KNOWLEDGE PROTECTION AND PARTNER SELECTION IN R&D ALLIANCES

A Dissertation

by

DAN LI

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2005

Major Subject: Management

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Approved by:

Co-Chairs of Committee,	Lorraine Eden
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ABSTRACT

Knowledge Protection and Partner Selection in R&D Alliances. (August 2005)

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Dr. Michael A. Hitt

This dissertation investigates three sets of research questions. First, how can partner selection be used as a mechanism to minimize R&D alliance participants' concerns about knowledge leakage? And what is the nature of the relationship among partner selection and two previously-studied protection mechanisms – governance structure and alliance scope? Extending this research question to the international context, the second set of research questions asks how international R&D alliances differ from their domestic counterparts in partner selection to protect their participants' valuable knowledge, and how different types of international R&D alliances vary in this regard. Distinguishing bilateral from multilateral R&D alliances, this dissertation examines a third set of questions about how multilateral R&D alliances differ from bilateral ones in partner selection for the purpose of protecting participants' technological assets. Hypotheses are proposed and tested with a sample of 2,185 R&D alliances involving companies in high technology industries.

Results indicate that the more radical the innovation an R&D alliance intends to develop, the more likely the alliance will be formed between Friends than Strangers. However, under the same situation, firms are less likely to select Acquaintances than Strangers. A substitution effect was detected among partner selection, governance

structure, and alliance scope used by firms to protect their valuable technological assets from being appropriated in R&D alliances. In addition, no empirical support was found for different partner selection preferences for firms forming domestic R&D alliances versus international R&D alliances. However, results show that firms, when forming *trinational* R&D alliances and/or *traditional international* R&D alliances, are more likely to select their prior partners than when forming *cross-nation domestic* R&D alliances. Moreover, this study shows that when an R&D alliance is formed by multiple companies, partner firms are more likely to be prior partners. I argue that concerns about knowledge leakage explain this result.

DEDICATION

To my parents

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CHAPTER I

INTRODUCTION AND RESEARCH OBJECTIVES

MOTIVATION AND RESEARCH QUESTIONS

Much of the world economy centers on intellectual property where the major growth industries are knowledge intensive industries such as microelectronics, biotechnology, and telecommunications (Thurow, 1997). For companies such as Microsoft, the basis for competitiveness resides in their technological and intangible assets, rather than their vast pool of tangible assets. Therefore, fighting to defend and extend the domain of their intellectual property is the way modern companies compete in the global economy.

Research and development (R&D) alliances, in particular, have become a popular vehicle for building and leveraging technological capabilities for firms operating in fast-paced and knowledge-intensive environments (Duysters & Hagedoorn, 1996; Narula & Duysters, 2004). In such alliances, partners pool their resources and capabilities to develop new technologies that they cannot develop on their own. However, while enjoying access to their alliance partners' technological assets, firms also put their own valuable knowledge at risk of appropriation. Thus, firms need to find the right balance between maintaining open knowledge exchange to further the technological development goal of the alliance, and controlling knowledge flow to avoid

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This dissertation follows the style and format of the ***Academy of Management Journal.***

unintended leakage of valuable technological assets (Kale, Singh, & Perlmutter, 2000; Oxley & Sampson, 2004).

Previous research has suggested two solutions to protect firms' valuable technological assets in R&D alliances. For example, transaction cost theorists suggest that the selection of a proper governance structure, or organizational form, can promote knowledge sharing and protect core technological assets from being appropriated by opportunistic partners (e.g., Pisano, 1989; Oxley, 1999). Specifically, equity-based governance structures are likely to provide better protection than non-equity-based structures. This is because the equity investments create a mutual hostage situation for the partners, hopefully preventing them from behaving opportunistically (Hennart, 1982; Teece, 1992). Other scholars suggest adjusting the scope of R&D alliances to control knowledge leakage (e.g., Khanna, 1998; Oxley & Sampson, 2004). Alliance scope decisions involve whether to restrict cooperation to R&D collaboration or extend it vertically to include manufacturing and/or marketing. When the costs of knowledge leakage are deemed to be particularly high, alliance scope can be narrowed to limit knowledge exposure.

However, there are circumstances in which even the most protective alliance forms and the most restricted alliance scope do not reduce leakage concerns sufficiently to ensure the appropriate level of knowledge sharing required to achieve the objectives of an R&D alliance. In this dissertation, I suggest the selection of a prior partner is an alternative, third way to control the threat of knowledge leakage and retain the firm's core technological assets in an R&D alliance.

I argue there are three types of potential partners in an alliance: Friends, Acquaintances and Strangers. I define *Friends* as firms that have had repeated alliance collaborations in the recent past. Friends not only know each other but have built high-level trust through their interactions. *Acquaintances* are firms that have engaged in a single alliance in the recent past. Acquaintances have accumulated some knowledge about each other, but trust may or may not have been established. Hence, the distinction between Acquaintances and Friends is based on the number of shared prior alliances, and therefore on the implicit degree of trust established through these prior alliances. I define *Strangers* as firms that have never been alliance partners.

Partner selection has important implications for the extent to which alliance partners expose valuable knowledge to each other. In circumstances where the costs of knowledge leakage are perceived to be high, one might expect that only Friends will be selected to limit knowledge appropriation. I develop these ideas in more detail later in this dissertation and identify the circumstances that are more likely to lead to the selection of prior partners (i.e., Friends or Acquaintances) in new R&D alliances, as a means to protect technological assets. I argue that the hazards of knowledge sharing will be most salient when the innovations to be developed are radical and/or the external protection of intellectual properties is weak. Both circumstances promote firms to carefully consider whether to select prior partners to protect their valuable knowledge from being appropriated. I further explore the extent to which the selection of prior partners, alliance scope and governance choices act as substituting mechanisms for protecting technological assets in R&D alliances. That is, when the R&D alliance is

governed by a protective structure and/or when it has a very narrow scope of joint activities, the need for selecting a trustworthy partner may not be as salient, and vice versa.

Research question 1.1: How do innovation radicality and intellectual property protection affect firms' partner selection as a mechanism to protect their technological assets in R&D alliances?

Research question 1.2: What is the nature of the relationship among partner selection, governance structure and alliance scope as alternative means for firms to protect technological assets in R&D alliances?

After generally analyzing knowledge protection and partner selection in R&D alliances, this dissertation carries the research to two specific types of R&D alliances – international R&D alliances and multilateral R&D alliances. Two more sets of research questions are pursued.

In general, R&D tends to stay "at home" (Kumar, 2001; Narula, 2002). Nonetheless, it is worth noting that R&D activity abroad has grown relative to its level 20 years ago (Narula & Duysters, 2004). Firms expanded fast internationally to exploit and acquire assets and technology that may be specific to particular locations. While there are many reasons for firms to move their R&D activities abroad, international R&D alliances are risky. Prior studies have shown that technology flows to nearby locations are greater and faster than flows to more distant locations (e.g., Jaffe & Trajtenberg, 1993; 1999). Involving partner firms from different national backgrounds, international alliances are perceived to represent complex inter-firm relationships. It has

been well accepted that international alliances pose additional risks due to political, public policy, economic, and social uncertainty (Brouthers, 1995). Therefore, the perceived risk of opportunism is higher in international than domestic alliances (McCutchen Jr., Swamidass, & Teng, 2004). Due to the lack of trust resulting from different national backgrounds, alliance partners have more concerns about knowledge leakage for their international R&D alliances than domestic ones. This dissertation examines how the international component of an R&D alliance complicates firms' partner selection in the context of knowledge protection.

Research question 2.1: How do domestic R&D alliances differ from international ones in firms' partner selection for the purpose of protecting their technological assets?

The international alliance literature has focused on two parent alliances formed between one foreign firm and one local firm. However, other types of alliances exist. I differentiate three distinct forms of international alliances based on the alliance partners' nationality. Specifically, this study defines partner nationality in terms of whether the international R&D alliance is formed by foreign-, local-, or third country-based firms. A *cross-national domestic R&D alliance* (DRDA) is an R&D alliance formed between foreign -based firms in the local market; and the home countries of foreign-based firms are the same. A *traditional international R&D alliance* (IRDA) is an R&D alliance formed between a foreign-based and a local-based firm. A *trinational international R&D alliance* (TRDA) is an R&D alliance formed between foreign-based firms in the local market; and the home countries of foreign-based firms are different. Therefore, three

nationalities are involved in a TRDA. Considering the complexity involved in each type of international R&D alliance from the perspective of cultural difference (both organizational and national cultures), I examine the differences in partner selection among these three types of international R&D alliances for the purpose of knowledge protection.

Research question 2.2: How do cross-border domestic, traditional international, and trinational R&D alliances differ in firms' partner selection for the purpose of protecting their technological assets?

Multilateral alliances have gradually emerged in many industries such as software development, communication, and pharmaceuticals (Gomes-Casseres, 1994). Compared to the conventional two-firm alliance, the multi-firm alliance is a single, large, overarching relationship joined by several companies for a common purpose. Several published articles have provided evidence for the prevalence of multilateral alliances. For instance, in the large database of 2,471 alliances from multiple industries and countries compiled by Gulati (1995a), twenty-seven percent of these alliances are reported to be trilateral alliances. In a related database used by Gulati and Singh (1998), about one-third are multilateral alliances, out of 1,570 alliances in the biopharmaceutical, new materials, and automobile industries.

While there is no doubt that multilateral alliances have the same value creation logic as bilateral alliances, "greater numbers of participants also complicate alliance design and governance" (Doz & Hamel, 1998: 224). In R&D alliances, concerns regarding knowledge leakage are higher when more partners are involved. This is

because when more than two partners are involved, the reciprocal exchange disappears and the direct monitoring of partners' behaviors becomes more difficult. Drawing on social exchange theory, this dissertation analyzes how multilateral R&D alliances differ from bilateral ones in partner selection for the purpose of knowledge protection.

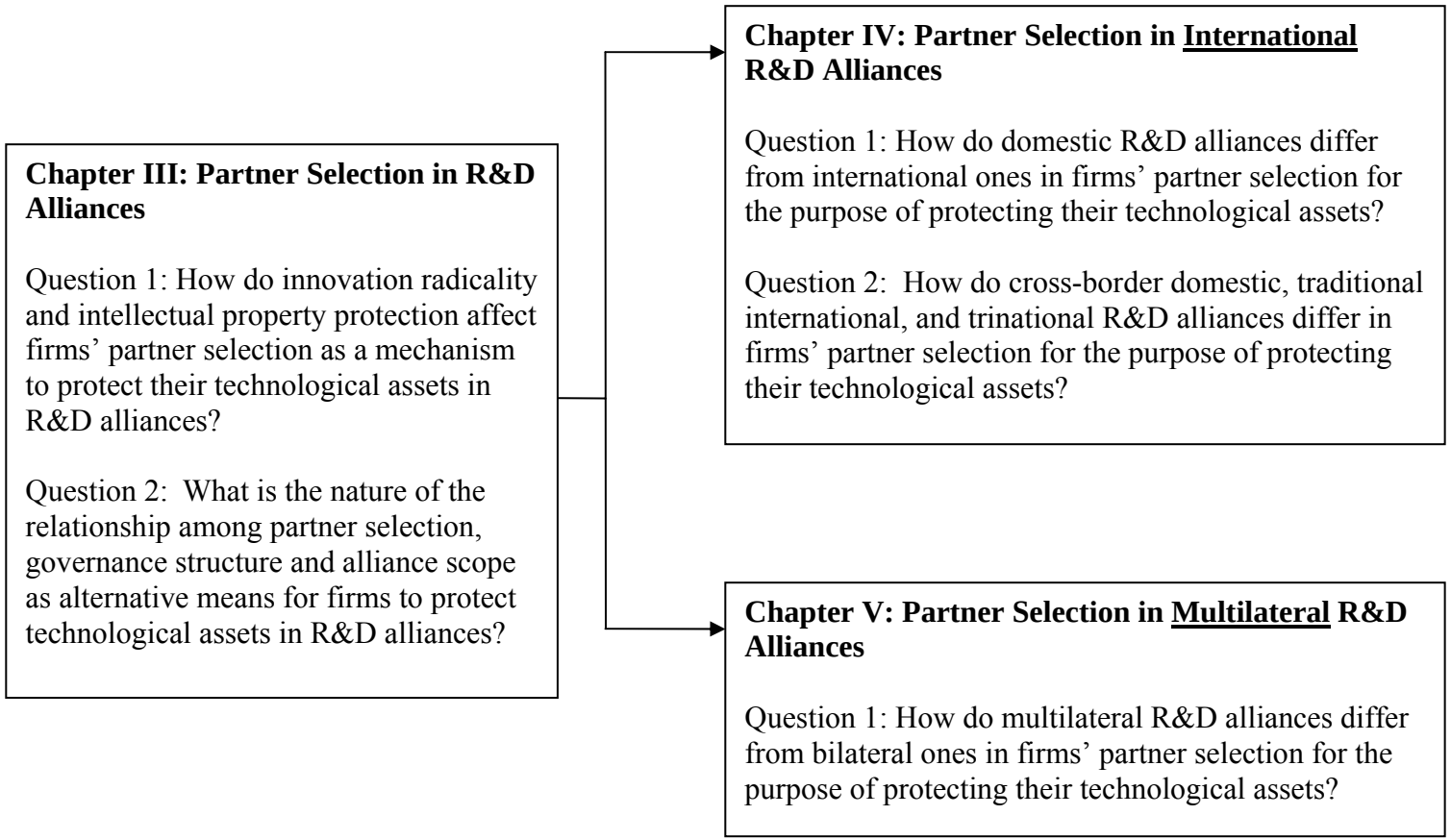
Research question 3: How do multilateral R&D alliances differ from bilateral ones in firms' partner selection for the purpose of protecting their technological assets?

Figure 1.1 offers a summary of the research questions investigated in this dissertation.

OVERVIEW OF RESEARCH METHODS

Theory and hypotheses developed in the present study are tested by using a sample of 2185 R&D alliances involving companies in high-technology industries from 1994 through 2003. The selection of this sample for the present study comes from both theoretical and pragmatic concerns. Theoretically, firms in high-technology industries are ideal for a study of R&D alliances. Survival and profitability in these high-technology industries are critically dependent on a firm's ability to create and commercialize innovations quickly. Therefore, firms establish R&D alliances at an unprecedented rate, as a way to spread the risk and cost of technological development. Pragmatically, the sample ensures the availability of the data needed to test the theory and hypotheses generated.

FIGURE 1.1.
Research Questions



Data are collected from various archival sources, the most important of which is the Securities Data Corporation (SDC) Database on Alliances and Joint Ventures. The SDC database contains information on all types of alliances, compiled from publicly available sources such as SEC filings and their international counterparts, trade publications, wires, and news sources. Although the coverage of alliances is still far from comprehensive, this database currently represents one of the most comprehensive sources of information on alliances.

A multinominal logistic analysis is selected to test the hypotheses concerning determinants of partner selection in R&D alliances, and a three-stage least squares analysis is selected to test the hypotheses concerning the substituting effects among partner selection, alliance scope and governance structure. T-tests are used to compare partner selection differences between domestic and international R&D alliances and across three sub-categories of international R&D alliances. Finally, multinominal logistic regression models are employed again to compare multilateral against bilateral R&D alliances.

CONTRIBUTIONS OF THE STUDY

This study contributes to our understanding of firms' alliance formation decision processes. First, the analysis suggests that managers can and do pay attention to the competitive implications of the potential loss of control of technological assets that comes with cooperation in R&D alliances. These considerations play a role in the design of R&D alliances. Although the point that partner selection is important for alliance formation and management has long been made (Tomlinson & Thompson, 1977; e.g.,

Geringer, 1991), it has rarely been implemented in prior empirical work. Instead, the most common empirical approach has been to "take-partners-as-given" and test the performance outcome of other decision variables such as governance structure. In this study, I am able to examine why firms select prior partners for the purpose of protecting their proprietary assets in R&D alliances, by focusing on the process rather than simply the outcome.

Second, this study enriches our understanding of trust between alliance partners. The literature has traditionally employed prior interaction as a proxy of trust. However, I argue that there is a clear distinction between Acquaintance and Friend, at least in the context of technology protection. Firms with knowledge about Acquaintances as result of a one-time alliance may or may not have established the trust towards them; whereas, through multiple alliances, Friends are those that firms can really trust. Such a differentiation is more salient when close interaction is needed for R&D collaborations. To protect their valuable technological assets, firms tend to select their Friends as partners for new R&D alliances, while trying to avoid Acquaintances which can appropriate their technologies more easily than Strangers. The empirical analysis offers support for such arguments.

Third, examination of the dynamic process of alliance formation enables us to understand how the three decision variables – *who* (partner selection), *how* (alliance governance), and *what* (alliance scope) – substitute for each other when firms form R&D alliances. Although preliminary, the analysis suggests that this is a line of inquiry with potentially important implications for the theory and management of inter-firm alliances.

This work contributes to an emergent research stream aimed at understanding the relationship between strategy and efficient economic organization. Firms that are able to benefit from R&D collaboration and at the same time effectively protect their own valuable knowledge are those that will maintain their competitive advantage and succeed in market competition.

Fourth, the present study provides evidence that non-conventional forms of international R&D alliances are frequently occurring and are important organizational forms. This study also provides a comparison of different types of international R&D alliances in terms of their implications for partner selection when there are knowledge protection considerations. It does so by introducing a new typology that looks at international R&D alliances formed by (1) foreign firms from the same home country; (2) foreign firms from different home countries; and (3) a foreign and a local firm. This research demonstrates that cross-nation domestic R&D alliances are the most modest scenario with the lowest knowledge leakage concerns, and therefore are less likely to be formed between firms that enjoy high levels of trust than trinational and traditional international R&D alliances. The in-depth analysis of various types of international R&D alliances enriches our understanding of how to protect participants' valuable knowledge in R&D collaboration across borders.

Lastly, my examination of multilateral R&D alliances helps to clarify key exchange processes in alliances, and contributes not only to the literature on partner selection but also to the larger body of literature on alliances. When the number of partners increases, the knowledge leakage concerns in R&D alliances are more serious.

Such a complicated inter-firm relationship has not been analyzed in previous studies. This dissertation fills the research gap by analyzing partner selection as a mechanism to protect partner firms' technological assets in bilateral and multilateral R&D alliances from the perspective of social exchange theory.

ORGANIZATION OF THE DISSERTATION

The remainder of this dissertation is organized as follows. Relevant research streams about partner selection for R&D alliances, international R&D alliances, and multilateral alliances are reviewed in Chapter II. The chapter points out both contributions and limitations of previous research on R&D alliance partner selection, and sets the stage for the theoretical framework developed in Chapters III, IV and V. In Chapter III, a theoretical framework of partner selection for R&D alliances in the context of knowledge protection is developed. Chapters IV and V extend the analysis of partner selection to international and multilateral R&D alliances, which have been growing rapidly during the past two decades. Hypotheses are presented in Chapters III, IV and V. The empirical analysis follows in Chapter VI, which provides a description of the research methods, sample selection, measurement issues, and statistical techniques used. Chapter VII displays the results of the empirical tests for the hypotheses generated in Chapters III, IV and V. Chapter VIII presents discussion of the results reported in Chapter VII. The dissertation ends with Chapter IX on implications of research and practices and limitations of the study.

CHAPTER II

THEORETICAL BACKGROUND

The overall objective of this chapter is to provide a review of extant research and demonstrate the limitations of previous alternative theories and models vis-à-vis the present study. The first section reviews theories and empirical evidence of how traditionally argued mechanisms (i.e., governance structure and alliance scope) can be utilized to protect participants' valuable technological assets in R&D alliances. The second section reviews the literature on partner selection and discusses how partner selection fits within the system of alliance formation decisions in industries where valuable knowledge must be protected. The third and fourth sections review relevant literature on international and multilateral alliances, respectively.

GOVERNANCE STRUCTURE, ALLIANCE SCOPE AND KNOWLEDGE PROTECTION

The number of R&D alliances has been increasing rapidly over the past years (Duysters & Hagedoorn, 1996; Narula & Duysters, 2004). This upsurge is explained by several reasons, such as the fast rate of technology change, the increasing complexity and high costs of developing new products and technologies, and the advantages of early market entry. Regardless of the motivation, alliance managers have to face the challenge of finding the right balance between knowledge sharing and knowledge protection in R&D alliances. It is true that external protection of intellectual property through copyrights and patents exists and is effective in many countries. For instance, companies such as Intel have large legal budgets to defend what they think is their property;

meanwhile, they are accused of aggressively attacking what others think is *theirs* to create uncertainties, time delays and higher start-up costs for their competitors (Thurow, 1997). However, external protection is only an *ex post* remedy rather than *ex ante* prevention. External protection can only take effect once the appropriation of intellectual property takes place.

To address their concerns about knowledge leakage in R&D collaborations, managers need to take precautionary steps during the process of forming alliances. Designing a protective governance structure and narrowing alliance scope are two solutions offered by prior literature. For instance, firms can design a protective governance structure, such as an equity-based joint venture, to create a mutual-hostage situation to reduce the chance of their partners' opportunistic behaviors (e.g., Hennart, 1982; Pisano, 1989; Teece, 1992; Oxley, 1999). In such a mutual-hostage situation, losses from opportunism will be shared by both partners. Alternatively, firms can limit the contact points with their partners by restricting joint activities. That is, they choose a narrower alliance scope for the R&D collaboration rather than combining R&D with other vertical operations (Oxley & Sampson, 2004).

Governance Structure and Knowledge Protection in R&D Alliances

Prior research in transaction cost theory has suggested that choosing an appropriate governance structure is one mechanism that firms use to promote knowledge sharing and protection in an alliance (Pisano, Russo, & Teece, 1988; Pisano, 1989; Oxley, 1997; Kale *et al.*, 2000). Although transaction costs, broadly defined, encompass a wide range of elements, the basic thrust of the transaction cost argument as applied to

strategic alliances builds on Alchian and Demsetz's (1972) discussion of team production and focuses on appropriation concerns of team players. Such appropriation concerns originate from the pervasive presence of uncertain behaviors by partners, combined with the difficulties of specifying intellectual property rights, and by the challenges of contractual monitoring and enforcement (Oxley, 1997). In discussing hierarchical governance structure, transaction cost economists typically focus on its agency features, which they view as addressing appropriation concerns through control mechanisms such as fiat, providing monitoring, and aligning incentives (Williamson, 1975, 1985). Hierarchical structures are thus thought to be more applicable when concerns of appropriation are potentially high. More hierarchical controls provide greater incentive alignment than fewer hierarchical controls (Alchian & Demsetz, 1972; Klein, Crawford, & Alchian, 1978).

According to this logic, researchers have linked the anticipation of appropriation concerns when the alliance is formed with the specific governance structure used to formalize the alliance. It has been suggested that the greater the potential concerns, the more hierarchical the contract used (Pisano *et al.*, 1988; Pisano, 1989; Oxley, 1997). For instance, Williamson (1975) claimed that "legal ordering" incentives such as shared ownership of specific investments can be used to restrain opportunism and safeguard future profits yielded by cooperation (Axelrod, 1984; Heide & Miner, 1992). Other transaction cost theorists, such as Hennart (1982; 1991) and Teece (1986), suggested that equity joint ventures offer "mutual hostage" positions to avoid opportunistic behaviors by partner firms. Empirical evidence for such explanations of alliance structure has been

provided by Pisano (1989) in a study of the biotechnology sector, by Pisano, Russo, and Teece (1989) in a study of the telecommunications sector, and by Oxley (1997) in a study of many different industries and countries.

However, the benefits of equity-based alliances must be weighed against their disadvantages (Gulati, 1995a). Equity-based alliances typically take a longer time to negotiate and organize than non-equity-based alliances and involve very high exit costs. Further, the administrative costs can be associated with the hierarchical supervision they encompass. Equity-based R&D alliances are even more expensive than other types of joint ventures. Prior research has suggested that transactions involving the sharing, exchange, or co-development of knowledge can be rather problematic because of the public goods nature of knowledge (Johnson, 1970; Arrow, 1974; Contractor & Wonchan, 2002). Many problems result from the difficulties of accurately assessing the value of the knowledge being exchanged as well as concerns on opportunism. High failure rate caused by the difficulties of transferring knowledge across organizational borders also compounds these problems. Therefore, equity-based R&D alliances usually involve more costs than other equity-based alliances with no joint R&D.

Alliance Scope and Knowledge Protection in R&D Alliances

The second solution offered by the literature is to craft a narrower alliance scope in the face of higher risks of appropriation.

The concept of alliance scope is relatively new in the alliance literature. Alliance scope is "one of the most important tasks partners will undertake… The partners must establish boundaries of geography, product categories, customer segments, brands,

technologies and fixed assets between the new entity and the parents. They must identify the activities in which the alliance may engage and those reserved for the parents." (*The Alliance Analyst,* July 5, 1997: 5). Such choices of which activities to include within an alliance are considered central by managers.

Khanna and colleagues (Khanna, 1998; Khanna, Gulati, & Nohria, 1998) provided the earliest theoretical analysis of alliance scope and its potential effect on the dynamics of technology-related alliances. Khanna *et al.* (1998) introduced the concept of the "relative scope" of a firm within an alliance to precisely measure the extent of activities in markets unrelated to the alliance as a proportion of all activities conducted by firms. The relative scope of a firm in an alliance j, is the ratio of the scope of the alliance to the total number of product markets in which the firm is active. The ratio lies between 0 and 1. Its value is closer to 0 if the scope of the alliance is very small, and its value is 1 if the firm has no interests in markets not covered by the alliance. Thus, the relative scope is a measure that is particular to a given firm in a given alliance. Different firms in the same alliance and the same firm in different alliances would have different relative scope values.

Such conceptualization of alliance scope indicates the extent of the partner firms' control. Of the markets in which two firms have mutual interests, they can choose which activities to include in the alliance and which to exclude. The choice of alliance scope affects the nature and timing of the benefit streams that occur to alliance participants (Khanna, 1998; Khanna *et al.*, 1998) and, therefore, alliance scope can play a key role in understanding a range of issues related to alliances.

However, Khanna's conceptualization of alliance scope is multidimensional and abstract. Oxley and Sampson (2004) pointed out that many aspects of alliance activities (e.g., the number of product categories or customer segments involved, or the dollar value of a joint project) are not reported by alliance participants and so are unavailable through secondary data sources such as an alliance announcement in the press. According to Oxley and Sampson, this may explain the dearth of prior research on alliance scope.

Considering conceptual clarification and data availability, Oxley and Sampson (2004) re-defined alliance scope by focusing on the functions of alliance activities. Alliance scope is the extent to which the partners combine multiple and sequential functions or value chain activities within the alliance[1], such as R&D, manufacturing and/or marketing. An increase in the vertical scope of an alliance predictably exacerbates the complexity of the collaborative challenge, all else being equal (Reuer, Zollo, & Singh, 2002). Pragmatically, Oxley and Sampson (2004) in their empirical settings focused attention on a simple measure of vertical scope that is particularly relevant to

[1] Here is an example from Arino, A., & de la Torre, J. 1998. Learning from failure: Towards an evolutionary model of collaborative ventures. ***Organization Science***, 9(3): 306-325.
NAMCO and Hexagon formed an equity-based alliance in 1991. NAMCO is a U.S.-based company which is active in a number of segments of the household products industry, including cleaning products, toiletries, and personal hygiene. Hexagon is a French-based company with high product diversity in three main fields: specialty chemicals, cosmetics, and pharmaceuticals. Despite its diversity, Hexagon has a star branded product in its "Hexa" cosmetic line – Hexa-Care line of hypoallergenic skin care product. As their alliance was first formed, NAMCO was engaged mainly in the distribution of Hexa-Care, whereas most manufacturing and packaging operations was carried out by Hexagon. That is, Hexagon would contribute to the JV its current product formulas, and any further product developments solicited by the JV would be performed by Hexagon's laboratories and charged back to the JV on a cost-plus-incentive basis. One year later, NAMCO suggested that a different manufacturing process, one that would allow its distributors to perform production and packaging functions, and not only distribution, would motivate them to push Hexa-Care more forcefully. As a result, Hexagon's board members agreed with this proposal.

R&D-related alliances, i.e., comparing alliances that involve R&D activities alone against those that combine R&D with other activities, specifically manufacturing and/or marketing. They explained that this is because an evaluation of horizontal scope is a much more subjective and challenging exercise. The 'horizontal' scope of activities, related to the size, complexity, and uncertainty of the particular project, also undoubtedly varies within functional areas and across alliances. In contrast to vertical scope, these project-specific features cannot be ascertained from available secondary reports of alliance events.

When the vertical scope of an R&D alliance is increased to encompass other activities, the extent of knowledge sharing and coordination inevitably rises (Reuer *et al.*, 2002). Therefore, protection of technological assets becomes more challenging with increases in alliance scope, as the tacit knowledge embedded in operating routines must be exposed to alliance partners if joint operations are to proceed efficiently. To jointly bring an R&D project through to commercialization requires many more points of contact between the partner firms, with a concomitant reduction in control over information flows across the relevant organizational boundaries (Teece, 1992).

Moreover, operational routines exhibit substantial inseparability, and it is likely that knowledge gained in the course of manufacturing and marketing efforts within the alliance will have important effects on other areas of partner firms' operations. As a result, it is almost impossible to effectively manage mixed activity R&D alliances without extensive sharing of tacit knowledge embedded in operational routines, which in turn may have significant effects on the relative competitive position of partner firms.

Oxley and Sampson's (2004) study of 208 R&D alliances has shown that an alliance scope decision is an important aspect of alliance management. Decisions to restrict alliance scope are made as a response to the elevated leakage concerns associated with knowledge sharing in particular competitive contexts.

PARTNER SELECTION AND KNOWLEDGE PROTECTION

Managers need to ask *whom* to ally with (partner selection) in addition to the two questions - *how* to allocate responsibilities and authority between partners (governance structure) and *what* activities to perform (alliance scope). To prevent partners' opportunistic behaviors, firms can choose partners that they can trust, rather than those about which they have no knowledge. Below, I will first review the literature on partner selection and then on the interrelationships among governance structure, alliance scope and partner selection.

Partner Selection in General

Partner selection is defined as the decision to enter in an alliance with a potential partner. Partner selection is based on the desire by the initiating firm to undertake particular alliance project with one or more partners. Such a selection decision considers how favorable or unfavorable the partner choice will be, and how attractive, valuable and correct the choice will be for the initiating firm (Geringer, 1991; Hitt *et al.*, 1995; Ireland, Hitt, & Vaidyanath, 2002).

Partner selection is the first difficult but critical decision that firms encounter, after they decide on employing a strategic alliance strategy (Hitt *et al.*, 1995; Ireland *et al.*, 2002). Rationales for careful partner selection are readily evident both in the

academic literature and the practitioner literature. Partner selection is important because the choice of a partner(s) may influence the "overall mix of available skills and resources, the operating policies and procedures, and the short- and long-term viability" of the cooperative relationship (Geringer, 1991: 55-56). As documented by scholars (e.g., Lane & Beamish, 1990; Hill & Hellriegel, 1994), selecting the right partners requires significant amounts of executives' time and resources.

Partner selection is difficult. The "heart of darkness" in strategic alliances is the conflict between partners, and such bitterness usually stems from the difficulty of finding the right/proper partners (Davies *et al.*, 1989; Lane & Beamish, 1990). The significant amount of time and effort senior managers spend in finding the appropriate partner(s) for their alliances has been documented by scholars, such as Lane and Beamish (1990) and Davies *et al.* (1989). In many cases, partnering firms would have been better off not to enter an alliance with a given partner than to deal with the aftermath of a failed relationship. Questions have been frequently asked by practitioners; for instance, what a firm can do to minimize the chances of alliance failure or how the firm can better manage the alliance process over the life cycle of an alliance.

Prior literature has proposed solutions, although limited, to minimize the chances of alliance failures. Most of the solutions are based on the similarity between partners; firms need to select partners similar to them to minimize the potential conflicts with their partners in the collaboration. For instance, Daniels (1971) examined foreign direct manufacturing investment in the U.S. and concluded that firms sought those of *similar sizes* as their partners. The rationale was that by selecting a partner of its similar size, a

company could be assured that the two firms placed about the same importance on the joint venture (JV) and the two firms were in relatively equal power positions for bargaining. Yan and Gray (1994) conducted a comparative case study and found that the bargaining power of potential partners affected the structure of management control, which, in turn, affected JV performance. Hitt et al. (1997) and Brouthers et al. (1995) argued that, for effective partner selection, partners must have *compatible strategic intents*, i.e., their strategy, goals, and purposes need to be compatible. The difference in strategic intents caused conflicts, not only administratively but also strategically. Therefore, an alliance is more likely to fail if it does not advance both partners' strategic intents. Evidence supporting such arguments were reported in studies by Dymsza (1988) and Lorange and Roos (1992). Fey and Beamish (2001) and Zeng (2003) found that the *similarity in partners' organizational cultures and management styles* led to a higher degree of cooperation among partners. Partners must also possess *commensurate levels of risk* (Brouthers *et al*., 1995). With commensurate levels of risk, alliance partners are willing to commit themselves in the cooperative relationship and a cooperative culture in the alliance is likely. Commensurate levels of risk can be particularly problematic when, for example, a well-established company approaches a small firm.

Another solution to minimize the chances of alliance failure is to form alliances with prior partners. "We prefer to work with a few biotech companies we know well over the years rather than reinvent new alliance and new relationships," says Dr. dintan

Walton, CEO of ParmaVentures[2] (Lam, 2004). Specific to R&D alliances, alliances with prior partners not only ease knowledge transfer but also reduce the hazards emerging from potential opportunistic behaviors due to the trust established. First, improved absorptive capacity from prior interactions smoothes the technology exchange between alliance partners (e.g., Kogut & Zander, 1992; Szulanski, 1996; Mowery, Oxley, & Silverman, 1998). Absorptive capacity is the ability of a firm to recognize the value of new external information, and in turn, assimilate and apply it to commercial ends to enhance the firm's innovative capabilities (Cohen & Levinthal, 1990). A common theme in previous literature on absorptive capacity is that prior interactions between technology transferring partners are critical for efficient and effective technology flow from one party to the other. For instance, both Cohen and Levinthal (1990) and Kogut and Zander (1992) argue that absorptive capacity is based on history and thus is path dependent. The stickiness of knowledge and the causal ambiguity surrounding knowledge transfer can be reduced and overcome through repeated interactions between the knowledge source and the recipient (von Hippel, 1994; Szulanski, 1996; Kale *et al.*, 2000). The benefits of smooth technology exchange become more salient when the technologies exchanged in the R&D cooperation are more sophisticated. Recent research by Zahra and George (2002) also points out that prior interactions facilitate the transformation of potential absorptive capacity (which is comprised of knowledge acquisition and assimilation capabilities) to realized absorptive capacity (which centers on knowledge transformation and exploitation). These arguments are consistent with

[2] PharmaVentures is a UK-based company that helps biotechnology companies make deals including strategic alliances, licensing, joint ventures, mergers and acquisitions and equity financing.

what Burt (2003) called the "information side" of social capital. That is, prior social interactions enhance firms' absorptive capacity and smooth the progress of technology exchange.

Second, prior alliance experience between firms can generate trust between alliance partners (Gulati, 1995a). The social capital between firms generated through their previous alliances supplies the mutual confidence that neither party will exploit the other's vulnerabilities (Sabel, 1993). In the context of technology protection, the biggest concern of firms entering R&D alliances is the predictability of their partners' behaviors. Although partners can specify what is core to each party and develop formal conduct codes to restrict behaviors that lead to the appropriation of valuable technological assets, such codes are difficult to write and typically incomplete. Given the public goods nature of knowledge (Johnson, 1970; Arrow, 1974; Contractor & Wonchan, 2002), it is impossible for each party to fully specify their core technologies. Even if partner firms can clearly draw the boundary of their proprietary assets, a complete contract is impossible to write beforehand, particularly in R&D alliances where intense interaction and exchange of knowledge are required to achieve the goal of developing new technologies. Therefore, trust is necessary for the parties to make a good-faith effort not to take excessive and unilateral advantage of each other, even when the opportunity is available. Moreover, through earlier alliances, jointly held social capital may also affect exchanging partners' managerial philosophies. For partner firms, decisions and behaviors conform to standards because they have been internalized as principles and values (Barney & Hansen, 1994). An exchange partner behaves in a trustworthy manner

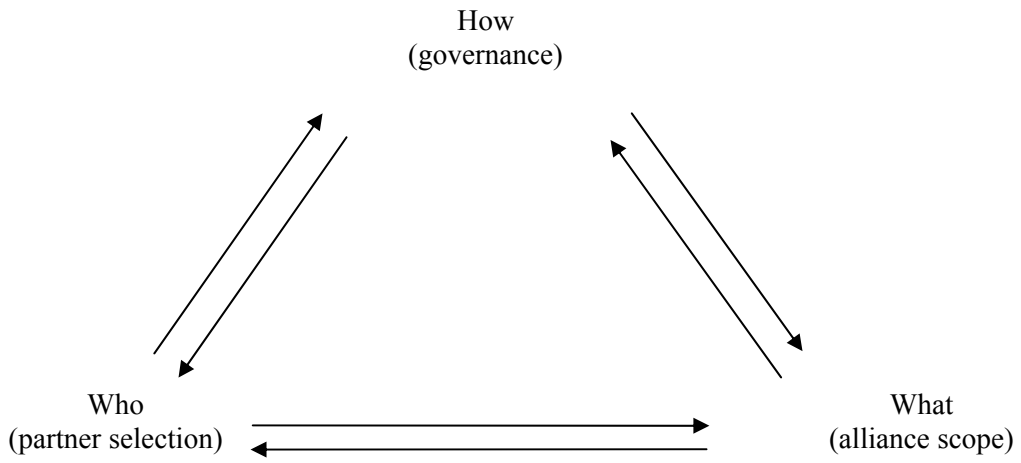
because to do otherwise would be to violate their values, standards, and principles of behavior.

Partner Selection, Governance Structure and Alliance Scope

The three questions – how, whom and what – are interrelated in that each decision choice is likely to affect the other two decisions (see Figure 2.1).

Prior research has suggested that an R&D alliance formed between partners with no trust or low-level trust increases the possibility of opportunism (Gulati, 1995a). Therefore, firms need a more protective governance structure, such as that afforded by an equity joint venture, and/or a narrower alliance scope, such as that provided by an exclusive R&D collaboration. In contrast to this literature, I view partner selection as an alternative "third way" for controlling partner opportunism. I expect firms to be more cautious in partner selection when the R&D alliance is based on a contractual relationship and/or when the alliance scope is broad. Hence, the set of three decisions represents a complex, dynamic, and endogenous system.

FIGURE 2.1.
Decision Triangle for R&D Alliance Formation



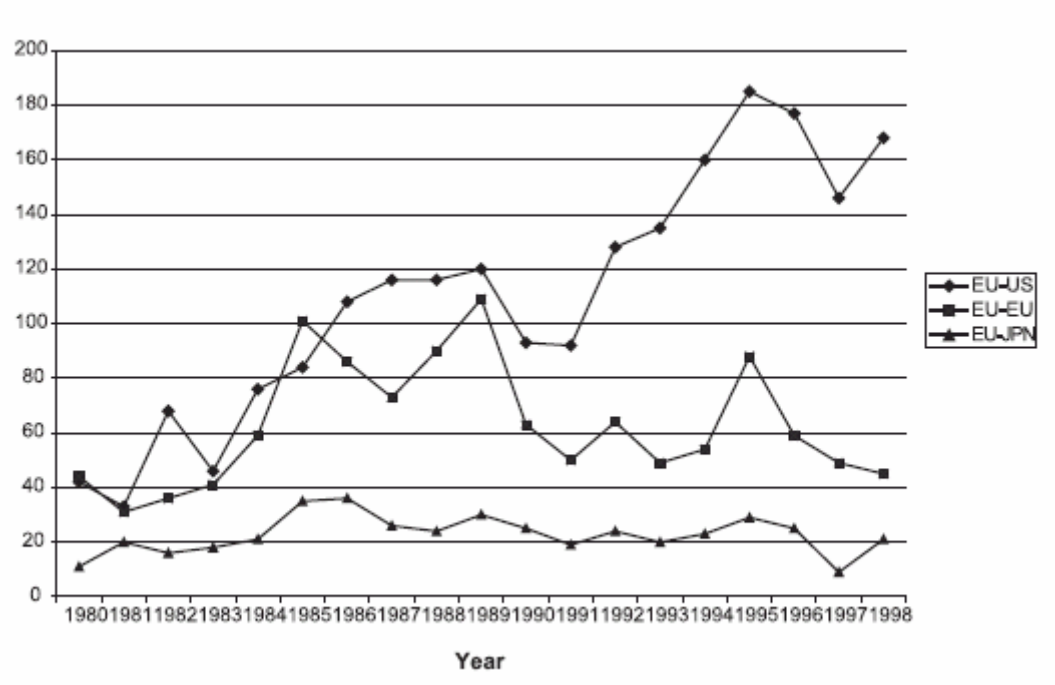
When analyzing how to protect valuable knowledge from leakage in an R&D alliance, the extant literature has tended to focus on selecting a secure governance structure and, most recently, on narrowing the alliance activity scope. The selection of partners has always been treated as exogenous. Little attention has been paid to partner selection as a decision variable, despite the repeated reminder that partner selection is the first critical decision in alliance formation (see, for example, Koot, 1988; Geringer, 1991; Brouthers *et al.*, 1995; Hitt *et al.*, 1995; Ireland *et al.*, 2002). I argue that selecting prior partners is an alternative mechanism to ease the concern of knowledge leakage in an R&D alliance. The basic rationale for selecting a prior partner is that two firms with prior alliances are likely to know and trust each other more than other firms with whom they have had no alliance experience (Ring & Van de Ven, 1994). I discuss in more detail later whether this proxy is proper, but the general agreement in the literature is that

trust should exist between prior partners. Therefore, trust may prompt firms to form R&D alliances with prior partners in order to avoid high risks of knowledge leakage.

KNOWLEDGE PROTECTION IN INTERNATIONAL R&D ALLIANCES

As pointed out above, R&D tends to stay "at home" (Kumar, 2001; Narula, 2002). Therefore, the trend of increasing R&D activities abroad, particularly international R&D alliances, is worth noting (Narula & Duysters, 2004). As Figure 2.2 shows, intra-European cooperation has lagged behind EU-US alliances.

FIGURE 2.2.
Number of New Strategic Technology Partnerships for EU Firms, by Partner Nationality



Notes: Adapted from Narula & Duysters (2004a: 205).
EU = European Union
US = United States
JPN = Japan

The literature has suggested that moving R&D abroad is due to both demand and supply issues. The demand issues are well known, and are generally associated with adaptive R&D in response to specific market conditions. That is, international R&D is motivated to adapt and tailor products for foreign markets and provide technical support to offshore manufacturing operations (Vernon, 1966, 1977; Abernathy & Utterback, 1978; Utterback, 1989; Dunning, 1995; Doz & Hamel, 1998; Kuemmerle, 1999). Recently, attention has been increasingly drawn to the supply issues (Cantwell, 1989; Casson, 1991; Archibugi & Michie, 1995; Kummerle, 1997). Firms expand fast internationally, as they are able not only to exploit their technological assets in various markets simultaneously, but also to acquire technological assets that may be specific to particular locations. International R&D is designed to obtain and internalize new knowledge that can be diffused throughout the organization. The supply-side factors have been increasingly important in motivating and shaping international R&D activities (Florida, 1997).

No matter whether the international R&D is motivated by demand or supply considerations, forming international R&D alliances is one of the major ways to develop and/or acquire technological assets across national borders. Firms conducting international R&D seek to utilize technological assets, which may be either firm specific or location specific (Narula, 2002). In the case where these technological assets are firm specific, they are often associated with clusters of firms, and country-specific characteristics. It is well acknowledged that location advantages are idiosyncratic and path dependent, and the nature of innovative activities in a given location is associated

with the national systems of innovation (Lundvall, 1992; Edquist, 1997). The nature of the benefits arising from a noncooperative arrangement require physical proximity to the firm or cluster, to seek indirect technology spillovers, which can be a highly costly, uncertain and random procedure that requires a long-term horizon. Where such immobile assets are country but not firm specific, they may be embodied in aspects of the national systems of innovation. Whether the advantage being sought is firm or country specific, the establishment of a greenfield laboratory is a feasible option, but start-up involves high costs and considerable time. In fields where innovation is rapid it may not provide a fast-enough response (Narula, 2002).

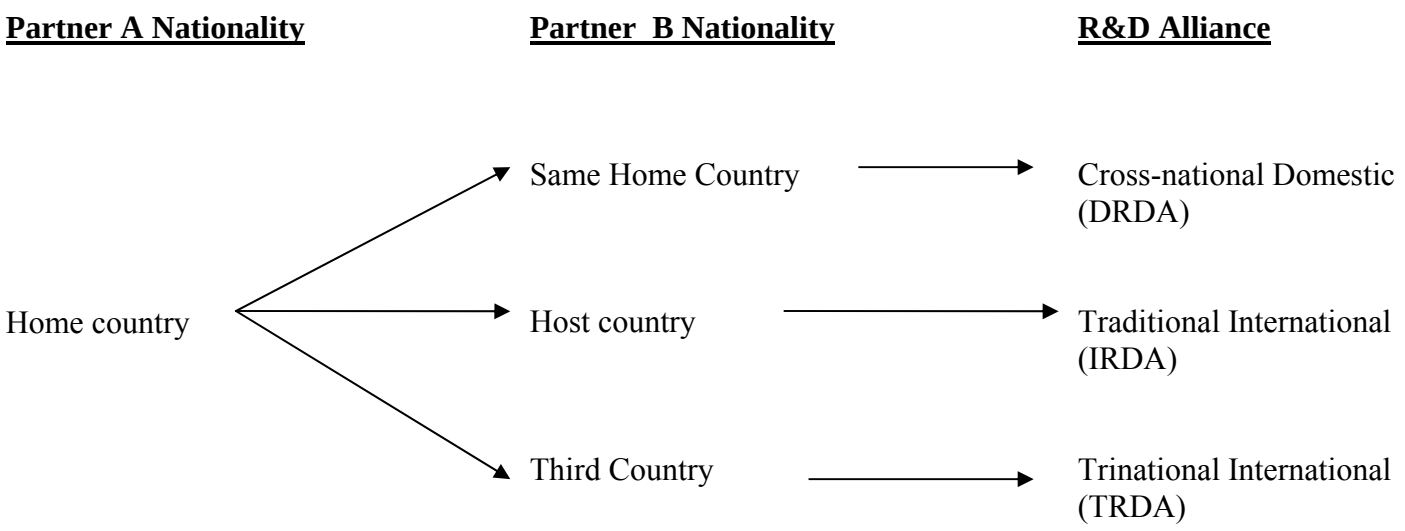
Despite the many reasons for firms to form R&D alliances abroad, international R&D alliances are complicated and risky. Prior studies have shown that technology flows to nearby locations are greater and faster than flows to more distant locations (e.g., Jaffe & Trajtenberg, 1993; 1999). Because they involve partner firms from different national backgrounds, international alliances are perceived as complicated in terms of inter-firm relationships. It has been well accepted that international alliances pose additional risks for partner, because of political, public policy, economic, and social uncertainty (Brouthers, 1995). Both the complicated business environment and unfamiliarity between alliance partners lead to a higher perceived risk of opportunism in international than domestic alliances (McCutchen Jr. *et al.*, 2004).

As a result, alliance partners should have more concerns about knowledge leakage for their international R&D alliances than domestic ones. Such concerns may be reflected on their cautious selection of alliance partners. However, the prior literature on

international alliances has not addressed the comparison between domestic and international R&D alliances regarding partner selection as a potential mechanism to protect alliance participants' technological assets.

The risks related to international R&D alliances are even more complicated when considering the nationalities of partners involved. The international alliance literature has focused on two-parent alliances formed between one foreign firm and one local firm. However, other types of alliances exist. I differentiate among three distinct forms of international alliances based on the alliance partner nationality. Specifically, this study defines partner nationality in terms of whether the international R&D alliance is formed by foreign-, local-, or third country-based firms. A *cross-national domestic R&D alliance* (DRDA) is an R&D alliance formed between foreign -based firms in the local market; and the home countries of the foreign-based firms are the same. A *traditional international R&D alliance* (IRDA) is an R&D alliance formed between a foreign-based and a local-based firm. A *trinational international R&D alliance* (TRDA) is an R&D alliance formed between foreign-based firms in the local market; and the home countries of the foreign-based firms are different. That is, three nationalities are involved in a TRDA. Figure 2.3 provides a summary and also a visual illustration of such a categorization.

FIGURE 2.3.
International R&D Alliance Typology from a Nationality Perspective



It is clear that, in the sequence of DRDA, IRDA, and TRDA, the complexity resulting from partner nationality increases. Generally speaking, firms are different from each other even if they are from the same home country; such differences are even greater if they are from different countries. While participating R&D alliances, partner firms' concerns of knowledge leakage should grow with the increasing complexity involved. In this dissertation, I examine the differences in partner selection among these three types of international R&D alliances, from the perspective of cultural differences.

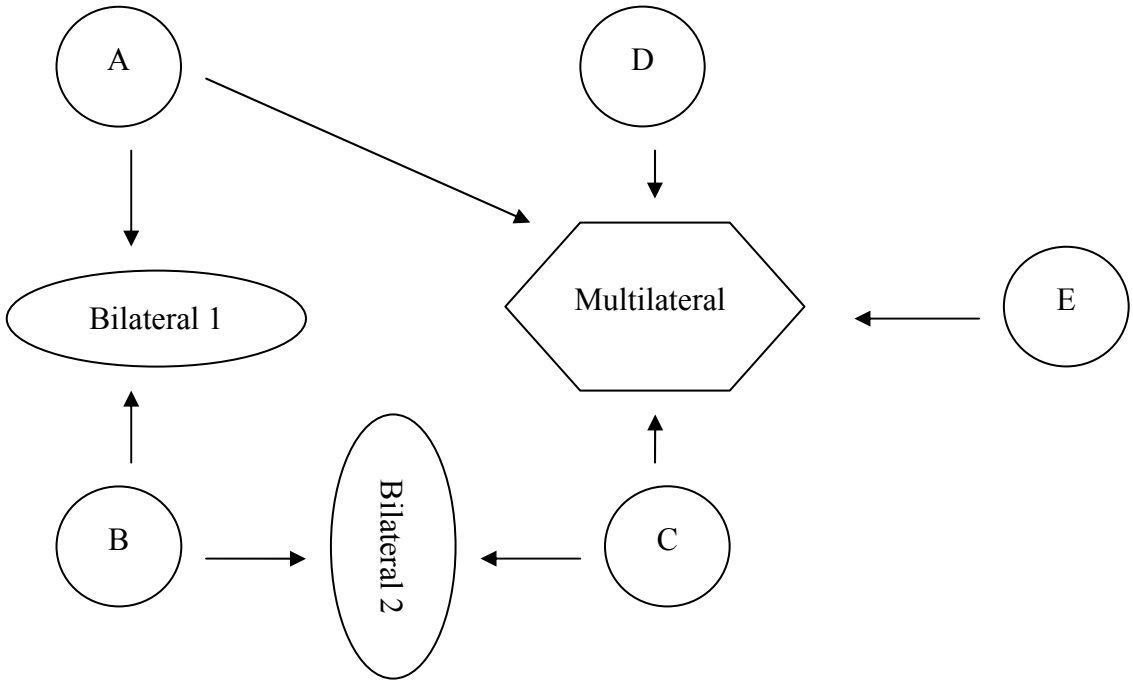
KNOWLEDGE PROTECTION IN MULTILATERAL R&D ALLIANCES

It is necessary to first define a multilateral alliance. Das and Teng (2002) distinguished between two broad types of interfirm partnerships: strategic alliances and alliance networks. A *strategic alliance* is a cooperative arrangement involving two or more firms, such as in equity joint ventures, joint R&D, and joint production; whereas, an *alliance network* is a collection of several alliances. A strategic alliance is a single arrangement that includes two or more firms, and an alliance network includes several alliances. For example, Anderson, Hakansson, and Johanson (1994) defined a business network as "a set of two or more connected business relationships, in which each exchange relation is between business firms that are conceptualized as collective actors" (p. 2). Whetten (1981) similarly noted that "a network consists of all interactions between organizations in a population" (p. 8). Thus, an alliance network consists of at least two alliances, each with two partners or with multiple partners.

A multilateral alliance is a strategic alliance formed by at least three partner firms. The term "multilateral alliance" has been used in Gulati (1995a), Gulati and Singh

(1998) and Doz and Hamel (1998); other terms have also been used in prior literature – "multiple partner alliance" in Gomes-Casseres (1994), "multi-firm alliance" in Hwang and Burgers (1997), and "constellation" in Das and Teng (2002). Figure 2.4 illustrates the differences among bilateral alliance, multilateral alliance, and alliance network. The multilateral alliance is formed by four firms (A, C, D, and E). All these entities and relationships together constitute an alliance network (A, B, C, D, E, Bilateral 1, Bilateral 2, and Multilateral).

FIGURE 2.4.
Bilateral Alliance, Multilateral Alliance, and Alliance Network



Notes: Adapted from Das and Teng (2002: 447)
Individual firms: A, B, C, D, and E
Bilateral alliance: Bilateral 1 (A + B) and Bilateral 2 (B + C)
Multilateral alliance: Multilateral (A + C + D + E)
Alliance network: A + B + C + D + E +Bilateral 1+ Bilateral 2 +Multilateral

There is no doubt that multilateral alliances have the same value creation logic as bilateral alliances; however, "greater numbers of participants also complicate alliance design and governance" (Doz & Hamel, 1998: 224). Cooperation has both an economic dimension and a social dimension (Blau, 1964). When the number of alliance partners increases, economic exchanges between partners are complicated because explicit contracts are even more difficult to write to govern the multilateral relationships. Therefore, social exchanges play a more central role under such conditions characterized by incomplete contracts and reciprocal exchanges of resources (Das & Teng, 2001). However, social exchanges are even more complicated than economic ones when the number of alliance partners increases.

Social exchange theorists distinguish between restricted and generalized social exchanges (Levi-Strauss, 1969; Ekeh, 1974). Restricted social exchange occurs when two parties directly exchange favors with each other, which is also known as a dyadic or mutual exchange. In contrast, generalized social exchanges take place among a group of at least three parties, and there is no direct reciprocity among them. In other words, what A receives from B is not contingent upon what A gives to B. Examples of generalized exchanges can be seen in the cooperative arrangements that farmers make to help each other out with harvesting chores and in the library consortia organized by local universities. The lack of one-to-one correspondence between the giver and the receiver is a key feature.

There are a number of important differences between restricted and generalized social exchanges (Blau, 1964; Ekeh, 1974; Gillmore, 1987; Molm & Cook, 1995;

Takahashi, 2000). First, given that reciprocity is voluntary, both restricted exchanges and generalized exchanges are subject to significant risks of opportunism. However, because restricted exchanges entail direct reciprocity between two parties, accountability is relatively high and opportunistic behaviors relatively easy to detect and remedy. By comparison, the risks are more prevalent in generalized exchanges (Takahashi, 2000). In multiparty (or generalized) exchanges, where A gives to B, B to C, and then C to A, A often does not have information about reciprocity between B and C. Thus, given the ambiguity and disjointed nature of exchanges, members of a generalized exchange system have more incentives for opportunism. Second, because of the considerable risks of opportunism, members involved in social exchanges have a high need for trust. Trust among exchange members reduces anxiety and allows reciprocity to take place over time. The need for trust is particularly high in generalized exchanges, because these exchanges are carried out by multiple parties that do not reciprocate with each other in a direct manner.

Multilateral R&D alliances, having at least three partner firms, are based on generalized exchanges and, thus, share the salient features of such exchanges, such as a higher risk of opportunism and a higher need for trust (Das & Teng, 2002). Therefore, partner firms' concerns about knowledge leakage are more serious in multilateral than bilateral R&D alliances. However, no studies have examined how partner firms' technological assets are protected in multilateral R&D alliances. This dissertation fills the research gap by investigating how partner selection, as a mechanism of knowledge protection, can be utilized differently in multilateral from bilateral R&D alliances.

SUMMARY

The present chapter reviews several closely related topics on R&D alliances and reaches several conclusions. First, knowledge protection in R&D alliance has important implications to the chances of alliance success. Prior researchers have proposed two mechanisms to promote knowledge protection. When knowledge leakage concerns are high, firms select to utilize protective governances and/or narrow alliance scope to avoid possible appropriation of their valuable technological assets. Although partner selection has been studied in previous literature, relevant research is incomplete and analyses of partner selection as a mechanism to protect knowledge in R&D alliances have not been completed. Second, while the general discussion on prior partner has been conducted in the recent strategy literature, the distinction among different types of prior partners has not been made. The literature has pointed out that alliances with prior partners not only ease knowledge transfer but also reduce the hazards emerging from potential opportunistic behaviors. However, both being prior partners, Acquaintances and Friends have noticeably different implications under various R&D collaborating situations. Such a distinction between Acquaintances and Friends has not been clarified in the literature. Third, as mentioned, researchers have proposed two mechanisms – governance structure and alliance scope – to protect partner firms' technological assets. With the third way (i.e., partner selection), no study has examined how these three play their roles simultaneously and what the relationships are among these three mechanisms. Fourth, international and multilateral R&D alliances have been on the rise. There are plenty of practical reports on the increasing complexity of R&D alliances. R&D alliances are

increasingly formed abroad or between partners from different countries; with the competitive landscape becoming more intense, firms have been engaging in R&D alliances formed among multiple partners. However, academic research has not caught up with these new phenomena, and knowledge protection in these R&D alliances has not been investigated.

In the analysis below, I fill these research gaps by exploring how partner selection can be used as a means to protect knowledge in R&D alliances and by discussing how firms' partner selection decisions may be altered in different types of R&D alliances (international and multilateral).

CHAPTER III

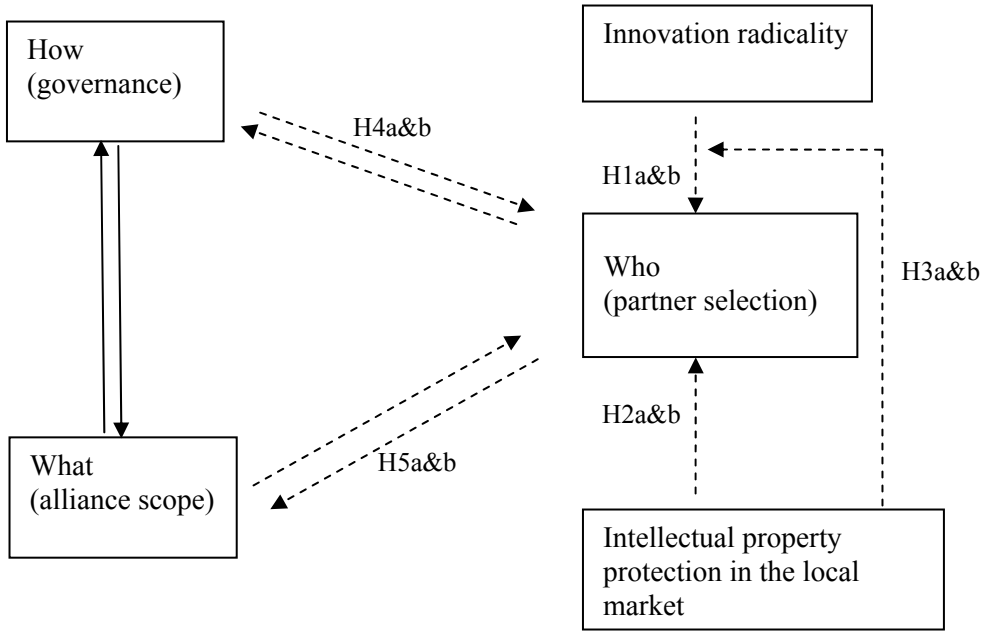
KNOWLEDGE PROTECTION AND PARTNER SELECTION IN R&D ALLIANCES

In this chapter, I first define different types of prior partners and generally discuss how firms make choices among Strangers, Acquaintances and Friends for R&D alliances. This is followed by an analysis of firms' selection of prior partners as an alternative way to protect their core technologies in R&D alliances. I also explore the nature of the relationship between partner selection, governance structure and alliance scope as alternative means for firms to protect knowledge resources in R&D alliances. Figure 3.1 summarizes the major theoretical arguments addressed in this chapter, which I develop below.

STRANGERS, ACQUAINTANCES, AND FRIENDS

I argue that a firm can choose from among three types of potential alliance partners − Strangers, Acquaintances, and Friends − as determined by their prior partnerships. The typical dictionary definition of a stranger is someone who is unknown to you. Therefore, I define *Strangers* as potential alliance partners that are unknown to each other. I assume they are unknown to each other if they have not been prior partners in an earlier strategic alliance. The dictionary definition of an acquaintance is someone you know and have some knowledge about. Therefore, I define *Acquaintances* as potential partner firms that know each other because they have been prior partners in one and only one earlier strategic alliance. A friend is typically defined as someone you

FIGURE 3.1.
Conceptual Framework (Chapter III)



Note: Broken lines represent causalities tested in this study; solid lines represent causalities tested in the literature.

know, like and trust. I define *Friends* as potential alliance partners that have been prior partners in multiple strategic alliances.

The categorization of potential partners as Strangers, Friends or Acquaintances is therefore based on the existence and number of their prior partnerships. While this is an explicit measure, implicitly I assume the number of prior partnerships is a proxy for the extent of trust involved between the potential partner firms. Repeated interaction has been used as a proxy for trust in the literature (Zucker, 1986; Gulati, 1995a). Since multiple prior partnerships represent high levels of repeated interaction, I argue that two firms with prior alliances are likely to trust each other more than firms with which they

have not had prior alliances (Ring & Van de Ven, 1994). Similarly, Parkhe (1993) observes that a prior history of cooperation between firms limits their perception of expected opportunistic behavior in new alliances.

Numerous definitions of trust have been presented in the literature (e.g., Bradach & Eccles, 1989; Lewicki, McAllister, & Bies, 1998). I adopt Sabel's (1993) definition of trust, for its suitability to the discussion of my topic, as the mutual confidence that no party to an exchange will exploit another's vulnerabilities. Being vulnerable implies that there is something of importance to be lost; therefore, making oneself vulnerable is taking risk (Gambetta, 1988). Trust is a willingness to take such risks (Mayer, Davis, & Schoorman, 1995). While trust is the mutual confidence that one's vulnerabilities will not be exploited in an exchange, the degree of trust varies between different exchange partners under various situations. Consistent with prior research (Parkhe, 1993; Gulati, 1995a), I argue that trust between prior partners (i.e., Friends and/or Acquaintances) is greater than trust between Strangers because of the existing interactions between prior partners.

I distinguish between Friends and Acquaintances based on the extent of trust established via earlier collaborations. Strong-form trust exists between Friends that share a unique history of interactions (Barney & Hansen, 1994). With strong-form trust, partners are trustworthy independent of whether or not exchange vulnerabilities or governance mechanisms exist. However, for Acquaintances, a single prior alliance at best provides sufficient information about the prior partner to generate weak-form trust and is unlikely to yield strong-form trust. Even worse, the single alliance may have

failed, possibly due to opportunistic behavior by the partner firm. In such cases, the prior partner is not a trusted Acquaintance but rather "the devil in disguise", suggesting the old conundrum, "better the (inside) devil you know than the (outside) saint you don't." While in theory, Acquaintances and Friends should vary along a continuum related to the number of prior alliances (and therefore the level of implicit trust embedded in the relationship), for ease of analysis in the present study I focus only on the polar cases.

ADVANTAGES AND DISADVANTAGES OF PRIOR PARTNERS

As recognized by the previous literature reviewed in Chapter II, there are multiple benefits of selecting prior partners over Strangers for new alliances (Gulati, 1995a). The trust/social capital between firms generated through their previous alliances supplies the mutual confidence that parties will not exploit each other's vulnerabilities (Sabel, 1993). In R&D alliances, the predictability of their partners' behaviors is important to firms. Due to the public goods nature of knowledge (Johnson, 1970; Arrow, 1974; Contractor & Wonchan, 2002), it is impossible for each party to precisely define their core technologies. Also, a complete contract beforehand is impossible to write in R&D alliances where intense interaction and exchange of knowledge are required to achieve the goal of developing new technologies. Trust established during prior interactions convinces partner firms that their partners will make a good-faith effort not to take excessive and unilateral advantage of the other, even when the opportunity is available.

So, why not select one firm with which to form all alliances? Obviously any one partner may not have all the complementary resources that the firm needs for different

purposes; but, more importantly, this is because there are also potential disadvantages associated with prior partners. First, repeated interactions with a limited number of partners may cause a firm to lose its flexibility in partner selection for new alliances. Although it is good for firms to build trust through multiple cooperative relationships, it may lock them in the established relationships (Gulati, 1995b). For instance, concerns about searching costs may prevent firms from looking beyond their own existing pool of social relationships (Ellis, 2000). Also, forming alliances with new partners may offend existing partners, particularly when the existing ones are able to provide similar (but perhaps not as good) technologies as the new partners.

Second, path-dependent learning may prevent the collaboration between prior partners from achieving the goal of developing radical innovations. Radical innovations are fundamental changes that represent a clear departure from existing practices through revolutionary changes in technology (Dewar & Dutton, 1986; Tushman & Rosenkopf, 1996; Hart & Christensen, 2002; Sheremata, 2004). Therefore, novelty is critical to develop radical innovations. However, partner firms that have had multiple interactions may have developed similar mental maps for innovation. It may be difficult for their collaboration to develop something divergent from the existing technologies. Hence, forming R&D alliances with prior partners that share similar learning patterns can slow expansion into novel technological domains in the long run.

The concerns about losing novelty are consistent with Leonard-Barton's (1992) arguments on core rigidities. Leonard-Barton considers a core capability as "the knowledge set that distinguishes and provides a competitive advantage" (p.113). Such a

knowledge set is composed of skills, technical systems and managerial systems, all of which are deeply rooted in values and norms of a firm. Core rigidities are the flip side of core capabilities. Skills, technical systems, managerial systems, and values served the firm well in the past can become an inappropriate set of knowledge causing problems for nondominant disciplines and/or future projects. Such core rigidities are particularly problematic in creating new, nontraditional capabilities.

Third, while firms are more likely to expose their valuable knowledge to prior partners than Strangers, risks of appropriation still exist and are even higher under certain circumstances. Due to the information asymmetry between partner firms, appropriation by Strangers can be stopped or delayed by informal methods of intellectual property protection such as lead time and learning curves. Prior partners, through earlier interactions, understand each other's know-how, operating routines, and managerial practices. If they choose to behave opportunistically, it is even easier for prior partners than for Strangers to appropriate the firm's core technologies.

As noted above, trust can be developed through repeated interactions between firms; trust eases partner firms' concerns about potential knowledge leakage in their alliances. However, the pace of trust development is much slower than the pace of the reduction of information asymmetry between partners. That is, information asymmetry between partners can be reduced to a minimum degree through one alliance while it usually takes several collaborations to build up the trust between partner firms. Therefore, Acquaintances are featured by the low level of information asymmetry and the low level of trust. Partnering with Acquaintances creates a serious situation for firms

to worry about whether their Acquaintances may behave opportunistically, because it is very likely that Acquaintances will succeed in "stealing" their partners' core technologies if they choose to do so. Therefore, appropriation concerns are more salient for Acquaintances than for Strangers and Friends. I also conclude that the distinction between an Acquaintance and a Friend represents a useful and relevant dichotomous measure of prior partners, with Friends being more trustworthy than Acquaintances.

TECHNOLOGY PROTECTION AND PARTNER SELECTION

This section examines how (1) different types of innovation that an R&D alliance intends to develop and (2) the intellectual property protection offered by the external market affect a firm's partner selection decision to protect its valuable knowledge exposed in an R&D alliance. How well technological assets can be protected is partly based on the degree of technological exposure in an R&D alliance. R&D projects can run the gamut from those involving development of new products or processes based on incremental modifications of existing technology, to radical, ambiguous projects where firms seek to develop the 'next generation' of a particular product. For R&D alliances seeking to develop different types of innovations (incremental vs. radical), the level of partner firms' exposure of their valuable knowledge varies. It is intuitive to expect that more protection/prevention of opportunism is needed when there is extensive exposure of partner firms' core technologies. In addition, the level of intellectual property protection granted by the external environment affects partner firms' alliance formation decisions. Firms rely on formal protection of their proprietary assets such as patents and copyrights; however, various degrees of protection effectiveness in different markets

leave partner firms to govern the residual opportunism through making careful partner selection decisions when the alliance was initially formed.

Incremental versus Radical Innovation

There are at least two types of innovations that R&D alliances can develop – radical and incremental (Dewar & Dutton, 1986; Sheremata, 2004). In general, radical innovations are based on new design concepts that break paradigms; whereas incremental innovations are based on minor improvements or adjustments in the current technology.

Radical innovations are fundamental changes that represent a clear departure from existing practices through revolutionary changes in technology. Thus, radical innovations are typically disruptive to the existing organizational capabilities (Christensen, 1997). Firms committed to disruptive innovations seek to locate entrepreneurial opportunities that can shift the basis of competition in the industry (Ireland, Hitt, & Sirmon, 2003). These firms try to proactively influence their competitive destiny rather than waiting to be influenced by the evolution of the markets in which they compete (Barney, 2002).

In contrast, incremental innovations are sustaining of the status quo (Tushman & Rosenkopf, 1996; Hart & Christensen, 2002). Incremental innovations help incumbent firms derive maximum value from their current capabilities by providing customers with similar products or services at a lower cost and/or easier accessibility. That is, incremental innovations do not substantively change either production or consumption patterns.

I acknowledge that the distinction between incremental and radical innovation is not clearcut (Hage, 1980; Sheremata, 2004). However, because the middle values are difficult to interpret and are not the emphasis of this study, I focus only on the two extremes. Moreover, although innovation has many dimensions (Downs Jr. & Mohr, 1976; Tornatzky & Klein, 1982; Ahuja & Lampert, 2001), radicality is of particular interest in this study because it affects the extent to which partner firms expose their technological assets to each other.

R&D alliances intending to develop incremental innovations raise fewer risks of technology leakage than those aiming at radical innovations, for at least two reasons. First, the preexistence of a product or process technology enables parties to delineate property rights at the outset with far less ambiguity than when the relevant technology does not exist (Pisano, 1989). Because incremental innovations are usually based on pre-existing knowledge, it is possible for partner firms to specify what technologies will be exposed and what will not. In contrast, it is almost impossible to specify beforehand what knowledge will be involved when the objective of an R&D project is to develop something breaking the current paradigm (radical innovation). It is difficult for both parties to be aware of what should be written into the contract. Thus, cooperation with the intent of developing incremental innovations poses fewer risks of technology leakage than that targeting at radical innovations. As such, steps to control partners' opportunistic behavior are less necessary for alliances focusing on incremental innovations than those on radical ones.

Second, radical innovations usually require new, subtle insights into customer needs and extensive coordination between alliance partners. Radical designs frequently take advantage of new process technology, and this also requires coordination with a company's advanced process technology development efforts. Incremental product developments, on the other hand, require relatively little direct coordination with customers and engineers of process technology or manufacturing. Customer requirements tend to be well understood and codified, and the innovation stays within the established specifications of the existing process technology.

Although the previous literature has claimed that forming alliances between prior partners may reduce the potential for opportunism (Sabel, 1993; Gulati, 1995a), the extent to which this is accurate depends upon the circumstances. I agree that it is necessary to form alliances with trustworthy partners when the R&D project is aiming at the development of radical innovations. This is the case for firms that are Friends to each other. However, this situation is different for firms that are only Acquaintances. Acquaintances know each other through one previous alliance, but no strong-form trust has been established. Sometimes, even worse, Acquaintances recognize each other as "the devil they know" if one or both partners behaved opportunistically in the earlier cooperation. Obviously, firms will not select the known devil for R&D alliances involving extensive interactions. Even if there is no negative experience between the possible partners, Acquaintances may avoid collaborating with each other for an R&D alliance involving radical innovations. This is because of the concern of over-exposure of their core technologies. In contrast to Strangers, Acquaintances are more familiar with

their partner firms' technological assets, and thus, are able to appropriate their valuable knowledge more easily. Under such circumstances, firms may intentionally avoid Acquaintances to protect themselves from over-exposing their technological assets and other operation-related assets. Only after additional rounds of interaction, Acquaintances may build trust between each other and start to engage in alliances involving valuable technologies.

Hypothesis 1a. The more radical the innovation goals of the R&D alliance, the more likely the alliance partners are to be Friends rather than Strangers.

Hypothesis 1b. The more radical the innovation goals of the R&D alliance, the less likely the alliance partners are to be Acquaintances rather than Strangers.

In short, to protect technological assets, the selection of a partner depends on the innovation characteristics that affect the firm's concerns about knowledge leakage. However, it also depends on the protection that the external environment can provide to alliance partners.

Intellectual Property Protection

Partner firms in an R&D alliance also rely on formal protection of their proprietary assets, such as patents and copyrights. However, various situations make the formal protection ineffective, or not as effective as expected, leaving firms to govern the residual opportunism through careful selection of partners. First, firms seeking protection for technology transferred across national borders face a complicated variety of legal rules and procedures (Oxley, 1999). Many countries are signatories to the Paris

Convention for the Protection of Industrial Property, which requires that foreign nationals are granted the same intellectual property protection as domestic citizens. However, the convention does not specify what standards of protection should be in place, and consequently the actual level of intellectual property protection varies significantly across countries. For instance, the effective duration of patent protection ranges from 5 years in several Latin American countries to close to 20 years in most European countries (Oxley, 1999).

Furthermore, governments in most developing countries know that every country that has enhanced its economy has done so by imitating. This may lead to policymakers intentionally relaxing their intellectual property protection. Under such a weak formal protection, firms must rely on trust to expect that their partners will not appropriate their valuable knowledge during the cooperation. If such partners with high level trust cannot be found, firms must either find alternative means to reduce the hazards of cooperation, such as equity-based governance, or forgo the benefits of collaborative R&D.

Second, fundamental shifts in technology are rapidly making the current system of intellectual property protection ineffective. "It is clear that the invention of a new gene cannot be handled in the same way as the invention of a new gearbox" (Thurow, 1997: 98). The current worldwide convention on intellectual property protection was designed more than 100 years ago to meet the simpler needs of a far less developed industrial era. Such a convention is based on an undifferentiated, "one-size-fits-all" system. Treating all advances in knowledge in the same way may have worked when most patents were granted for new mechanical devices, but current knowledge-intensive

industries pose challenges that are far more complex. The changes in technology nature shift the duty (also the costs) of protecting advanced knowledge from the market to partner firms. Firms, particularly those in high-technology industries, depend on social mechanisms, rather than economic mechanisms, to protect their core knowledge from being appropriated in R&D alliances. Thus, whether a partner is trustworthy becomes extremely important for firms with concerns about intellectual property protection. Firms form R&D alliances with prior partners rather than Strangers, expecting that their partners will cooperate in good faith.

Third, different cultures and different parts of the world perceive intellectual property rights quite differently. Respect for individual property rights is deeply rooted in the individualism of many Western cultures and nations (Hofstede, 1994). However, collective and group-oriented Eastern cultures are at odds with such a belief (Zeller, 1999). For instance, the idea that people should be paid to be creative stems from the Judeo-Christian and Muslim belief in a God who created humankind in His image. However, there is no counterpart in Hindu, Buddhist or Confucian societies. This adds to the perceived risks, for firms operating in foreign countries, of exposing their valuable technological assets locally. In this situation, firms choose partners with whom they have similar philosophy and respect towards intellectual property protection. Such understanding and confidence in partners can only be achieved through repeated interactions. Generally, firms that are Friends are more able to do so than firms that are Acquaintance or Strangers.

Hypothesis 2a. The weaker the intellectual property rights protection, the more likely the alliance partners are to be Friends rather than Strangers.

Hypothesis 2b. The weaker the intellectual property rights protection, the more likely the alliance partners are to be Acquaintances than Strangers.

Furthermore, the characteristics of innovations to be developed in an R&D alliance and the formal protection of intellectual protection in the market jointly affect firms' selection of cooperative partners. I have argued above that the radicality of the innovation is positively related to the formation of an R&D alliance between Friends but negatively related to the alliance formation between Acquaintances. In a market with weak intellectual property protection, the concerns of knowledge leakage are even stronger than in a market with strong protection. Therefore, firms are less likely to rely on their social considerations to structure the R&D cooperation in a strong-protection environment than in a weak-protection environment. That is, the positive relationship between the innovation radicality and the formation of R&D alliances between Friends is not as strong in a strong-protection environment as in a weak-protection environment. Similarly, the negative relationship between the innovation radicality and the formation of R&D alliance between Acquaintances is not as strong in a strong-protection environment as in a weak-protection one.

Hypothesis 3a. Intellectual property rights protection weakens the positive relationship between the radicality of innovation goals of the R&D alliance and the likelihood of alliance formation between Friends rather than Strangers.

Hypothesis 3b. Intellectual property rights protection weakens the negative relationship between the radicality of innovation goals of the R&D alliance and the likelihood of alliance formation between Acquaintances rather than Strangers.

Dynamic Aspects of Alliance Formation

As I argued earlier, the three questions in R&D alliance formation – whom (partner selection), how (governance structure), and what (alliance scope) – are interrelated and each choice made is likely to affect the other two decisions. In this section, I examine the set of decisions as a dynamic and endogenous system.

Cooperation often has a social dimension as well as an economic dimension (Blau, 1964). Transaction cost theorists treat transactions as independent from each other. For instance, Williamson (1975) claims that "legal ordering" incentives, such as shared ownership of specific investments, can be used to restrain opportunism to safeguard future profits yielded by cooperation (Axelrod, 1984; Heide & Miner, 1992). Hennart (1982; 1991) and Teece (1986) suggest that equity joint ventures offer "mutual hostage" positions that can guarantee performance as part of the internationalization process to avoid opportunistic behavior. However, according to Murakami and Rohlen, "[T]he value of the relationship itself is typically ignored and the impersonality of the transaction is assumed" (1992: 70). To govern a cooperative relationship, both economic and social mechanisms matter.

Different from hierarchical arrangements such as shared-ownership, trust has been viewed as the glue that keeps business partners together (Barber, 1983; Palay,

1984; Killing, 1988; Lorenz, 1988). Buckley and Casson (1988) address the same issue by concluding that equity joint ventures are only needed when other means of guaranteeing forbearance from cheating on contracts, such as trust, are weak. Similarly, Gulati (1995a) also argues that firms with prior interactions are likely to rely on trust, rather than an expensive equity-based structure, to govern their cooperative relationship. Hence, weak protection of intellectual property in the market or high level of exposure of core technology (required by the goal of the alliance such as developing next-generation technology) tends to push the partners to select either equity-based governance for their cooperation or prior partners to eliminate or reduce opportunism.

Hypothesis 4a. When the R&D alliance is structured as an equity joint venture, the likelihood is lower that the alliance partners are prior partners.

Hypothesis 4b. When the R&D alliance is between prior partners, the likelihood is lower that the alliance governance structure is an equity joint venture.

When firms consider establishing an R&D alliance they need to decide on the scope of the alliance. An R&D alliance can exclusively focus on pure R&D activities. An increase in the vertical scope of the alliance leads to the combination of R&D with other activities, such as manufacturing and/or marketing. When the vertical scope of an R&D alliance is increased to encompass other activities, the extent of knowledge sharing and coordination inevitably rises (Reuer *et al.*, 2002). To jointly bring an R&D project through to manufacturing and commercialization requires many more points of contact between the partner firms, with a concomitant reduction in control over information

flows across the relevant organizational boundaries (Teece, 1992). Moreover, operational routines exhibit substantial inseparability, and it is likely that knowledge gained in the course of manufacturing and marketing efforts within the alliance will have important effects on other areas of partner firms' operations. As a result, it is almost impossible to effectively manage mixed activity R&D alliances without extensive sharing of tacit knowledge embedded in operational routines, which in turn may have significant effects on the relative competitive position of partner firms.

Because an enlarged alliance scope requires a greater degree of partner firms' core technologies exposed to each other, protection of technological assets becomes more challenging with increases in alliance scope. Firms are reluctant to accept such a high level of exposure of their valuable technologies without the strong-form trust toward their partners. Therefore, as the alliance scope expands, firms are more likely to pursue their prior partners, with which trust has been established, to form R&D alliances. Additionally, when firms are confident that their "old buddies" will not take unilateral advantage of them, it is tempting to extend their collaboration to other activities to achieve a higher level of synergy.

Hypothesis 5a. When the alliance scope is broad, the likelihood is higher that the alliance partners are prior partners.

Hypothesis 5b. When the R&D alliance is between prior partners, the likelihood is higher that the alliance scope is broad.

SUMMARY

The present chapter first defines three types of partners that firms may choose from for new R&D alliances – Strangers, Acquaintances and Friends. The chapter then analyzes firms' selection of prior partners as an alternative way to protect their core technological assets in R&D alliances. Specifically, hypotheses are proposed regarding how innovation radicality and intellectual property protection in the market influence firms' partner selection choices for their new R&D alliances. Further, this chapter explores the nature of the relationship between partner selection, governance structure and alliance scope, and hypothesizes that partner selection, governance structure and alliance scope can be used as substituting mechanisms by firms to protect their valuable technological assets from being appropriated in R&D alliances.

While the above arguments are about general R&D alliances, the following two chapters investigate partner selection in international and multilateral R&D alliances.

CHAPTER IV

KNOWLEDGE PROTECTION AND PARTNER SELECTION IN INTERNATIONAL R&D ALLIANCES

This chapter first examines how domestic and international R&D alliances differ when partner selection is used as a mechanism to protect participating firms' technological assets. Due to the lack of trust resulting from different national backgrounds, alliance partners have more concerns about knowledge leakage for their international than domestic R&D alliances. This affects their decisions about partner selection. The chapter then examines three types of international R&D alliances categorized by partner nationality to see how partner selection varies across these three types of international R&D alliances.

DOMESTIC VERSUS INTERNATIONAL R&D ALLIANCES

While there are many reasons for firms to move their R&D activities abroad (as reviewed in Chapter II), international R&D alliances are risky. Hymer (1960; 1976) first observed that foreign entrants incur unfamiliarity costs due to differences in home and host countries' economic, social, legal, and political and cultural systems. Transferring his observation to international strategic alliances, we can conclude that partner firms with different nationality backgrounds encounter more challenges of communication and coordination in their collaboration than their counterparts in domestic strategic alliances.

One of the most salient differences stems from national cultures. National culture refers to deeply set values that are common to the members of a nation (Hofstede, 1991; Hill, 1997). It is a system of shared norms, values, and priorities that, taken together,

constitute a "design of living" for a person. National culture provides meaning to "how things ought to be" and "how things ought to be done" for individuals in a country (Berger & Luckmann, 1967; Terpstra & David, 1991). The influence of national culture is strong and long lasting. For example, Hofstede (1991) found that national culture explains 50 percent of the differences in managers' attitudes, beliefs, and values. Laurent (1983) found that managers of multinational organizations retain many of their original national values despite routinely working in culturally diverse situations.

Therefore, for partners from different countries, there is a lack of shared norms and values (Park & Ungson, 1997). The influence of a society's culture permeates all aspects of life within the society, including the values, practices and systems of managers. The cross-cultural interactions found in international alliances bring together people who may have different patterns of behaving and believing and different cognitive blueprints for interpreting the world (Maruyama, 1984; Black & Mendenhall, 1990; Barkema & Vermeulen, 1997). The lack of common understanding may undermine the partners' interpretation of each other's strategic intent (Hitt *et al.*, 1995) and reduce effective communication (Rao & Schmidt, 1998) and trust (Aulakh, Kotabe, & Sahay, 1996; Doney, Cannon, & Mullen, 1998). Therefore, international alliances have greater obstacles for building trust and a concomitant higher potential for appropriation concerns than domestic alliances because the difficulties of specifying intellectual property rights, legally enforcing intellectual property, and monitoring partner activities are greater among cross-border firms (Pisano, 1990; Oxley, 1997).

Due to the lack of shared norms, partners' behaviors are less predictable in an international than a domestic R&D alliance. International R&D alliance partners have more concerns about knowledge leakage for their cross-border R&D collaboration than domestic R&D alliance partners. However, at the same time, a complete contract is even more impossible to write beforehand because of more uncertainties involved in international than domestic operations. Under such situations (i.e., more concern on knowledge leakage plus greater environmental complexity), international R&D alliance partners have a higher need for social mechanisms, such as trust between them, to assure the protection of their own valuable technological assets from being appropriated during the collaboration. Trust built up during prior interactions is valuable in this case and can be used to convince partner firms that their partners will make a good-faith effort not to take unilateral advantage of each other by appropriating its valuable technological assets. Therefore, it is more likely for partner firms to be prior partners in an international than a domestic R&D alliance.

Hypothesis 6. The likelihood of alliance formation between prior partners is greater in an international than a domestic R&D alliance.

NON-CONVENTIONAL INTERNATIONAL R&D ALLIANCE FROM NATIONALITY PERSPECTIVE

The international alliance literature has largely focused on two parent alliances formed between one foreign and one local firm. However, other types of alliances exist. I differentiate three distinct forms of international alliances based on the alliance partners' nationalities. Partner nationality involves the country-of-origin of the parent

firm. Following Makino and Beamish (1998), I define the nationality of the firm in terms of the country-of-origin, not the location, of the firm. I used this definition because home-country effects of foreign firms tend to persist for long periods of time due to the fact that the founding conditions and the basis of competitive advantages of the parent firms strongly reflect home-country conditions (Porter, 1990). Also, many studies have defined the nationality of a foreign parent in terms of the national origin of the firm, not in terms of its location (e.g., Kogut & Singh, 1988; Erramilli, 1996). Figure 2.3 in Chapter 2 illustrates the three types of international R&D alliances – cross-national domestic R&D alliance (DRDA) formed by two foreign firms from the same home country in the local market, traditional international R&D alliance (IRDA) formed by a foreign and a local firm, and trinational international R&D alliance (TRDA) formed by two foreign firms from different home countries in the local market.

I examine the differences among these three international R&D alliances from the perspective of cultural differences. Culture refers to patterns of beliefs and values that are manifested in practices, behaviors, and various artifacts shared by members of an organization or a nation (Hofstede, 1980; Trice & Beyer, 1993). Whereas organizations from different nations differ in fundamental values, organizations from the same nation differ mainly in organizational practices (Hofstede *et al.*, 1990). Therefore, the following discussion is based on organizational differences in terms of both national culture and organizational culture.

As argued above, national culture is a systems of shared norms, values, and priorities, which together provides meaning to "how things ought to be" and "how things

ought to be done" for individuals in a country (Berger & Luckmann, 1967; Hofstede, 1991; Terpstra & David, 1991; Hill, 1997). Company executives retain much of their original national values even when working in a different national culture (Laurent, 1983). National cultural differences differentiate partners based on their values and norms, which further reduces the effectiveness of communication and cooperation between partners.

Organizational culture is "a pattern of basic assumptions – invented, discovered, or developed by" an organization as "it learns to cope with its problems of external adaptation and internal integration – that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems" (Schein, 1985: 9). Organizational culture is the social or normative glue that holds an organization together (Sorge & Maurice, 1990). Organizational culture forms a type of social control that identifies and reinforces appropriate behaviors and attitudes for organization members to display (O'Reilly & Chatman, 1996). Organizational cultures differentiate alliance partners based on their management practices. Differences in practices represent conflicting expectations and incompatible organizational processes. Partners with dissimilar organizational cultures may expand time and energy to establish managerial practices and routines to facilitate interaction, and may incur higher costs and more mistrust than cultural similar partners (Sirmon & Lane, 2004).

Managers from the same national background differentiate their work practices as a result of the influence of heterogeneous organizational cultures (Hofstede *et al.*,

1990). However, organizational culture does not completely supersede or displace the influence of one's national culture (Hofstede *et al.*, 1990). As a matter of fact, firm specific organizational cultural differences are often interwoven with the fabric of the partners' national cultural differences as reflected in the phrases: European family capitalism, American managerial capitalism, and Japanese group capitalism (Parkhe, 2003).

Firms operating internationally face obstacles stemming from national cultural differences, organizational cultural differences, and/or the combination of these two (Pothukuchi *et al.*, 2002; Sirmon & Lane, 2004). For instance, Barkema and colleagues found that the termination of joint ventures was more susceptible to cultural distance than wholly-owned subsidiaries because the former had to accommodate both national and organizational cultural differences, or "double-layered acculturation" (Barkema, Bell, & Pennings, 1996; Barkema & Vermeulen, 1997) while the latter faced only national cultural differences. Parkhe (1991) also suggests that the combination of diverse national contexts and organizational culture of alliance partners may further hamper effective inter-partner collaborations and negatively affect the longevity of alliances.

Though all international R&D alliances face cultural barriers, the barriers are not the same for different types of international R&D alliances. Partner firms of a DRDA are from the same home country; therefore, cultural barriers only stem from organizational cultural differences between partners. Partner firms of an IRDA are from two different countries; therefore cultural barriers stem from both national and organizational cultural differences. Similarly, partner firms of a TRDA are also from two different countries and

cultural barriers arise from both national and organizational cultural differences. However, in comparison with IRDA, partner firms of TRDA have to encounter more complexity because both partner firms are foreign. One of IRDA partner firms is local and helps to diminish its foreign partner's liability of foreignness (i.e., costs of doing business abroad that result in a competitive disadvantage for an MNE subunit (Zaheer, 1995)). In contrast, both partner firms of a TRDA are foreign to the local market; therefore, partners of TRDA encounter more complexities than partner firms of an IRDA. Therefore, the complexity degree of the three types of international R&D alliances can be ranked as TRDA > IRDA > DRDA.

Both national and organizational cultural differences present diverging practices that lead to conflicting expectations and incompatible organizational processes. Partners with dissimilar cultures have to consume more time and energy to establish managerial practices and routines to facilitate interaction, than do culturally similar partners. Further, the more complex the cultural differences, the more potential conflicts may arise between alliance partners and the more concerns firms will have regarding partners' potential appropriation of their valuable technological assets in their R&D alliances. Trust established during previous interactions is more likely to be relied on to convince a firm that its partners will make a good-faith effort not to take unilateral advantage by appropriating its valuable technological assets. Therefore, the likelihood of R&D alliance formation between prior partners can be ranked in the sequence of TRDA > IRDA > DRDA.

Hypothesis 7. The likelihood of selecting prior partners for international R&D alliances decreases in the sequence of TRDA > IRDA > DRDA.

SUMMARY

The present chapter first analyzes the complexity involved in international R&D alliance and proposes that alliance formation between prior partners is more likely for international than domestic R&D alliances. This is because the lack of trust resulting from different national backgrounds causes alliance partners to have more concerns about knowledge leakage for their international R&D alliances than domestic ones. The chapter then differentiates three types of international R&D alliances from a nationality perspective and examines them by looking at national and organizational cultural differences between partners jointly. I propose that alliance formation between prior partners is most likely in trinational R&D alliances (TRDAs) and least likely in cross-national domestic R&D alliances (DRDAs).

CHAPTER V

KNOWLEDGE PROTECTION AND PARTNER SELECTION IN MULTILATERAL R&D ALLIANCES

This chapter investigates multilateral R&D alliances. Alliances can be between two or more partners. When the number of partners increases, the management of R&D collaboration becomes more complicated. From a social exchange perspective, this chapter analyzes how partner selection can be used differently in multilateral than bilateral R&D alliances, for the purpose of knowledge protection. As defined in Chapter II (Literature Review), a multilateral R&D alliance refers to an R&D alliance formed between more than two firms.

SOCIAL EXCHANGE COMPLEXITY IN MULTILATERAL R&D ALLIANCES

A multilateral R&D alliance[3] is a single, large, overarching R&D alliance joined by at least three companies for a common purpose. Such alliances have gradually emerged in many industries. Usually, multilateral R&D alliances are formed to cope with the tremendous resource requirements and/or risks involved in large-scale R&D projects. While multilateral alliances have the same value creation logic as bilateral R&D alliances, the involvement of more than two participants complicates alliance design and governance (Doz & Hamel, 1998).

In multi-firm settings such as multilateral R&D alliances, relationships among firms can no longer be examined in a segregated, dyadic manner. As discussed in Chapter II, multilateral alliances, with at least three partner firms, are based on

[3] The comparison between bilateral alliance, multilateral alliance and alliance network can be found in Chapter II and visually illustrated in Figure 2.4.

generalized exchanges. Different from restricted social exchange occurring when two parties directly exchange favors with each other, generalized social exchanges take place among a group of at least three parties, and there is no direct reciprocity among them (Takahashi, 2000). Research on group behavior suggests that beyond a certain threshold, an increase in the number of participants in any group can lead to dysfunctional behavior within the group and to a decline in its ability to perform assigned tasks (Steiner, 1972; Hackman, 1987). Multilateral alliances pose larger organizational problems than bilateral alliances. "[M]anaging multi-firm alliances presents important challenges to managers" (Hwang & Burgers, 1997: 101).

Within multilateral R&D alliances, the presence of more than two partners heightens the possibility of opportunism and conflict. Although both restricted and general social exchanges are subject to significant risks of opportunistic behaviors, accountability is relatively high and opportunistic activities are relatively easy to detect and remedy in restricted exchanges. By comparison, risks are more prevalent in generalized exchanges (Takahashi, 2000). Given the ambiguity and disjointed nature of exchanges, participating firms in multilateral R&D alliances have more incentives for opportunistic behaviors such as appropriating other partner firms' valuable technological assets, than participating firms in bilateral R&D alliances. Therefore, trust is more valuable in multilateral than bilateral R&D alliances to govern partners' activities.

However, trust is more difficult to establish among multilateral R&D alliance partners, in contrast to partners of bilateral R&D alliances. Parkhe (1993) notes that increasing the number of partners in an alliance can limit the level of trust between

alliance partners. This is because the increasing number of partners in an alliance can make identifying and realizing common interests more difficult, which complicates the task of ensuring trust between alliance partners. Moreover, having more partners makes it less likely that all the partners will trust one another in the alliance. Monitoring each partner's contributions and introducing appropriate sanctions in the face of opportunistic behaviors is harder to implement when there is a large group of participants involved.

KNOWLEDGE PROTECTION IN MULTILATERAL R&D ALLIANCES

Multilateral R&D alliances are based on generalized exchanges and, thus, share at least two salient features of such exchanges. First, partner firms of multilateral R&D alliances face higher risks of opportunism. Exchanges in multilateral alliances are carried out by multiple parties that do not reciprocate with each other directly; monitoring each other's behaviors is difficult. Therefore, partner firms of multilateral alliances have more concerns about whether their partners will behave opportunistically and take unilateral advantage of them. Protecting their valuable technological assets is a major consideration that concerns multilateral R&D alliance participants. Second, partner firms of multilateral R&D alliances have a higher need for trust, because of the considerable risks of opportunism involved. Trust among alliance partners reduces anxiety and allows reciprocity to take place over time. Therefore, when selecting partners for multilateral R&D alliances, in contrast to bilateral ones, firms are more likely to focus on their prior partners they can trust.

Hypothesis 8. The likelihood of alliance between prior partners is higher in a multilateral than a bilateral R&D alliance.

I argued in Chapter III that the more radical innovation an R&D alliance intends to develop, the more cautious the alliance partners are regarding knowledge leakage. Such concerns are sharper when the number of R&D alliance participants increases. In multilateral R&D alliances, in contrast to bilateral ones, partners have more concerns about knowledge leakage and therefore have a greater need for trust among each other to address such concerns. When the innovation that an R&D alliance intends to develop is radical and requires a higher level of disclosure of partner firms' core technological assets, worries about partners' opportunistic behaviors are greater. Therefore, the causal relationships between innovation radicality and partner selection in R&D alliances are strengthened in a multilateral R&D alliance, in contrast to a bilateral one.

Hypothesis 9a. The positive relationship between the radicality of innovations to be developed and the likelihood of alliance formation between Friends is stronger in a multilateral than a bilateral R&D alliance.

Hypothesis 9b. The negative relationship between the radicality of innovations to be developed and the likelihood of alliance formation between Acquaintances is stronger in a multilateral than a bilateral R&D alliance.

I also argued in Chapter III that formal protection of intellectual property affects firms' selection of R&D alliance partners. Such effects are stronger when the R&D alliance is multilateral than bilateral. In multilateral R&D alliances, the enlarged concern on other partners' appropriation of their technological assets causes partner firms to be more sensitive to the change of their protective environments. When the intellectual

property protection decreases, the need to rely on prior partners which they can trust is higher in multilateral R&D alliances, in contrast to bilateral ones.

Hypothesis 10. The negative relationship between the intellectual property protection offered by the local market and the likelihood of alliance formation between prior partners is stronger in a multilateral than a bilateral R&D alliance.

SUMMARY

This chapter emphasizes multilateral R&D alliances. When the number of partners increases, the management of R&D collaboration is complicated. From a social exchange perspective, this chapter argues that multilateral R&D alliance is featured by partners' concerns about higher risks of others' opportunism and more reliance on trust to govern their collaborations. I propose that alliance formation between prior partners is more likely in multilateral R&D alliances, and that the causal relationships proposed in Chapter III are strengthened in multilateral R&D alliances, in contrast to bilateral ones.

The next chapter describes the research design used to empirically test the theoretical hypotheses proposed in Chapters III, IV and V.

CHAPTER VI

METHODOLOGY

This chapter describes a research design that is used to test the hypotheses proposed in Chapters III, IV, and V. Below, I present the sample selection, measurements of variables, and statistical analysis techniques.

SAMPLE SELECTION

The overall sample is composed of 2185 R&D alliances (i.e., alliances involving collaborative R&D activities exclusively and in combination with manufacturing and/or marketing activities) involving firms in high-technology industries, from 1994 to 2003. Firms in these industries are ideal for a study of R&D collaboration. Survival and profitability in these high-technology industries are critically dependent on firms' abilities to create and commercialize innovations quickly. Therefore, they establish R&D alliances at an unprecedented rate as a way to spread the risk and cost of technological development.

The list of these high-technology industries is published at the AeA website (http://www.aeanet.org/Publications/IDMK_definition.asp). AeA, founded in 1943, is the largest association of high-tech companies in the United States, representing all segments of the technology industry. AeA's definition of high-tech industry consists of SIC codes that fall into two broad categories – high-tech manufacturing (SIC codes: 357, 365, 366, 367, 381, 382, 384, and 386) and high-tech services which include communications services (SIC codes: 481, 482, 484, and 489), and software and computer-related services (SIC code: 737). The list does not include broad categories if

the high-tech portion does not represent a clear majority. SIC codes and industry names of all industries included in this study can be found in Appendix A.

These sample R&D alliances are re-combined to create three categories to test the hypotheses proposed in Chapters III, IV and V, respectively. Figure 5.1 indicates the three research designs, based on Shadish, Cook and Campbell (2002). Hypotheses proposed in Chapter III are tested in the setting of domestic bilateral R&D alliances, the most traditional definition of R&D alliances in the strategic management literature. The sample size is 1159. Hypotheses proposed in Chapter IV are tested using a sample including both domestic and international bilateral R&D alliances. The sample size is 1921, among which 1159 are domestic and 762 are international. Hypotheses proposed in Chapter V are tested by a sample composed of domestic bilateral and multilateral R&D alliances. The sample size is 1423, of which 1159 are bilateral and 264 are multilateral. Because of the complications raised by international multilateral R&D alliances (see "Discussion" for future research avenues in this respect), the fourth cell is excluded in the present study.

FIGURE 5.1.
Empirical Settings

	Domestic	International
Bilateral	✓	✓
Multilateral	✓	**Future research**

(a) Overall empirical setting

	Domestic	International
Bilateral	✓	
Multilateral		

(b) Empirical setting for hypotheses proposed in Chapter III

	Domestic	International
Bilateral	✓	✓
Multilateral		

(c) Empirical setting for hypotheses proposed in Chapter IV

	Domestic	International
Bilateral	✓	
Multilateral	✓	

(d) Empirical setting for hypotheses proposed in Chapter V

Note: Shadowed cells are included.

I collected the information on alliances from the Securities Data Corporation (SDC) Database on Alliances and Joint Ventures. The SDC database contains information on all types of alliances, compiled from publicly available sources such as SEC filings and their international counterparts, trade publications, wires, and news sources. Although the coverage of alliances is still far from comprehensive, this database currently represents one of the most comprehensive sources of information on alliances.

MEASURES

I list below the measures of dependent, independent, and control variables according to their sequence of appearance in the dissertation.

Dependent Variables

Partner selection

The first dependent variable is PARTNER, a categorical variable created from information in the SDC database to capture the relationship between alliance partners. PARTNER is set to 1 when the alliance partners are Strangers (i.e., partner firms have had no alliance during the past five years), 2 when the alliance partners are Acquaintances (i.e., partner firms have had one alliance during the past five years), and 3 when the alliances partners are Friends (i.e., partner firms have had two or more alliances during the past five years). A five-year period is used because recent research suggests that the lifespan for alliances is usually no more than five years (Kogut, 1988, 1989; Gulati, 1995b).

I also create two dummy variables for the analysis of the dynamic aspects of alliance formation decisions. The first dummy variable, PRIOR, takes on the value of 1 when an R&D alliance is formed between Acquaintances or Friends and 0 when an alliance is between Strangers. The second dummy variable, FRIEND, equals to 1 when an R&D alliance is formed between Friends and 0 otherwise.

Governance structure

A dummy varies is generated to capture alliance governance mode. EQUITY is set to 1 when the R&D alliance is organized by equity-based joint venture; 0 when it is organized by non-equity-based contract. Information on governance is collected from the SDC database.

Alliance scope

I create a dummy variable SCOPE to capture the vertical scope of alliance activities. SCOPE is set to 1 when alliance activities include manufacturing and/or marketing in addition to collaborative R&D. Such alliances are broader in scope than alliances involving R&D activities exclusively, for which SCOPE equals to 0. Information to create this variable is collected from the SDC database.

Independent Variables

Innovation radicality

RADICALITY, the measure of innovation radicality, is coded from synopses of alliance activities provided by the SDC database, with a scale from 1 (very incremental) to 7 (very radical). The synopses of alliance activities were coded by two independent coders. The percent agreement is 73% and Cohen's kappa[4] is 0.79, which is well above the satisfactory level of 0.70. Disagreements are discussed and resolved by the two raters; the resolved scores were used in the analysis below.

I also employ a dummy variable, RADICALITY2, to measure innovation radicality. The variable takes on the value of one when the innovative goal of an R&D alliance is to develop radical innovations. An innovation is categorized as radical when the alliance synopsis suggests that the primary activity is to pursue next generation technologies. This would include, for example, the alliance between Hitachi and Asahi Optical to develop a next-generation optical head that increases DVD storage capacity to

[4] Cohen's kappa is used to assess inter-rater reliability and is considered to be an improvement over using % agreement to evaluate this type of reliability. Kappa has a range from 0 ~ 1.00, with larger values indicating better reliability.

100GB. The omitted category of alliances involves incremental innovation when the synopsis suggests that alliance activities are focused on development of new products or processes based on existing technologies. An example would be the R&D alliance between Texas Instruments and Sharp to provide research and development services for camera-equipped cellular phones. Sharp agreed to supply camera lenses while Texas Instrument to make the semiconductor; both activities are based on the firms' existing technologies. Similar results were observed using RADICALITY and RADICALITY2.

Intellectual property protection

PROTECTION is a continuous variable ranging from 1.34 to 9.51 for the markets where the sample alliances are located. This variable is centered in order to reduce multicollinearity problems appearing in regression models with interaction terms with independent variables.

Information on intellectual property protection in the local market is taken from the World Competitiveness Yearbook (WCY) published by the International Institute for Management Development (IMD). The WCY, which has been published since 1989, is the world's most comprehensive annual study on the competitiveness of nations. IMD conducts executive surveys annually to quantify issues that are not easily measured such as intellectual property protection. The survey responses reflect perceptions of business executives who are dealing with international business markets. The executives are asked to evaluate the conditions of the country in which they work and have resided during the past year, drawing from the wealth of their international experience. By so

doing, the WCY ensures that the evaluations portray an in-depth knowledge of their particular environment.

International R&D alliance

Difficulties in defining the nationality of a partner occur when a parent firm is wholly or partly a subsidiary of another parent firm, or a third firm with a different nationality. To simplify and clarify partner nationality, the following criteria from Makino and Beamish (1998) were adopted. First, when the partner is an independent firm, partner nationality is defined as the national origin of the parent firm. Second, when the partner is a subsidiary, partner nationality is defined as the national origin of the parent firm. Finally, when the partner is itself a joint venture, partner nationality is defined as the national origin of the firm that possesses the largest share of the equity.

DRDA (cross-national domestic R&D alliance) is identified if both alliance partners of the R&D alliance are of the same nationality, but the nationality is different from the country where their alliance is located. IRDA (traditional international R&D alliance) is recognized if one alliance partner is local and one is foreign. *TRDA* (trinational R&D alliance) is identified if the partner firms are of different nationalities and neither of the nationalities is the country where their alliance is located. These three types of R&D alliances compose international R&D alliances studied in this dissertation.

Multilateral R&D alliances

I create a dummy variable, *MULTILATERAL*, which takes on the value of 1 when the R&D alliance involves more than two firms and 0 if only two partner firms are

involved. All multilateral R&D alliances included are domestic, as specified above in Sample Selection section.

Control Variables

Industry

I include a dummy variable, INDUSTRY, for the industry of the focal firm. The focal firm of an alliance is the partner that carries the major equity share (>50%), or is specified as the central organizer of the collaboration, or, if none of these two criteria can be applied, the first company whose name appear in the alliance's name published in alliance announcement. Technologies used in some industries involve more uncertainty than others. For instance, system software generally has greater irreducible technological uncertainty than hardware design. Therefore, firms in different industries may have different levels of concerns with protecting their technological assets, which can adjust their decisions in selecting R&D alliance partners. In the analysis, I control for the focal firm's industry by including a dummy variable, INDUSTRY. The focal firm is identified through the synopses text published by SDC. INDUSTRY is set to 1 if the primary SIC codes of alliance participants are 481, 482, 484, 489 and 737 (high-technology service industries, including both communication and computer-related services). INDUSTRY is set to 0 if the primary SIC codes of alliance participants are 357, 365, 366, 367, 381, 382, 384, and 386 (high-technology manufacturing industries).

Year

Because the dataset covers R&D alliances over a ten year period, I must be concerned with the possibility that firms and industries have changing preferences

regarding partner selection. Thus, I also include nine dummy variables to control for the ten years in my analysis.

In addition, EQUITY and SCOPE are included as control variables in regression models analyzing alliance partner selection. As discussed above, EQUITY is expected to be negatively associated with the likelihood of selecting a prior partner; SCOPE is expected to be positively associated with the likelihood of selecting a prior partner.

STATISTICAL MODELS

Several types of statistical models are used to test the hypotheses proposed. All statistical analyses are conducted using STATA/SE, version 8.0.

Multinominal Logistic Regression

Multinominal logistic regression is used to test Hypotheses 1a ~ 3b and 8 ~ 10a, because the dependent variable, PARTNER is categorical. The multinominal logistic regression estimates the effect of an explanatory variable on a partner category as the relative effect compared to the effect of the explanatory variable on one particular partner category (the baseline) (Long, 1997; Greene, 2000). In this study, I chose Stranger as the baseline because the hypotheses were proposed with Strangers as the comparison group. Coefficients for the independent variables are estimated for each of the two groups, Acquaintances and Friends. That is, for each multinominal logistic regression model, there are two sets of coefficients – one for Acquaintances, one for Friends.

Three-Stage Least Squares Analysis

To test the hypotheses on the dynamic aspects of alliance formation decision (Hypotheses 4a ~ 5b), I allow for the interdependencies among the three decision variables. I do so by employing a three-stage least squares (3SLS) analysis. 3SLS estimates a system of structural equations, where some equations contain endogenous variables among the explanatory variables (STATA Manual, version 8.0). Typically, the endogenous explanatory variables are dependent variables from other equations in the system. The 3SLS estimation is an improvement on ordinary least square (OLS) estimation since the former corrects for the likelihood of omitted variable and simultaneity bias. The endogenous variables in this study are PRIOR/FRIENDS, EQUITY, and SCOPE.

T-test Analysis

One-tailed t-tests are used to test Hypotheses 6, 7 and 8. For Hypothesis 6, a one-tailed t-test is utilized to compare the percentage of alliance formation between prior partners for domestic and international R&D alliances. For Hypothesis 7, three one-tailed t-tests are operated to compare the percentage of alliance formation between prior partners for TRDA, IRDA, and DRDA (i.e., TRDA > IRDA, TRDA > DRDA, and IRDA > DRDA). For Hypothesis 8, a one-tailed t-test is utilized to compare the percentage of alliance formation between prior partners for bilateral and multilateral R&D alliances. All comparisons are conducted twice with PRIOR and FRIENDS respectively.

SUMMARY

In sum, this chapter describes the methods that are used to select the sample industry and firms, the measures that are employed to gauge the important variables, and an overview of the statistical models. The empirical execution and the findings are provided in Chapter V. Chapter VI provides a discussion of the results reported. Implications, limitations and avenues for additional research emerging from this dissertation are elaborated in the concluding chapter.

CHAPTER VII

RESULTS

This chapter is divided into three sections presenting results of the hypotheses regarding partner selection as an alternative mechanism of knowledge protection in Chapter III, the hypotheses on partner selection for international R&D alliances in Chapter IV, and the hypotheses on partner selection for multilateral R&D alliances in Chapter V.

PARTNER SELECTION AS A KNOWLEDGE PROTECTION MECHANISM

Table 7.1 presents descriptive statistics for the sample of 1159 R&D alliances included in the empirical analysis. Several interesting features of my sample are worth mentioning here. With respect to the main dependent variable, the majority of the sample alliances (71 percent) are between Strangers while 29 percent are between Acquaintances (11 percent) or Friends (18 percent). Fifteen percent of the sample alliances are equity joint ventures, the remainder being contractual alliances. Also, 41 percent of the sample alliances involve manufacturing and/or marketing in combination with R&D, while 59 percent involve R&D collaboration exclusively. Consistent with the literature, the correlation between scope and governance is positive and statistically significant at 0.06. Multicollinearity between variables was checked carefully and was not a problem.

TABLE 7.1.
Descriptive Statistics (Domestic Bilateral R&D Alliances)

Variable	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9
1. PARTNER	1.47	0.78	1	3	1.00								
2. PRIOR	0.29	0.45	0	1	0.94*	1.00							
3. FRIEND	0.18	0.38	0	1	0.92*	0.74*	1.00						
4. EQUITY	0.15	0.36	0	1	-0.04	-0.02	-0.07*	1.00					
5. SCOPE	0.41	0.49	0	1	0.10*	0.11*	0.08*	0.06*	1.00				
6. RADICALITY	3.92	1.61	1	7	0.19*	0.12*	0.25*	-0.01	-0.12*	1.00			
7. PROTECTION	0.00	0.68	-4.95	1.62	0.04	0.04	0.03	-0.16*	0.07*	0.02	1.00		
8. INDUSTRY	0.49	0.50	0	1	-0.06	-0.05	-0.06*	0.00	-0.01	-0.13*	0.06*	1.00	
9. YEAR	1995.90	2.37	1994	2003	-0.04	-0.03	-0.05	0.07*	-0.08*	-0.05	-0.12*	-0.16*	1.00

Note: N=1159; * $p<.05$

Overall, as shown in Tables 7.2 and 7.3, the theoretical model of partner selection as a protective mechanism suggested in Chapter III and illustrated in Figure 3.1 is generally supported by the data. Below, I review the statistical evidence of each hypothesis in turn.

Hypothesis 1a. The more radical the innovation goals of the R&D alliance, the more likely the alliance partners are to be Friends rather than Strangers.

Hypothesis 1b. The more radical the innovation goals of the R&D alliance, the less likely the alliance partners are to be Acquaintances rather than Strangers.

Estimation results for this set of hypotheses are shown in Table 7.2, which includes several multinominal logistic regressions. Model 1 and 2 include only control variables; Model 3 and 4 add independent variables. With respect to radicality of innovation that an R&D alliance intends to develop, I find, as predicted, that RADICALITY has a negative coefficient when comparing Acquaintance against Strangers. The negative coefficient is at the 1% or lower significance level (Model 3 in Table 7.2: $\beta = -0.19$, $p<0.01$). When comparing Friend against Strangers, RADICALITY has a positive coefficient at the 1% or lower significance level (Model 4 in Table 7.2: $\beta = 0.41$, $p<0.001$). Therefore, strong support is found for the predicted effects of innovation radicality that, when innovation radicality is high, R&D alliances are more likely to be formed between Friends than Strangers (Hypothesis 1a), but less likely to be formed between Acquaintances than Strangers (Hypothesis 1b).

TABLE 7.2.
Multinominal Logistic Regression (Domestic Bilateral R&D Alliances)

	Model 1 (ACQ)	Model 2 (FRD)	Model 3 (ACQ)	Model 4 (FRD)	Model 5 (ACQ)	Model 6 (FRD)
Control variables						
Industry	0.01	-0.42 **	-0.07	-0.21	-0.07	-0.19
Scope	0.43 *	0.48 **	0.33 †	0.70 ***	0.33 †	0.70 ***
Equity	0.30	-0.57 *	0.35	-0.63 *	0.35	-0.63 *
Independent variables						
Radicality	-	-	-0.19 **	0.41 ***	-0.20 **	0.42 ***
Protection	-	-	0.12	-0.00	0.09	0.48
Radicality * Protection	-	-	-	-	0.01	-0.12
Intercept	-2.18 ***	-1.40 ***	-1.44 ***	-3.27 ***	-1.44 †	-3.31 ***
N	1159		1159		1159	
LR-chi2	42.87*		121.01***		122.45***	

Notes:
1. ACQ = Acquaintance. FRD = Friend. The comparison baseline is Stranger.
2. Two-tailed t statistics where † $p< .10$, * $p< .05$, ** $p< .01$, *** $p< .001$
3. Because of the space limit, I did not include individual coefficients on year dummies in this table.

Hypothesis 2a. The weaker the intellectual property rights protection, the more likely the alliance partners are to be Friends rather than Strangers.

Hypothesis 2b. The weaker the intellectual property rights protection, the more likely the alliance partners are to be Acquaintances than Strangers.

Unfortunately, neither of the coefficients on PROTECTION is statistically significant in Model 3 and 4 in Table 7.2. Thus the sample does not provide any empirical support for Hypothesis 2a and Hypothesis 2b on the effects of intellectual property protection in the local market.

Hypothesis 3a. Intellectual property rights protection weakens the positive relationship between the radicality of innovation goals of the R&D alliance and the likelihood of alliance formation between Friends rather than Strangers.

Hypothesis 3b. Intellectual property rights protection weakens the negative relationship between the radicality of innovation goals of the R&D alliance and the likelihood of alliance formation between Acquaintances rather than Strangers.

To test the interacting effect proposed, Model 5 and 6 in Table 7.2 add the interaction term between RADICALITY and PROTECTION. None of the coefficients of the interaction term is statistically significant; therefore, the arguments regarding the weakening moderation effects proposed in Hypothesis 3a and Hypothesis 3b are not supported.

I now turn to the second estimation concerning the dynamic aspects of alliance formation decisions. As shown in Table 7.3, these three decision variables are closely entangled and interacting with one another. I conduct 3SLS with two measures regarding prior partners. Using the Hausman specification tests (Durbin & Waston, 1971; Hausman, 1978; Davidson & MacKinnon, 1993), we compared our OLS models to 3SLS models, and 3SLS models are preferred in all cases.

I first use PRIOR to include both Acquaintance and Friend partners; I then use a more rigorous measure FRIEND to include Friend partners only. Therefore, the second measure reflects prior *successful* collaborations rather than simply previous interactions as represented by PRIOR. Although these two 3SLS regression models provides the same results, the one with FRIENDS as a rigorous measure of previous successful cooperation offers much stronger evidence than the one with PRIOR as a simpler measure.

Hypothesis 4a. When the R&D alliance is structured as an equity joint venture, the likelihood is lower that the alliance partners are prior partners.

Hypothesis 4b. When the R&D alliance is between prior partners, the likelihood is lower that the alliance governance structure is an equity joint venture.

As predicted in Hypotheses 4a and 4b, the coefficient on EQUITY is negative and statistically significant in the PRIOR/FRIEND equations (PRIOR equation: $\beta = -0.07$, $p<0.10$; FRIEND equation: $\beta = -0.16$, $p<0.001$) and the coefficients on PRIOR and FRIENDS are positive and statistically significant in EQUITY equations (PRIOR as

TABLE 7.3.
Three-Stage Least Squares Regression

3SLS with PRIOR, EQUITY, and SCOPE as exogenous variables					
	PRIOR		**EQUITY**		**SCOPE**	
Prior	-		-0.43	†	0.25	***
Equity	-0.07	†	-		0.20	***
Scope	0.21	***	0.11	***	-	
Radicality	0.04	***	0.00		-0.05	***
Protection	0.00		-0.12	***	0.06	*
Industry	-0.03	*	0.00		-0.04	
Intercept	0.06		0.93	***	0.56	***
N	1159		1159		1159	
Chi2	95.00	***	106.21	***	136.42	***
3SLS with FRIEND, EQUITY, and SCOPE as exogenous variables					
	FRIEND		**EQUITY**		**SCOPE**	
Friend	-		-0.14	***	0.30	***
Equity	-0.16	***	-		0.23	***
Scope	0.18	***	0.12	***	-	
Radicality	0.06	***	0.01		-0.06	***
Protection	-0.02		-0.12	***	0.06	*
Industry	-0.02		0.00		-0.04	
Intercept	-0.11	**	0.04		0.61	***
N	1159		1159		1159	
Chi2	170.04	***	132.02	***	137.40	***

Notes:
1. Two-tailed t statistics where † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.
2. Because of the space limit, I did not include individual coefficients on year dummies in this table.

independent variable: β = -0.43, p<0.10; FRIEND as independent variable: β = -0.14, p<0.001). Thus, when alliance scope is organized in a protective governance structure, the need to select partners with strong-form trust is reduced. On the other hand, when the alliance is organized between trustworthy partners, firms are less likely to adopt an expensive governance structure such as an equity-based joint venture. Therefore, I find a substitution effect between governance and selection of prior partner, as predicted in Hypotheses 4a and 4b.

Hypothesis 5a. When the alliance scope is broad, the likelihood is higher that the alliance partners are prior partners.

Hypothesis 5b. When the R&D alliance is between prior partners, the likelihood is higher that the alliance scope is broad.

As suggested by Hypotheses 5a and 5b, the coefficient on SCOPE is positive and statistically significant in the PRIOR/FRIEND equations (PRIOR equation: β = 0.21, p<0.01; FRIEND equation: β = 0.18, p<0.001) and the coefficients on PRIOR and FRIENDS are positive and statistically significant in SCOPE equations (PRIOR as independent variable: β = 0.25, p<0.001; FRIEND as independent variable: β = 0.30, p<0.001). The results suggest that when alliance scope is narrowed, the need to select partners with strong-form trust to address knowledge leakage concerns is reduced. Conversely, when the alliance is organized between trustworthy partners, firms are more wiling to engage in activities of broad scope. Thus, the substitution effect between alliance scope and selection of prior partner is found, as predicted in Hypothesis 5a and 5b.

Also, consistent with Oxley and Sampson (2004), I detect the substitution relationship between governance and alliance scope. The coefficient on EQUITY is positive and statistically significant in the SCOPE equation (PRIOR as an independent variable: $\beta = 0.20$, $p<0.001$; FRIEND as an independent variable: $\beta = 0.23$, $p<0.001$) and the coefficient on SCOPE is positive and statistically significant in the EQUITY equation (PRIOR as an independent variable: $\beta = 0.11$, $p<0.001$; FRIEND as an independent variable: $\beta = 0.12$, $p<0.001$). That is, when alliance scope is narrowed, the need to govern alliance activities in a protective structure such as joint venture is reduced. On the contrary, when the alliance is organized as a joint venture involving equity investment, the partners are more wiling to engage in activities of broad scope. Therefore, the substitution effect between governance and alliance scope is found, as the literature predicted (Oxley & Sampson, 2004).

There is an additional interesting finding worth noting. In Table 7.3, the coefficient on RADICALITY is positive and statistically significant in PRIOR and FRIEND equations (PRIOR equation: $\beta = 0.04$, $p < 0.001$; FRIEND equation: $\beta = 0.06$, $p < 0.001$), but not in EQUITY equations. The coefficient on PROTECTION is negative and statistically significant in EQUITY equations, but not in PRIOR/FRIEND equations (with PRIOR as an independent variable: $\beta = -0.12$, $p < 0.001$; with FRIEND as an independent variable: $\beta = -0.12$, $p < 0.001$). This finding suggests that firms may employ mechanisms to address different concerns (in this case, concerns stemming from internal versus external) in protecting their technological assets. Detailed discussion in this regard can be found in Chapter VIII.

DOMESTIC VERSUS INTERNATIONAL R&D ALLIANCES

Table 7.4 demonstrates eight comparison pairs to test hypotheses proposed in Chapter IV.

Hypothesis 6. The likelihood of alliance formation between prior partners is greater in an international than a domestic R&D alliance.

Hypothesis 6 suggests that alliance formation between prior partners is more likely to be observed in international than domestic R&D alliances. The first two t-tests in Table 7.4 are used to test this hypothesis – one with the measure of prior partner including both Acquaintances and Friends (PRIOR), one with the measure of prior partner including Friends only (FRIEND). Unfortunately, none of the t-values are statistically significant at $p < 5\%$ level. Therefore, my data do not support the arguments on different partner selection preferences between domestic and international R&D alliances.

TABLE 7.4.
Comparison across Groups (Domestic versus International R&D Alliances)

#	Variable	Mean	N	S.D.	Mean	N	S.D.	Hypothesis	T-value
		Domestic R&D alliances (D)			International R&D alliances (I)				
1.	PRIOR	0.29	1159	0.45	0.30	762	0.46	H6: D < I	-0.42 (n.s.)
2.	FRIEND	0.18	1159	0.38	0.19	762	0.39	H6: D < I	-0.36 (n.s.)
			TRDA			IRDA			
3.	PRIOR	0.24	46	0.43	0.29	679	0.45	H7: TRDA>IRDA	-0.74 (n.s.)
			TRDA			DRDA			
4.	PRIOR	0.24	46	0.43	0.46	37	0.51	H7: TRDA>DRDA	-2.14*
			IRDA			DRDA			
5.	PRIOR	0.29	679	0.45	0.46	37	0.51	H7: IRDA>DRDA	-2.20*
			TRDA			IRDA			
6.	FRIEND	0.17	46	0.38	0.19	679	0.39	H7: TRDA>IRDA	-0.22 (n.s.)
			TRDA			DRDA			
7.	FRIEND	0.17	46	0.38	0.16	37	0.37	H7: TRDA>DRDA	0.14 (n.s.)
			IRDA			DRDA			
8.	FRIEND	0.19	679	0.39	0.16	37	0.37	H7: IRDA>DRDA	-0.38 (n.s.)

Notes:
1. TRDA = trinational R&D alliances. IRDA = traditional international R&D alliances. DRDA = cross-national domestic R&D alliances.
2. One-tailed t statistics where * $p<.05$.

Hypothesis 7. The likelihood of selecting prior partners for international R&D alliances decreases in the sequence of TRDA > IRDA > DRDA.

T-tests #3 ~ #8 are used to examine whether alliance formation between prior partners is more likely in TRDA than IRDA, TRDA than DRDA, and IRDA than DRDA. T-tests #3 ~ #5 conduct the comparison employing the measure of prior partner including both Acquaintances and Friends (PRIOR); T-tests #4 ~ #8 with the measure of prior partner including Friends only (FRIEND). Support is found that alliance formation between prior partners (including Acquaintances and Friends) is more likely in TRDA ($t = -2.14$; $p < 0.05$) and IRDA($t = -2.20$; $p < 0.05$), than in DRDA. In other words, DRDA is the least likely to be formed between prior partners. However, the same tests with a narrower measure of prior partner (Friends only) generated no statistically significant results. Therefore, I conclude that Hypothesis 7 is partially supported. Further discussion on the insignificant findings can be found in next chapter.

BILATERAL VERSUS MULTILATERAL R&D ALLIANCES

Table 7.5 demonstrates descriptive statistics for the sample of 1423 R&D alliances included in the empirical analysis. The majority of the sample alliances (81 percent) are bilateral while 19 percent are multilateral with at least three firms. Fifteen percent of the sample alliances are equity joint ventures, the remainder being contractual alliances. Descriptive statistics of other variables are similar to those generated by the first sample of 1153 bilateral R&D alliances (See Table 7.1). Again, multicollinearity between variables was checked carefully and was not a problem.

TABLE 7.5.
Descriptive Statistics (Domestic Bilateral and Multilateral R&D Alliances)

Variable	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10
1. PARTNER	1.52	0.81	1	3	1.00									
2. PRIOR	0.31	0.46	0	1	0.94*	1.00								
3. FRIEND	0.20	0.40	0	1	0.92*	0.75*	1.00							
4. EQUITY	0.18	0.39	0	1	-0.05*	-0.03	-0.08*	1.00						
5. SCOPE	0.41	0.49	0	1	0.04	0.05	0.03	0.08*	1.00					
6. RADICALITY	3.97	1.54	1	7	0.21*	0.15*	0.25*	-0.04	-0.15*	1.00				
7. PROTECTION	0.00	0.84	-4.86	1.35	0.03	0.02	0.02	-0.25*	0.03	0.04	1.00			
8. INDUSTRY	0.46	0.50	0	1	-0.07*	-0.06*	-0.08*	-0.01	0.02	-0.16*	0.08*	1.00		
9. YEAR	1996.00	2.48	1994	2003	-0.04	-0.03	-0.05	0.05	-0.08*	-0.00	-0.07*	-0.16*	1.00	
10. MULTILATERAL	0.19	0.39	0	1	0.14*	0.13*	0.13*	0.16*	-0.02	0.07*	-0.23*	-0.11*	0.08*	1.00

Notes: N=1423; * $p<.05$

Hypothesis 8. The likelihood of alliance between prior partners is higher in a multilateral than a bilateral R&D alliance.

Hypothesis 8 proposes that alliance formation between prior partners is more likely to be observed in multilateral than bilateral R&D alliances. The first two t-tests in Table 7.6 are used to test this hypothesis – one with the measure of prior partner including both Acquaintances and Friends (PRIOR), one with the measure of prior partner including Friends only (FRIEND). Both t-tests indicate show support for this hypothesis (comparison on PRIOR: t = -4.87, $p < 0.001$; on FRIEND: t = -4.98, $p < 0.001$).

TABLE 7.6.
Comparison across Groups (Bilateral versus Multilateral R&D Alliances)

#	Variable	Mean	N	S.D.	Mean	N	S.D.	Hypothesis	T-value
		Bilateral R&D alliances (B)			Multilateral R&D alliances (M)				
1.	PRIOR	0.29	1159	0.45	0.44	264	0.50	H8: B < M	-4.87***
2.	FRIEND	0.18	1159	0.38	0.31	264	0.47	H8: B < M	-4.98***

Note: One-tailed t statistics where *** $p<.001$.

Three hypotheses were proposed regarding the moderating effects of alliance multilateralism on the causal relationships between partner selection and innovation radicality and intellectual property protection.

Hypothesis 9a. The positive relationship between the radicality of innovations to be developed and the likelihood of alliance formation between Friends is stronger in a multilateral than a bilateral R&D alliance.

Hypothesis 9b. The negative relationship between the radicality of innovations to be developed and the likelihood of alliance formation between Acquaintances is stronger in a multilateral than a bilateral R&D alliance.

Hypothesis 10. The negative relationship between the intellectual property protection offered by the local market and the likelihood of alliance formation between prior partners is stronger in a multilateral than a bilateral R&D alliance.

Estimation results for these two sets of hypotheses are shown in Table 7.7, which includes several multinominal logistic regressions. Model 1 and 2 include only control variables; Model 3 and 4 add independent variables – RADICALITY, PROTECTION and MULTILATERAL. Similar results on RADICALITY and PROTECTION are generated as those in Table 7.2. MULTILATERAL has a positive and statistically significant coefficient when comparing FRIEND again STRANGER (Model 4 in Table 7.7: $\beta = 0.86$, $p<0.001$). This confirms what I found in the t-tests presented in Table 7.6; alliance formation between prior partners is more likely in multilateral than bilateral R&D alliances. Models 5 and 6 add the interaction between RADICALITY and MULTILATERAL; Models 7 and 8 add the interaction between PROTECTION and MULTILATERAL. However, none of the coefficient estimates supports the predictions made in Hypotheses 9 and 10.

TABLE 7.7.
Multinominal Logistic Regression (Domestic Bilateral and Multilateral R&D Alliances)

	Model 1 (ACQ)	Model 2 (FRD)	Model 3 (ACQ)	Model 4 (FRD)	Model 5 (ACQ)	Model 6 (FRD)	Model 7 (ACQ)	Model 8 (FRD)
Control variables								
Industry	-0.07	-0.44 **	-0.11	-0.12	-0.08	-0.11	-0.11	-0.12
Scope	0.24	0.21 **	0.22	0.43 **	0.25	0.44 **	0.21	0.43 **
Equity	0.29	-0.54 **	0.26	-0.60 **	0.30	-0.58 **	0.26	-0.60 **
Independent variables								
Radicality	--	--	-0.14 *	0.47 ***	-0.20 **	0.40 ***	-0.14 *	0.42 ***
Protection	--	--	0.08	0.09	0.05	0.08	0.13	0.08
Multilateral	--	--	0.32	0.86 ***	-1.75 *	0.20	0.30	0.86 ***
Radicality * Multilateral	--	--	--	--	0.52 **	0.16	--	--
Protection * Multilateral	--	--	--	--	--	--	-0.08	0.03
Intercept	-1.92 ***	-1.10 ***	-1.46 ***	-3.24 ***	-1.32 ***	-3.19 ***	-1.47 ***	-3.23 ***
N	1423		1423		1423		1423	
LR-chi2	37.59*		144.77***		152.46***		144.95***	

Notes:
1. ACQ = Acquaintance. FRD = Friend. The comparison baseline is Stranger.
2. Two-tailed t statistics where † $p<.10$, * $p<.05$, ** $p<.01$, *** $p<.001$
3. Because of the space limit, I did not include individual coefficients on year dummies in this table.

SUMMARY

This chapter presents the empirical evidence regarding partner selection as a protective mechanism to cope with R&D alliance partner firms' concerns about knowledge leakage. As predicted, evidence supports that, in contrast to Strangers, firms are more likely to select Friends for new R&D alliances intending to develop radical innovations. However, firms are less likely to select Acquaintances than Strangers. I also detect a substitution effect among partner selection, governance structure and alliance scope. That is, these three decisions are used as alternative mechanisms by firms to protect their valuable technological assets from being appropriated in R&D collaborations. Moreover, firms do not seem to have different preferences regarding partner selection for international and domestic R&D alliances. However, it is found that alliance formation between prior partners is the least likely in DRDA, in contrast to IRDA and TDA. Finally, firms are more careful about partner selection and tend to choose their prior partners when the number of participants increases (i.e., multilateral R&D alliances), than when the number of partners is two. A further discussion of these empirical results will be presented in the next chapter.

CHAPTER VIII

DISCUSSION

This chapter discusses the results presented in the preceding chapter. Corresponding to the structure of the preceding chapters, this chapter is divided into three major sections. The first section discusses the results regarding partner selection as a protective mechanism in R&D alliances in general; the second section discusses the results regarding the comparison between domestic and international R&D alliances and among three types of international R&D alliances, on partner selection; and the final section discusses the results regarding the comparison between bilateral and multilateral R&D alliances.

PARTNER SELECTION AS A KNOWLEDGE PROTECTION MECHANISM

Chapter III proposes that the more radical the innovation goals of the R&D alliance, the more likely are the alliance partners to be Friends rather than Strangers and, on the contrary, the less likely are the alliance partners to be Acquaintances than Strangers. By examining the sample composed of R&D alliances involving high-technology companies, these arguments receive strong support in the present study. Decisions to select different partners are made as a response to the elevated leakage concerns associated with knowledge sharing. When an R&D alliance seeks radical innovation development and the exposure of valuable knowledge is high, firms are extremely cautious in selecting their partners. In such a situation, they are more likely to select Friends than Strangers as alliance partners, but intentionally avoid Acquaintances

that are able to appropriate the focal firm's technological assets more easily than Strangers.

Chapter III also proposes that the stronger the intellectual property rights protection, the less likely are the alliance partners to be prior partners (Acquaintances or Friends) rather than Strangers. Data employed in the present study did not offer support for these arguments. Additional analysis of the dynamic aspects of alliance formation seems to offer insights regarding these insignificant findings. Although not hypothesized, it is worth noting that different protection mechanisms may be employed to cope with various leakage concerns. Governance design is used to deal with the ineffective external protection mechanism provided by the market; whereas, partner selection is used to manage the internal contacts with partners which are required by the objective of R&D collaborations (i.e., to develop radical or incremental innovations).

Regarding the dynamic aspects of alliance formation, Chapter III proposes substitution relationships among partner selection, governance structure, and alliance scope as mechanisms to address firms' concerns about knowledge leakage in R&D alliances. For R&D alliance formation, firms consider governance structure, alliance scope and partner selection simultaneously; one decision affects the other two. The results provide strong support for the hypothesis that selecting trustworthy partners substitutes for protective governance structures and narrower alliance scope in R&D alliances, and vice versa. Specifically, when a prior partner is selected to form an R&D alliance, it is less likely for the alliance to be governed by equity commitment and it is more likely for the alliance to expand the cooperation to a broad scope. On the contrary,

when a non-equity-based governance structure is utilized for a new R&D alliance or a broad alliance scope is crafted, participating firms are more likely to select their prior partners to ease their concerns about partners' potential appropriation of their valuable technological assets. In addition, consistent with the literature, the substitution effects between governance structure and alliance scope are also detected. In sum, these three decisions represent a dynamic and endogenous system as predicted in Chapter III.

DOMESTIC VERSUS INTERNATIONAL R&D ALLIANCES

Chapter IV proposes that, in contrast to domestic ones, international R&D alliances are more likely to be formed between prior partners. However, the comparison between 1159 domestic R&D alliances and 762 international R&D alliances does not display any difference regarding partner selection. It seems that whether or not partners are from the same country does not affect firms' partner selection in the context of technology protection. This raises the question whether the internationalized economy has really merged countries as a "global village." Cultural and institutional differences do not seem to be so critical for firms, at least in high-technology industries.

In-depth examination of three types of international R&D alliances suggests that trinational R&D alliances (TRDA) are the most likely, and cross-national domestic R&D alliances (DRDA) the least likely, to be formed between prior partners. Results were found to support the hypothesis that DRDA is the less likely to be formed between prior partners compared to both TRDA and traditional international R&D alliances (IRDA). However, the argument that TRDA is the most likely to be formed between prior partners did not receive any support. Therefore, it seems that firms are cautious about the

complexity resulting from different nationalities of partner firms, which raises more concerns about knowledge protection. Firms with different national backgrounds rely more on prior relationships and trust built through prior interactions than firms with the same national background. Yet, when the complexity stems from partner firms' nationalities, involving a third country (where their R&D alliance is located) does not seem to concern the partner firms. This may be because firms have to be internationally experienced enough to form TRDAs, the most complicated type of international R&D alliances. Future research in this regard is promising and will be further discussed in next chapter.

BILATERAL VERSUS MULTILATERAL R&D ALLIANCES

Chapter V hypothesizes that, in contrast to bilateral ones, multilateral R&D alliances are more likely to be formed between prior partners. The comparison between 1159 bilateral R&D alliances and 264 multilateral R&D alliances indicate strong support for this hypothesis. When multiple partner firms are involved and direct monitoring is difficult, trust is relied on more to address partner firms' concerns about knowledge leakage in R&D alliances.

I argued that the causal relationships between partner selection and radicality of innovation developed by an R&D alliance and intellectual property protection are moderated by the number of partners in R&D alliance. No statistically significant results were found to support these arguments. This indicates that multilateral R&D alliances may be more complicated than the arguments presented herein predicted. When the innovation that an R&D alliance intends to develop is radical, firms may try to involve

as many partners as possible. On the one hand, involving more partners decreases the risks shared by each partner because the more the radical innovation is, the more risks will be borne by the innovation developers. On the other hand, radical innovations often require more resources (financial, human resources, etc.) than incremental innovations. Firms may need multiple partners involved to develop radical innovations. Under these situations, innovation radicality may be the cause for an R&D alliance's multilateralism. Similar logic can be applied to the relationship between intellectual property protection and R&D alliance multilateralism. Future research avenues in this regard are suggested in the next chapter.

SUMMARY

This chapter discusses the empirical evidence regarding partner selection as a protective mechanism that firms can utilize in their R&D alliances. While all three protective mechanisms – partner selection, governance structure, and alliance scope – can be used alternatively to address partner firms' concerns about knowledge leakage, partner selection seems to be utilized to address concerns stemming internally from innovation characteristics. Governance structure seems to be employed to address such concerns originating externally from weak intellectual property protection. Moreover, partner selection for international and multilateral R&D alliances appears to be more complicated than what this dissertation predicts. At least in high-tech industries, firms are becoming less culturally sensitive than before. There is no preference difference in partner selection between domestic and international R&D alliances. Further,

multilateral R&D alliances may be formed to cope with high risks and great resource requirements by radical innovations.

CHAPTER IX

CONCLUSIONS, IMPLICATIONS, AND LIMITATIONS

This concluding chapter summarizes both the theory and the empirical evidence of the present study, discusses its limitations, and points out its implications for future strategy research related to R&D alliances, particularly partner selection for R&D alliances. I also discuss implications for managerial practice that are suggested by my findings.

CONCLUSIONS

Partner selection is an important strategic issue for all firms engaging in R&D alliances. The present research is a first effort in studying partner selection from the perspective of knowledge protection in R&D alliances.

The literature review in Chapter II concludes that knowledge protection in R&D alliance has important implications to the chances of alliance success. Prior researchers have proposed two mechanisms to promote knowledge sharing and knowledge protection – protective governances and/or narrow alliance scope. As a possible mechanism to be utilized by firms to protect their technological assets in R&D alliances, partner selection has not received appropriate attention in the literature. Relevant research is incomplete, and publications on partner selection as a mechanism to protect knowledge in R&D alliances have not appeared in the literature. With R&D alliances becoming increasingly complex, as evidenced by the heightened number of international and multilateral R&D alliances, careful partner selection is even more critical when firms decide to expose their valuable technological assets to collaborating parties.

However, these new phenomena have not received appropriate attention in the literature, and knowledge protection in these R&D alliances has not been investigated.

This dissertation first analyzes how the knowledge leakage concerns raised by the radicality of innovation that an R&D alliance intends to develop and the intellectual property protection in a market can affect firms' preference in different types of partners. The analysis was started by categorizing potential partners that a firm may select for its R&D alliances. It is hypothesized that R&D alliances are more likely to be formed between Friends, but less likely to be between Acquaintances, than Strangers when the innovation to be developed is radical. I also propose that R&D alliances are more likely to be formed between prior partners (either Friends or Acquaintances) than Strangers when the intellectual property protection provided by the external market is weak.

Considering the increasing number of international and multilateral R&D alliances, R&D alliances are becoming more and more complex. The present study conducts an in-depth analysis on partner selection in these two types of alliances. I propose that international R&D alliances have a higher likelihood of being formed between prior partners than their domestic counterparts. Considering the complexity in R&D alliances stemming from national and/or organizational cultural differences, three kinds of international R&D alliances are categorized – cross-national domestic (DRDA), traditional international (IRDA), and trinational (TRDA) R&D alliances. It is hypothesized that the likelihood of alliance formation between prior partners can be ranked as TRDA > IRDA > DRDA.

I also propose that multilateral R&D alliances have a higher likelihood of being formed between prior partners than their bilateral counterparts. When the number of partners increases, the management of R&D collaboration is complicated. From a social exchange perspective, the present study argues that multilateral R&D alliance is featured by partners' concerns about higher risks of others' opportunism and more reliance on trust to govern their collaborations. Therefore, alliance formation between prior partners is more likely in multilateral R&D alliances, and whether an R&D alliance is multilateral moderates the causal relationships between partner selection and innovation radicality and intellectual property protection.

Empirical evidence provides support for the effects of innovation radicality on R&D alliance partner selection. The type of innovation an R&D alliance intends to develop has a strong impact on partner selection. In order to protect their valuable technological assets, firms are more likely to choose Friends, but less likely to choose Acquaintances, than Strangers to form R&D alliances.

Strong support was found regarding the relationships among the three protective mechanisms – partner selection, governance structure, and alliance scope. As predicted, when a non-equity-based governance structure is utilized for a new R&D alliance or a broad alliance scope is crafted, participating firms are more likely to select prior partners to ease their concerns about partners' potential appropriation of their valuable technological assets. On the contrary, when a prior partner is selected to form an R&D alliance, it is likely that the alliance will be governed by a equity commitment and it is more likely for the alliance to expand the cooperation to a broad scope. Further, firms

seem to use partner selection to address concerns stemming *internally* from innovation characteristics, and to use governance structure to address concerns originating *externally* from weak intellectual property protection.

Evidence was also found to support the argument that multilateral R&D alliances are more likely to be formed between prior partners than bilateral ones. However, no support was found that international R&D alliances are different from domestic ones in their partner selection when considering protecting partner firms' technological assets. Yet, differences across different types of international R&D alliances were found; DRDA is the less likely to be formed between prior partners than IRDA and TRDA. The lack of evidence for several other hypotheses leads to deeper thoughts of international and multilateral R&D alliances and the conclusion that partner selection for international and multilateral R&D alliances may be more complicated than what this dissertation predicts.

Overall, the findings from the present study conclude that (1) the more radical the innovation that an R&D alliance intends to develop, the more likely the alliance is formed between Friends, but the less likely between Acquaintances, than Strangers; (2) partner selection, governance structure, and alliance scope can be used as substitution mechanisms to address firms' concerns of protecting their technological assets in R&D alliances; (3) firms forming DRDAs are less likely to select their prior partners than those forming IRDAs and TRDAs; and (4) multilateral R&D alliances are more likely to be formed between prior partners than bilateral ones.

IMPLICATIONS

By focusing on partner selection, the present study provides new insights to our understanding of knowledge protection in R&D alliances. It first recognizes the competitive implications of the potential loss of control of technological assets in R&D alliances, and focuses on partner selection as a decision variable in addressing such concerns about knowledge leakage. The most common empirical approach in prior literature has been to "take-partners-as-given" and studies the performance outcome of other decision variables such as governance structure. In this dissertation, I was able to examine why firms select prior partners for the purpose of protecting their proprietary assets in R&D alliances, by focusing on the process rather than simply the outcome.

Second, this study enriches our understanding of trust between alliance partners. Diverging from the literature traditionally employing prior interaction as a proxy of trust, I argue that there is a clear distinction between Acquaintance and Friend, at least in the context of technology protection. Both are prior partners; Acquaintances and Friends are different in the degree of trust between firms, but similar in the low extent of information asymmetry. Such a differentiation is more salient when close interaction is needed for R&D collaborations. To protect their valuable technological assets, firms tend to select their Friends as partners for new R&D alliances, while trying to avoid Acquaintances which can appropriate their technologies more easily than Strangers. The empirical analysis offers support for such arguments.

Third, this dissertation examines a dynamic process of alliance formation, enabling us to understand how the three decision variables – *who* (partner selection),

how (alliance governance), and *what* (alliance scope) – substitute for each other when firms form R&D alliances. Firms that are able to benefit from R&D collaboration and at the same time effectively protect their own valuable knowledge are those that will maintain their competitive advantage and succeed in market competition. Although the current research is still preliminary, the analysis presented here suggests that this is a line of inquiry with potentially important implications for the theory and management of inter-firm alliances (see discussion below in the section "Implications for Theory Development").

Fourth, the current study provides evidence that non-conventional forms of international R&D alliances are frequently occurring and are important organizational forms. This study also offers a comparison of different types of international R&D alliances regarding their implications for partner selection when there are knowledge protection considerations. It does so by introducing a new typology of international R&D alliances. This research demonstrates that cross-nation domestic R&D alliances are the most modest scenario with the lowest knowledge leakage concerns, and therefore are least likely to be formed between firms that enjoy high levels of trust, than trinational and traditional international R&D alliances. The in-depth analysis of various types of international R&D alliances enriches our understanding of how to protect participants' valuable knowledge in R&D collaboration across borders.

Lastly, the analysis of multilateral R&D alliances, by examining their exchange processes, contributes not only to the literature on partner selection but also to the larger body of literature on alliances. When the number of partners increases, the knowledge

leakage concerns in R&D alliances are more serious. Such a complicated inter-firm relationship has not been analyzed in previous studies. This dissertation fills the research gap by analyzing partner selection as a mechanism to protect partner firms' technological assets in bilateral and multilateral R&D alliances from the perspective of social exchange theory.

Furthermore, this dissertation has several significant implications for both academic research and managerial practice.

Implications for Future Research

One of the most important contributions of this study is that it points out and empirically demonstrates that partner selection can be used as a protective mechanism in R&D alliance. This has significant implications for research on R&D alliances.

First, the present study suggests that the partner selection decision is an important aspect of alliance management. The analyses presented in this dissertation suggest that alliance managers can and do pay attention to the potential loss of valuable technological assets in a R&D collaboration. The study also reaffirms some of the main conclusions of previous studies of alliance organization undertaken within the transaction cost economics tradition. Specifically, protective governance structures are available for firms to choose to secure their valuable technologies.

Second, it is fascinating to note that different mechanisms are used to manage different knowledge leakage issues. I found that governance design was used to deal with the ineffective external protection mechanism provided by the market, and partner selection was used to manage the internal contacts with partners that were demanded by

the objective of R&D collaborations. This additional finding is interesting because the extant literature has traditionally attributed the explanatory power to governance design while treating partner selection as given. Although the present study is far from definitive in this regard, it does suggest an important avenue for future research on alliance management.

Third, the present study makes a first endeavor in pushing forward the categorizing and measuring Acquaintances and Friends; more attention should be given to this issue. While one good prior interaction may be much better than the sum of several failed alliances, the current measures were not able to capture such differences. Follow-up studies on the characteristics of prior alliances (such as activities involved, time duration of alliances) should be promising. A related future research suggestion is the issue of Acquaintance firms. I included in this study the analysis of Acquaintances in a general manner; a detailed examination of Acquaintances is necessary. For example, how do Acquaintances with unpleasant experiences consider each other as potential partners for new R&D alliances? What about Acquaintances involved in serious law suits (in this case, Acquaintances may become enemies)?

Additional complexity stems from the definition of "prior relationship" in multilateral alliances. In this study, I looked at only the focal firm and the second partner. But what about the foal and the second partner firm's joint consideration for the third partner, the fourth, and …? Therefore, a network perspective may be needed to develop more accurate measurements of prior partners in multilateral alliances.

Fourth, multilateral R&D alliances are complex, not only because it is difficult to define who are prior partners, but also because the complicated relationship with incentives in these alliances. For instance, when the innovation that an R&D alliance intends to develop is radical, firms may try to involve as many partners as possible. On the one hand, involving more partners will decrease the risks shared by each partner because the more the radical innovation is, the more risks will be borne by the innovation developers. On the other, radical innovations often require more resources (financial, human resources, etc.) than incremental ones. Firms may need multiple partners involved to make it possible to develop radical innovations. Under these situations, innovation radicality can be the cause for an R&D alliance's multilateralism. Similar logic can be applied to the relationship between intellectual property protection and R&D alliance multilateralism. Future research avenues in this regard will be of particular interest to alliance scholars.

Fifth, I found that whether an R&D alliance is international did not affect firms' partner selection in the context of technology protection. This raises the question whether the internationalized economy has really merged countries as a "global village." Cultural and institutional differences do not seem to be so critical for firms, at least in high-technology industries. Therefore, a modification of the traditional international business literature may be necessary.

Additionally, the analysis of international R&D alliances base on regionalization rather than globalization may be interesting. Some scholars, such as Alan Rugman, have argued that there is no globalized company, only regionalized company (Rugman, 2000;

Rugman & Verbeke, 2004). The three regions – US, EU, and Japan – compose the majority of "globalization." Interestingly, such arguments are evidenced by my sample. Therefore, I call for analyses focusing on these three regions either as the R&D alliance host country or partners' home countries. Further investigation on specific combination of these regions in R&D alliance would also be promising. For example, R&D alliances with EU focal firms and U.S. partners should differ from those with the same focal firms but Japanese partners, due to the differences between the U.S. and Japan. Moreover, China has become the fourth largest hosting area for R&D alliances. It could be useful to examine more closely how China, the largest emerging economy, started to surface as the fourth region for R&D activities in this world.

Sixth, there is a rising group of R&D alliances – multilateral international R&D alliances – in today's business world. While the number of such alliances is still limited, these collaborations are important considering the huge amount of financial resources involved. Attention devoted to most of the issues (not just partner selection) of such R&D alliances will be worthwhile in the future.

Finally, the present study has not only theoretical but also methodological implications for alliance research. Methodologically, and also theoretically, the present study highlights the importance of taking a dynamic approach in the study of alternative knowledge protection mechanisms in R&D alliances. Most previous research has taken a static approach. The present study convincingly demonstrates that a simultaneous consideration of the decision variables provides a more accurate picture of firms'

decision processes for R&D collaborations. Such dynamic methodologies should be applied more to strategy research to fine-tune the pictures of business reality.

Implications for Managerial Practice

The present study has several implications for managerial practice. First, it suggests that partner selection can be used as an alternative mechanism to secure firms' technological assets in R&D collaboration. Such a mechanism can be used to substitute for other protective means such as an expensive equity-based governance structure and an inconvenient narrow alliance scope design. Different from the literature, this study suggests that it may not be desirable to choose a prior partner when the focal firm is not very familiar with that partner. Particularly when the R&D collaboration requires a high level of exposure of a firm's technological assets, the firm should pay additional attention to a potential partner. If the potential partner is an Acquaintance, the firm may be better off to give up the collaboration opportunity rather than to pursue it at the risk of appropriation of its technological assets.

Second, it may not be wise to apply the same management logic to alliances that involve multiple partner firms. When the collaboration is not directly between two firms, it is difficult, and sometimes impossible to monitor what partners are doing. This is true whether they contribute what they suppose to contribute to the collaboration and whether they take advantage of other partners in the alliance or not. Careful selection of partners in such a complicated group may be the first cautious step that firms can take. While equity-based governance may also be useful, the lack of direct monitoring makes the punishment of shirking partners difficult.

Finally, in today's global economy, it is tempting to enter attractive countries to search for R&D "gold mines." It is also tempting to partner with several firms involved in such "gold mines" located in other countries to share risks. However, while watching out for external risks in the foreign market, it is crucial for partner firms to look inside and check their partners and their behavior.

LIMITATIONS

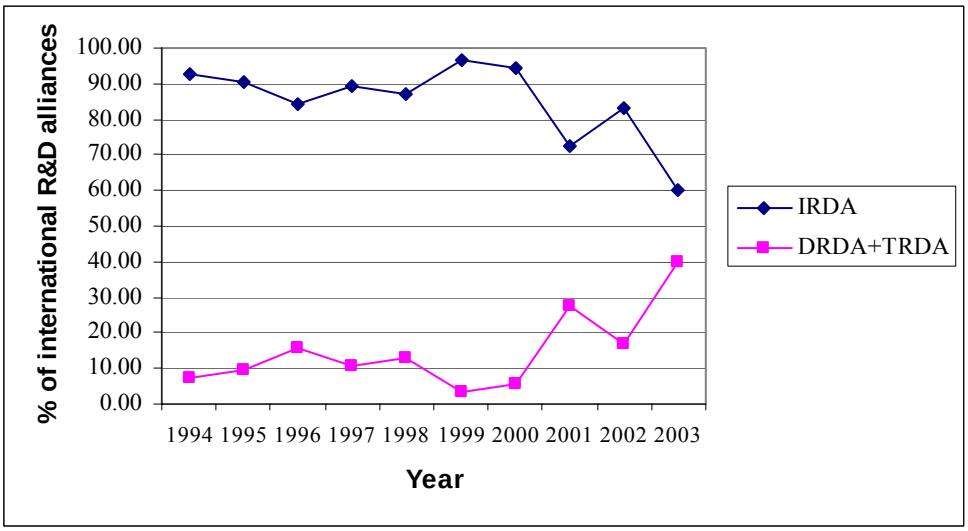
The present study has several limitations.

First, the measurements of Friend and Acquaintance are coarsely grained. I empirically defined that Acquaintances are prior partners with which a firm has had one alliance during the past 5 years, and that Friends are prior partners with which the firm has had more than one alliance during the past 5 years. There is no doubt that one prior relationship may build up strong trust between partners while three or four unimportant collaborations may still be unable to convince partner firms to trust each other. Also, the time duration of prior relationships is coarsely grained in the present study. While some alliances barely survive through the honeymoon stage, others may last over tens of years (Levinthal & Fichman, 1988). Empirical difficulty prevented me from advancing the measurements of Acquaintances and Friends. However, the current measurements do represent the first endeavor in pushing forward relevant research.

A second related limitation of the present study concerns the limited numbers of non-conventional international R&D alliances in the sample. DRDA and TRDA are increasing in number as shown in Figure 9.1; the sum of DRDA and TRDA rose from 8% in 1994 to 40% in 2003. However, the overall portion of non-conventional form of

international R&D alliances is merely 11% in my sample. This prevents the utilization of advanced statistical tools to further analyze the data. However, the present study did demonstrate that the non-conventional forms of international R&D alliances are on the rise and more attention from scholars should be devoted to questions associated with this phenomenon.

FIGURE 9.1.
Trends in Non-conventional International R&D Alliances



Thirdly, the present study takes knowledge sharing as given and only focuses on knowledge protection. Apparently, during the formation stage of an R&D alliance, decisions on partner selection, govern structure and alliance scope are made based on both knowledge sharing and knowledge protection. Generally speaking, knowledge sharing is of the higher priority than knowledge protection in a R&D alliance because

knowledge sharing and knowledge generation are the goals of such collaborating relationships. Yet, when the R&D alliance requires a higher degree of knowledge exposure to ensure sharing and creating, knowledge protection may rise to a higher priority because losing core technological assets means not only losing in the alliance, but also losing in the market. However, considering the lack of study of knowledge protection, this dissertation chose to emphasize this aspect and leave the simultaneous consideration of knowledge sharing and knowledge protection to future studies.

Lastly, the present study emphasizes the moderating effects of multilateralism on the relationships between partner selection and innovation radicality and intellectual property protection. However, the relationships among partner selection, multilateralism, innovation radicality and intellectual property protection may be much more complicated than what is examined in this study. Specific preferences about partner selection in multilateral R&D alliances may be caused by innovation radicality and intellectual property protection, as predicted in this dissertation. At the same time, the formation of an R&D alliance involving multiple players may be directed by the radical innovation the alliance intends to develop or the weak protection of intellectual property that the external market is able to offer.

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APPENDIX A

LIST OF INDUSTRIES AND THEIR 4-DIGIT COMPONENTS

SIC CODE	INDUSTRY NAME
HIGH-TECH MANUFACTURING	
Computers and Office Equipment	
3571	Electronic Computers
3572	Computer Storage Devices
3575	Computer Terminals
3577	Computer Peripherals
3578	Calculating and Accounting Machines
3579	Office Machines
Consumer Electronics	
3651	Household Audio and Video Equipment
3652	Phonographic Records and Prerecorded Tapes and Disks
Communications Equipment	
3661	Telephone and Telegraph Apparatus
3663	Radio and TV Broadcast and Communications Equipment
3669	Other Communications Equipment
Electronic Components and Accessories	
3671	Electron Tubes
3672	Printed Circuit Boards
3675	Electronic Capacitors
3676	Electronic Resistors
3677	Electronic Coils, Transformers, and Inductors
3678	Electronic Connectors
3679	Other Electronic Components
Semiconductors	
3674	Semiconductors and Related Devices
Industrial Electronics	
3821	Laboratory Apparatus
3822	Environmental Controls
3823	Process Control Instruments
3824	Fluid Meters and Counting Devices
3825	Instruments to Measure Electricity
3826	Laboratory Analytical Instruments

3829	Other Measuring and Controlling Devices
Photonics	
3827	Optical Instruments and Lenses
3861	Photographic Equipment and Lenses
Defense Electronics	
3812	Search and Navigation Systems, Instruments, and Equipment
Electromedical Equipment	
3844	X-Ray Apparatus and Tubes and Related Irradiation Apparatus
3845	Electromedical and Electrotherapeutic Apparatus
HIGH-TECH SERVICES	
Communications Services	
4812	Radiotelephone Communications
4813	Telephone Communications
4822	Telegraph and Other Message Communications
4841	Cable and Other Pay Television Services
4899	Other Communications Services
Software and Computer-related Services	
Software Services	
7371	Computer Programming Services
7372	Prepackaged Software
7373	Computer Integrated Systems Design
Data Processing and Information Services	
7374	Computer Processing and Data Preparation
7375	Information Retrieval Services
7376	Computer Facilities Management Services
Rental, Maintenance, and Other Computer-Related Services	
7377	Computer Rental and Leasing
7378	Computer Maintenance and Repair
7379	Other Computer-Related Services

VITA

DAN LI

EDUCATION

2005 Ph.D. in Business Administration
Major: Strategic Management
Minor: International Business
Texas A&M University

1999 M.S. in Corporate Management
Tsinghua University, China

1997 B.S. in International Economics
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ACADEMIC EMPLOYMENT

2005- Assistant Professor of Management
Kelley Business School
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2002-05 Research Assistant, Strategic Management/International Business
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2000-02 Teaching Assistant, International Business/Strategic Management
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