&D. Gaining market access and market share was indicated by four specific objectives: market access, market share, R&D localization for competitive advantage, and technology recognition.

Considering that in some cases there is more than one motive that drives the formation of an R&D alliance, we also gathered data on secondary motives for the alliances in the sample. Due to the small number of cases with declared secondary motive, however, these data were not used in the analysis.

Origin of the MNC

Different foreign partner countries of origin have different culture distances from local partners. Given the possibility that this cultural distance might affect objectives, governance form selection, or alliance function, foreign partner country origin was added as a control variable (Hitt et al. 2000; Kale et al. 2000). Previous research work (Hagedoorn, et al. 2000) reveals 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.

Table 2 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 3 illustrates the coding scheme. An example of coding using text data contained in the research data base is shown in Table 4.

One researcher coded the data. The coding scheme evolved as the first researcher coded the first 20 or so alliances while occasionally consulting with the second researcher. Once this coding was finished, the second researcher checked the data coding and raised questions. After discussion, all of these questions were satisfactorily addressed. Not a single decision from final coding of the first researcher required a change. There was total agreement between the two researchers.

Table 2: Key Words for the Categorization of Motive, Form and Function

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Table 3: Coding Scheme

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Table 4: Example of Coding

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4.3 Data analysis and results

Tables 5a and b contain, respectively, the data on the 72 cases in the sample for which data for motive, form and function was available, and the data for the 8 cases for which

form could not be determined. Table 6 contains data on the origin and size of the MNCs with alliances in the sample. One can see that:

1) The two most frequent motives of MNCs in forming R&D alliances in China have been for establishing vertical linkages (25/80) and obtaining human resources (19/80);
2) The majority of the alliances have taken the form of non-equity based R&D cooperation agreements (52/72);
3) The majority of the alliances have performed development-oriented R&D activities (65/80);
4) The majority of research alliances developed for the motive of human resources use a non-equity form (14/15);
5) A significant fraction of development alliances are established for the motive of vertical linkages using a non-equity form (18/57);
6) Of the 31 MNCs with alliances in the sample, the majority were from North America; and
7) The MNCs in the sample are large companies. The smallest MNC had 1,700 employees.

Table 5a: Motive, Form and Function

for the 72 Alliances with Data for All Three Variables

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Table 5b: Motive and Function

for the 8 Alliances Lacking Data on Form)

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Table 6: The Origin and Size of the MNCs with Alliances in the Sample

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Hypothesis 1

Hypothesis 1 states that international R&D alliances in China formed by MNCs to nurture government relationships or to seek local market access and market share 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.

The Chi-square test results for H1 are shown in Table 7. The data show that MNCs have a strong preference for non-equity based cooperative agreements but within that context, there is some evidence for H1 ($p = 0.118$).

Because the lowest expected count in the chi-square tests is less than 5, the observed significance level based on the Chi-square distribution may be suspect. 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 in Table 8. With motives 4 and 5 taken out of the data, there is stronger evidence for the limited H1 ($p = 0.032$). The number of cells with expected counts less than 5 is many fewer and the lowest expected count is much great: 2.70 versus 0.83.

Table 7: First Chi-square Test for H1

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Table 8: Second Chi-square Test for H1

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Hypothesis 2

Hypothesis 2 states that international R&D alliances in China formed by MNCs to nurture government relationships, to seek local market access and market share, to establish vertical linkages, 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.

The Chi-square test results shown in Table 9 provide strong evidence for H2 ($p = 0.00$).

With motive values 4 and 5 again removed from the data because the lowest expected value is again less than 5, the two sided Pearson Chi-Square test shown in Table 10 still has significance of $p = 0.000$. 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 9: First Chi-square Test for H2

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Table 10: Second Chi-square Test for H2

(Goes about here)

Hypothesis 3

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

The Chi-square test results for H3 are shown in Table 11. The data show 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 ($p = 0.007$). 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 11: Chi-square Test for H3

(Goes about here)

Origin of MNC

The data for origin of MNC and form in Table 10 show that MNC from Japan and South Korea have a preference of equity-based R&D joint venture, different from the results of the sample. The results of Chi-square tests for the hypotheses with origin of

MNC as the control variable were not used, however, because of the very small value of minimum expected cell counts.

Table 12: Crosstab for Origin of MNC and Form

(Goes about here)

We have no theoretical explanation for why the Asian MNCs in the sample (Fujitsu, LGE, NEC and Samsung) are different in this way. There may be cultural difference in the choice of form, but it is a small sample of Asian MNCs and they are all large. The data do suggest an issue for future research.

5. Discussion and Conclusions

Our data show that the two most frequent motives of MNCs when establishing R&D alliances with Chinese organizations are establishing vertical linkages and obtaining human resources. The alliances based on vertical linkages can benefit both partners 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 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 have all established extensive R&D alliances in China to take advantage of the local human resources.

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. Technology 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 of 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.

The 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 relationships, 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.

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.

This study contributes to the academic knowledge of R&D strategic alliances in a number of ways. We construct a framework of relationships among motive, form and function of international R&D alliances and support it empirically based on a sample of 80 international R&D alliances between MNCs and Chinese partners. Part of the framework is the identification of 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.

We also contribute managerially relevant insights into the growth of R&D alliances in China and the impact of Chinese government policy on this growth. This information can help managers understand the specific business environment in China.

To carry out empirical tests, we constructed 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, and enables empirical research which goes beyond case-based studies or experience-based statements.

The nature of this database, developed from public sources, means that the empirical findings of our study are reproducible by other researchers. Such reproducibility is an important and attractive aspect for any scientific study.

Our data contain a list of Chinese companies who have valued capabilities to be alliance partners of MNCs in IT and telecom industry. This can help the alliance managers of MNCs who are considering R&D alliances in China to find potential partners in unfamiliar market like China.

The study has a couple of limitations worth noting. For example, agreements involving small firms and R&D activities in existing manufacturing or marketing alliances are likely underrepresented in our data because of the lack of public information. We also focus on the perspective of multinational corporations. Future research could study the perspective of the local partners of emerging economies or of both partners. This study analyzes R&D alliances cross-sectionally. Research focused on the dynamic characteristics of alliances within a specific context, for example a series of alliances between the same partners, could shed further light on the relationships between alliance motive, form and function.

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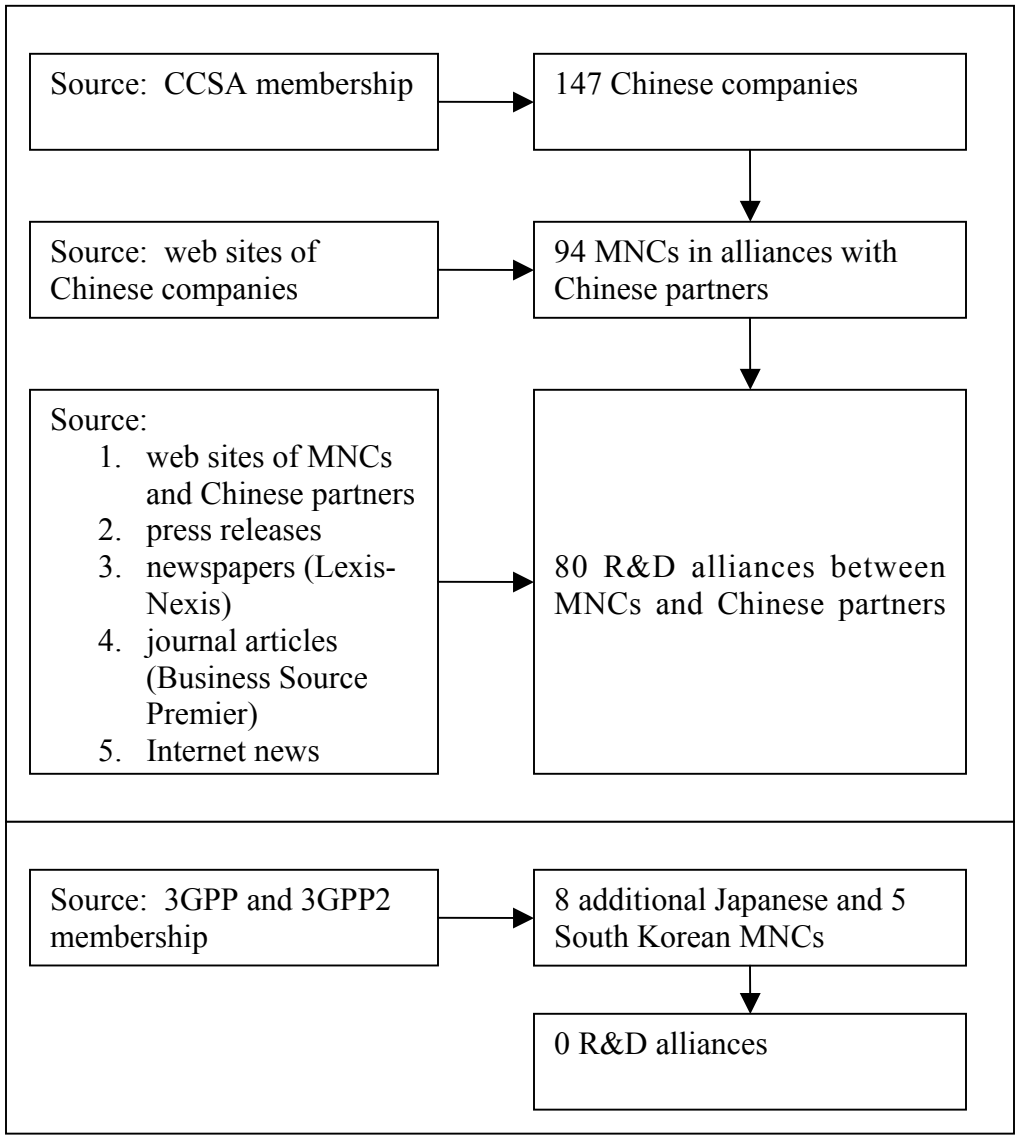

Figure 1: Procedures of Data Collection

Table 1: The Connection between Hypotheses 1, 2 and 3

Hypothesis 1 in table format

Form	**Motive**
equity based joint venture	*M1, M6*
non-equity based coop agreement	*M2, M3, M4, M5*

Hypothesis 2 in table format

Function	development	research
Motive	*M1, M3, M4, M5, M6*	*M2*

Hypotheses 1 and 2 in table format

Form\Function	development	research
equity based joint venture	*M1, M6*	
non-equity based coop agreement	*M3, M4, M5*	*M2*

Alliance motives:

M1 Government relationships
M2 Human resources
M3 Vertical linkages
M4 Transfer of complementary technology
M5 Economies of Scale
M6 Market access and market share

Table 2: 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 xx 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 3: 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 4: 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		

Table 5a: Motive, Form and Function
for the 72 Alliances with Data for All Three Variables

Motive			Function: Dev't	Function: Res.
Government relationships	Form	Non-equity	6	
		Equity	4	
Human resources	Form	Non-equity	2	14
		Equity	2	
Vertical linkages	Form	Non-equity	18	
		Equity	4	
Complementary technology	Form	Non-equity	4	
		Equity	2	
Economies of scale	Form	Non-equity	1	1
		Equity	1	
Market access/share	Form	Non-equity	6	
		Equity	7	

Table 5b: Motive and Function
for the 8 Alliances Lacking Data on Form

	Function	
Motive	Dev't	Res.
Government relationships	2	
Human Resources	1	
Vertical Linkages	2	
Complementary technology	2	
Economies of scale		
Market access/share	1	

Table 6: The Origin and Size of the MNCs with Alliances in the Sample

Region	Number of companies	Average number of employees	Number of employees
U.S. & Canada	19	73,200	1,700 – 151,000
Europe	8	86,500	35,500 – 430,000
Japan and South Korea	4	133,800	66,600 – 195,000

Table 7: First Chi-square Test for H1

Motive * Form Crosstabulation

			Form		
			Non-equity based RCA	Equity-based RJV	Total
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.

Table 8: Second Chi-square Test for H1

Motive * Form Crosstabulation

			Form		
			Non-equity based RCA	Equity-based RJV	Total
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.

Table 9: First Chi-square Test for H2

Motive * Function Crosstabulation

			Function		
			Development-oriented	Research-oriented	Total
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.

Table 10: Second Chi-square Test for H2

Motive * Function Crosstabulation

			Function		
			Developme nt-oriented	Research -oriented	Total
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.

Table 11: Chi-square Test for H3

Form * Function Crosstabulation

			Function		
			Developme nt-oriented	Research -oriented	Total
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.

Table 12: Crosstab for Origin of MNC and Form

MNC Origin * Form Crosstabulation

Count

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