External Technology Sourcing Through Alliances or Acquisitions: An Analysis of the Application-Specific Integrated Circuits Industry

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Abstract

In today's turbulent business environment innovation is the result of the interplay between two distinct but related factors: endogenous R&D efforts and (quasi) external acquisition of technology and know-how. Given the increasing importance of innovation, it is vital to understand more about the alternative mechanisms—such as alliances and acquisitions—that can be used to enhance the innovative performance of companies. Most of the literature has dealt with these alternatives as isolated issues. Companies, however, are constantly challenged to choose between acquisitions and strategic alliances, given the limited resources that can be spent on research and development. This paper contributes to the literature because it focuses on the choice between innovation-related alliances and acquisitions. We focus on the question of how the trade-off between strategic alliances and acquisitions is influenced by previous direct and indirect ties between firms in an industry network of interfirm alliances. We formulate hypotheses pertaining to the number of direct ties between two companies, their proximity in the overall alliance network, and their centrality in that network. In so doing, we distinguish between ties that connect firms from the same and from different industry segments, and those that connect firms from the same or from different world regions. These hypotheses are tested on a sample of strategic alliances and acquisitions in the application-specific integrated circuits (ASIC) industry. The findings show that a series of strategic alliances between two partners increases the probability that one will ultimately acquire the other. Whereas previous direct contacts tend to lead to an acquisition, this is not true of previous indirect contacts, which increase the probability that a link between the companies, once it is forged, takes the form of a strategic alliance. In the case of acquisitions, firms that are more centrally located in the network of interfirm alliances tend to be acquirers, and firms with a less central position tend to become acquired. These findings underscore the importance of taking previously formed interfirm linkages into account when explaining the choice between strategic alliances and acquisitions, as these existing links influence the transaction costs associated with both alternatives.

(*Strategic Alliances*; *Mergers and Acquisitions*; *Innovation Strategy*; *High-tech Industries*; *Technology Sourcing*; *Capability Building*; *Transaction-Cost Theory*)

Introduction

Many high-tech industries are characterized by fierce competition. To create sustainable performance differentials with competitors, firms must constantly invest in the creation of new technological capabilities (Leonard-Barton 1994). Acceleration of R&D efforts and the development of internal innovative capabilities are no longer sufficient to cope with the increasing cost, speed, and complexity of technological developments in high-tech industries. Increasingly, even the largest companies are obliged to use external sources of technology through licensing, strategic technology agreements, or mergers and acquisitions (Cohen and Levinthal 1989, 1990; Gomes-Casseres 1996; Harrison et al. 2001; Lambe and Spekman 1997; Mytelka 1991; Porter and Fuller 1986; Teece 1992). In the remainder of this paper we will use the term "acquisition" to refer to all interfirm linkages that lead to integration of two entities. Such a combination can refer to the merging of two more-or-less equal companies, as well as to acquisitions in which one company obtains majority ownership over another (Hagedoorn and Duysters 2002). We make such a distinction because it is often difficult to distinguish between mergers and acquisitions. Acquisitions are often presented as mergers in the press in order to avoid negative

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publicity—particularly in an international setting (Hagedoorn and Sadowski 1999). The crucial aspect of both mergers and acquisitions for the purpose of our study is that the firms involved cease to exist as independent entities and are managed in an integrated manner.

This paper explores how innovative firms choose between two alternative organizational forms of external sourcing of technology: cooperation by means of strategic technology alliances and acquisition activities. Given the increasing importance of innovation as a major competitive weapon for many organizations (Porter 1990), and the fact that innovation can be seen as one of the driving forces of twentieth-century growth (Franko 1989, Harberger 1984), it is important to study alternative mechanisms that can be used to enhance the innovative performance of firms.

Strategic technology alliances can be described as cooperative efforts in which two or more separate organizations, while maintaining their own corporate identities, join forces to share reciprocal inputs. Acquisitions, on the other hand, can be considered as cases of joint activities in which two—once separate—companies are combined into one company. Strategic technological alliances, as well as acquisitions, are alternatives to the sourcing of technological capabilities over a market interface. In older work on mergers and acquisitions, innovation was hardly ever mentioned as an important motive. More recent contributions to the innovation literature, however, clearly stress the growing importance of acquisitions in the knowledge acquisition process (Chakrabarti et al. 1994, Gerpott 1995, Grandstrand et al. 1992, Hitt et al. 1991, Link 1988). Acquisitions are increasingly important organizational modes for the external acquisition of technological know-how—especially in R&D-intensive (high-tech) industries—because markets for information, know-how, and technology are notoriously inefficient (Hennart 1991). Generally speaking, technological know-how cannot be bought "off the shelf," because it is difficult to evaluate and/or transmit. Evaluation is problematic because know-how cannot be given for inspection to a prospective buyer without the risk of attenuation of property rights (Das et al. 1998). Moreover, technological know-how cannot be transmitted easily from one firm to another because it may be tacit or embedded in other knowledge that is not part of the deal (Larsson et al. 1998). In a study of short-term contracts used in high-technology sourcing, Nordberg et al. (1996) found that these arrangements led to high transaction costs.

If markets fail, a firm may decide to gain access to technological know-how through acquisition of another firm in which the technology is embedded, or through a strategic alliance in which the know-how and assets of both firms are in some way combined (Doz 1996, Hamel 1991, Inkpen and Crossan 1996, Kogut 1988a, Lambe and Spekman 1997, Mowery et al. 1996, Stuart 2000, Young-Ybarra and Wiersema 1999). An acquisition solves many of the problems of the transmittal of technological know-how, particularly as the relationship between the integrated entities evolves over time (Bresman et al. 1999). However, when contemplating an acquisition, a firm often struggles with valuation and pricing of the target assets (Balakrishnan and Koza 1993). If firms enter into a strategic alliance, they avoid the terminal transaction of transferring ownership rights, but still have to take into account a market interface existing between the two firms (or between the parent firm and its joint venture). Thus, the problem of transmitting knowledge may be mitigated but not altogether solved (Das et al. 1998, Larsson et al. 1998).

This paper explores the factors influencing the choice between strategic alliances and acquisitions as alternative means of external technology acquisition. Decisions concerning external technology sourcing influence the composition of the technological resources owned by companies, and thus ultimately the competitive advantage of firms (Mowery 1988, Mytelka 1991, Poppo and Zenger 1998). The literature on strategic alliances and mergers and acquisitions is vast and expanding, but very few studies have focused on the choice between these two modes. Garette and Dussauge (2000) discuss the pros and cons of alliances and acquisitions in the European context. Focusing on horizontal acquisitions and scale alliances, these authors conclude that alliances are inherently less efficient than acquisitions. They also note that alliances can be pursued to tap the skills and resources of partners, and that for this purpose alliances can be more effective than acquisitions. However, they do not systematically compare the pros and cons of alliances and acquisitions in the context of technology sourcing. Hoffmann and Schaper-Rinkel (2001) review the literature on alliances and acquisitions, and distinguish between three categories of factors influencing the choice between these alternatives: environmental characteristics, transactional characteristics, and company characteristics. On the basis of interviews and workshops with predominantly German business managers, they conclude that alliances are more favorable in high-uncertainty environments with dispersed knowledge. Acquisitions, however, seem to be preferable in situations in which flexibility is less urgently needed, and the utilization of economies of scale and scope is more important.

These two papers provide a useful starting point for further exploration of the choice between alliances and acquisitions. Our paper contributes to the literature by

analyzing the choice between strategic alliances and acquisitions as alternative means of external technology acquisition. The focus on technology acquisition as a motive, rather than on scale or scope (as in Garette and Dussauge 2000), is based on the observation that this is a predominant motive for strategic alliance activity (Hagedoorn and Sadowski 1999, Lambe and Spekman 1997). In contrast to both Garette and Dussauge (2000) and Hoffmann and Schaper-Rinkel (2001), we empirically test our hypotheses using a dataset of strategic alliances and acquisitions.

In exploring the choice between alliances and acquisitions, we base our reasoning on transaction-cost theory. This approach has been used to explain many facets of strategic alliances (Young-Ybarra and Wiersema 1999). Transaction cost theory is particularly useful in explaining the choice between discrete organizational alternatives (Williamson 1991), in our case alliances and acquisitions. Employing the reasoning of transaction-cost theory, we focus on characteristics of structural industry conditions as factors that influence external technology sourcing by firms. In particular, how do previous strategic alliances influence subsequent acquisitions? The rationale for this focus is that existing direct and indirect linkages through strategic alliances are sources of information that may crucially alter trade-offs in the choice between subsequent alliances and acquisitions. Hence, the choice between these two alternative ways of external technology sourcing is explained in a dynamic perspective, in which the effect of earlier actions is taken into account.

For our empirical research we studied companies that were active in the market for application-specific integrated circuits (ASICs) in the period 1985–1994. Because of the importance of technological innovation, the semiconductor industry is an appropriate context for studying interfirm linkages as a means of access to technological capabilities of partner firms (Stuart 2000). As described in the data section, this is particularly true of the ASIC segment of the semiconductor industry (because of the importance of keeping up with quickly changing technological developments and tumultuous alliance and merger and acquisition activities). We study characteristics of the network of firms active in the ASIC market. How do these characteristics influence the choice between strategic alliances and acquisitions? We focus on the following network characteristics: earlier strategic alliances between two focal firms, the proximity of these firms in the network of relationships between all firms in the study, differences between intraindustry and interindustry and industry-segment ties, and differences between domestic and international ties.

The paper also explores an additional question: If the link between the two firms takes the form of an acquisition, then who acquires whom? Here, too, we focus on the position of the acquired and acquiring firms in the prior overall network of interfirm relationships.

The paper is organized as follows. The next section uses a transaction cost perspective to discuss the relative advantages and disadvantages of strategic alliances and acquisitions as alternative organizational forms of external technology sourcing. We then focus on the question of characteristics of the acquired and acquiring firms. Hypotheses pertaining to both sets of questions are formulated. The third section describes the dataset, the operationalization of the variables, and the method of analysis. In the fourth section we discuss the results of our analysis. Finally, we draw conclusions and make suggestions for future research.

Theory and Hypotheses

If a firm resolves to externally source technological know-how, and if it is able to identify another firm that possesses the desired resources, then it still needs to choose a mode for linking up with these resources. Assume that a pure market transaction is impossible for the reasons discussed in the first section; the choice is then between some kind of strategic alliance with, or acquisition of (or merger with), the other firm. Below we will first discuss strategic alliances and acquisitions as alternative organizational forms of external technology sourcing. Subsequently, we focus on factors that may be assumed to influence the choice between the two modes. Finally, we address the question of who acquires whom in the case of an acquisition.

Strategic Alliances and Acquisitions Defined

The label "strategic alliance" has been used for a wide variety of interfirm linkages (Osborn and Hagedoorn 1997). Nonequity linkages of a contractual nature are examples of strategic alliances, but equity-based linkages (such as joint ventures) also may fall under this heading. The crucial difference between strategic alliances and acquisitions as defined in this paper is that the latter create organizational hierarchies in the classical sense, and the former do not (Hagedoorn and Sadowski 1999). Thus, we define strategic alliances as all those interfirm linkages that do not result in one firm having majority ownership of the other (or the creation of a new entity comprising both firms, in the case of a merger). Strategic technology alliances can take a variety of forms. Many different taxonomies of strategic technology alliances exist in the literature (see Auster 1987, Chesnais 1988, Contractor and Lorange 1988, Duysters and Hagedoorn 2000, Harrigan 1985).

We focus on alliances that are characterized by a high level of organizational interdependence and strategic motivation. Although there is no direct relationship between organizational modes and strategic content, Hagedoorn and Schakenraad (1990) established that over 85% of existing R&D joint ventures and research corporations, joint R&D agreements and research pacts, are strategically motivated. Other alliance modes were found to be less strategically motivated. This means that we focus exclusively on strategically motivated modes (joint ventures and research corporations, joint development agreements, and research pacts). Given the amount of commonalities in these alliances, it makes little sense to differentiate among them. In studying interorganizational alliances between semiconductor producers as a means of access to technology and know-how, Stuart (2000) found that an analysis including a wide variety of alliances led to similar findings as an analysis concentrating only on certain types of alliances. This suggests that as modes of external technology sourcing, different types of strategic alliances can be lumped together in a comparison with the main alternative, acquisitions.

This paper will therefore focus on what we think constitutes the major dividing line between alternative means of external technology sourcing, viz., that between hierarchical governance under common ownership and all setups in which hierarchical coordination is diluted and mixed with other coordination mechanisms. Hence, we argue for an analysis of two discrete alternatives rather than a continuum running from contractual agreement through equity joint ventures to acquisition. The reason is that strategic alliances and acquisitions, thus defined, are modes of governance that have their own inherent logic and require different management styles and skills.

The logic underlying classical hierarchies (as formed by acquisitions) is that of administration, with managerial authority as the ultimate touchstone. According to Hennart (1991), the fundamental decision of multinational firms investing abroad is whether they want full control or shared ownership. If that observation can be generalized to decisions concerning external technology sourcing, then the crucial distinction is that between acquisitions and all strategic alliances (equity-based as well as nonequity-based) in which the partnering firms remain distinct independent entities.

In strategic alliances, which cannot be governed by managerial fiat like classical hierarchies, a contractual logic or a logic of association prevails, depending on the form of the alliance. Because governance by managerial fiat is impossible, coordination in strategic alliances must be sustained by discrete negotiation over specific contractual conditions, or by mutual expectations of reciprocity (Osborn et al. 1998). Consequently, managing strategic alliances calls for management skills that differ from those in traditional hierarchical firms, e.g., lateral communication, openness, and conflict resolution (Larsson et al. 1998). Although we argue that the fundamental choice for firms is between modes of external sourcing that offer full ownership and control (i.e., acquisitions) and all other forms (i.e., strategic alliances of all kinds), we will test this categorization against an alternative to ensure the robustness of our findings. A number of recent contributions (Gulati 1995b, Hagedoorn et al. 2000) have argued that an important distinction can be made between equity alliances and nonequity contractual agreements. If ordered in terms of the strength of interorganizational control they allow for, acquisitions can plausibly be assumed to offer the strongest control, followed by equity alliances and nonequity alliances (Hagedoorn 1993, James and Weidenbaum 1993). In our empirical analysis we will check whether our findings remain unaltered when we subdivide alliances into equity–nonequity modes.

Choosing Between Strategic Alliances and Acquisitions

As discussed above, both strategic alliances and acquisitions can be interpreted as responses to failures in the market for technological know-how. But what are the relative advantages and disadvantages of both strategic actions? Studies comparing acquisitions with alternative strategies typically employ a transaction cost theory framework—even if sometimes more like a guiding metaphor than as a very specific set of propositions (Koza and Lewin 1998, Osborn and Hagedoorn 1997). Recent studies of the choice between acquisitions and joint ventures, for instance, emphasize various aspects of transaction-cost theory. One approach focuses mainly on the problem of evaluating a possible candidate for acquisition (Balakrishnan and Koza 1993, Reuer and Koza 2000). Typically, information about the quality and performance characteristics of the relevant assets is not common knowledge, and the information provided by the present owners may be opportunistically biased, causing adverse selection problems. Premerger inspections give limited solace, as latent as well as apparent problems may still crop up later (Ravenscraft and Scherer 1987). This line of reasoning, rooted in the measurement branch of transaction-cost economics (Williamson 1985), can be called the *information asymmetry argument*.

Hennart and Reddy (1997, 2000) offer a different transaction-cost-based explanation of the choice between acquisitions and (in this case: Greenfield) joint ventures. Acquisitions are less attractive if the desirable assets in the takeover candidate are difficult to disentangle from unwanted or undesirable ones. In that case, a strategic alliance—for instance, in the form of a joint venture—

becomes relatively more attractive. Hennart and Reddy (1997) mention the example of a small biotechnology firm that would like to buy (part of) the sales force of a pharmaceutical firm, but might not be able to separate this function from other, unwanted, functions and assets. This argument, which can be dubbed the *indigestibility argument*, is rooted in the asset-specificity branch of transaction-cost theory (Williamson 1985). An acquisition including unwanted assets leads to higher management costs, which are not offset by higher yields because the unwanted assets are unrelated to the core business of the acquiring firm. The problem may be aggravated by differences in organizational or national culture between the acquiring and the acquired firm. On top of that, acquisition and internalization may lead to a loss of high-powered incentives. Balakrishnan and Koza (1993) also acknowledge the problem of digestibility, as well as the other issues mentioned by Hennart and Reddy (1997), but they emphasize the ex ante market failure problems, rather than the ex post organizational failure problems.

There is no a priori reason to assume that the information asymmetry argument is more forceful than the indigestibility argument, or vice versa. We suggest that the relative importance of the ex ante and the (anticipated) ex post problems emphasized by the two approaches depends on the conditions under which the choice between a strategic alliance and an acquisition is made. The information asymmetry argument is most forceful when the (prospective) partner firms have little firsthand or secondhand information about each other. From this point of view, we should look at existing direct and indirect ties as information channels between the firms in explaining the choice between alliance and acquisition. The indigestibility argument focuses on how different the two firms are in terms of assets. Firms operating in the same market or market segment may be assumed to be more alike in terms of asset composition than firms operating in different industries. However, the indigestibility argument may also be applied to difficulties (unrelated to asset characteristics) in integrating an acquired firm. Every firm has its own idiosyncratic culture, and differences in corporate culture may pose an impediment to a successful merger or takeover. If the firms are from different countries, then national cultural differences between the acquiring and acquired firms may aggravate integration problems (Hennart and Reddy 1997, Kogut and Singh 1988). Various factors influencing the trade-off between strategic alliances and acquisitions are discussed below.

Prior Direct Ties Between Partner Firms

Firms contemplating the establishment of a strategic alliance or an acquisition can use various sources of information. Certainly, observations made by managers of the company in direct transactions or in other interactions with the other firm will be highly valued. This suggests that the existence of previous ties between companies may influence the choice of mode of governance in a subsequent link. A strategic alliance—in the form of a joint venture, for instance—makes it possible for a firm to gather valuable information about its partner's resources, capabilities, and reliability (Balakrishnan and Koza 1993; Gulati 1995a, 1998). Thus, the number of prior ties provides an indication of the amount of information partners have about each other. The more information they have, the less serious will be information asymmetry problems in partner valuation. Consequently, this removes a major impediment to realizing an acquisition.

Strategic alliances offer partners the opportunity to learn from and about each other (Inkpen 1998). Over time, firms develop capabilities or routines for their mutual interaction. Partners become acquainted with each other's idiosyncrasies, thereby deepening their mutual understanding, which in turn improves the quality of the relationship. Both the absorptive and communicative capabilities of firms are enhanced by interaction in prior ties (Larsson et al. 1998). This suggests that such collaboration can help to alleviate managerial indigestibility problems caused by differences in corporate cultures, thereby facilitating integration in case of an eventual acquisition.

The decision to shift to an acquisition after a number of previous alliances should be seen in a longitudinal perspective (Gulati 1998). Firms can use incremental strategies in exploring and gaining control over external technological know-how. Investment in a strategic alliance is like taking an option on technological know-how of yet uncertain value, and shifting from a strategic alliance to an acquisition is like the striking of that option (Bowman and Hurry 1993, Haspeslagh and Jemison 1991). If this "encroachment strategy" (Hagedoorn and Sadowski 1999) is used, a firm will move from a strategic alliance to an acquisition as soon as the interaction within the alliance has sufficiently dissolved the information asymmetry and mitigated the managerial indigestibility problem. An additional motive for an acquisition exists when there is a technological alliance between a large firm and a smaller firm that provides new technology. Das et al. (1998) suggest that the larger firms tend to become critically dependent on their smaller partners, which may be a reason for the larger firm to circumvent hold-up problems by eventually acquiring the smaller partner. However, our transaction-cost-based reasoning also applies in these cases. Thus, controlling for size, we hypothesize:

HYPOTHESIS 1. *The greater the number of prior strategic alliances between two firms, the smaller the probability that a subsequent link between them will again be*

a strategic alliance, and the greater the probability that a subsequent link will take the form of an acquisition.

Although there has been some previous research related to this issue, none of it directly addresses our hypothesis. Hennart (1991), and Hennart and Reddy (1997), study the mode of entry of Japanese firms into the United States, focusing on the choice between wholly owned subsidiaries and greenfield joint ventures. They conclude that indigestibility provides the best explanation for the observed behavior. Balakrishnan and Koza (1993) compare stock market reactions to joint-venture and merger announcements, and conclude that acquisitions obtained more favorable responses when acquirers and targets were more similar, a finding which they explain on the basis of the expected smaller information asymmetry in these cases.

While these three studies have no longitudinal perspective, three other studies do. Vermeulen and Barkema (2001), approaching the subject from a learning perspective, look at the propensity of a firm to use either start-ups or acquisitions for corporate expansions. Start-ups add no new knowledge to the parent firm, with the result that the firm's knowledge base eventually becomes antiquated. After a series of start-ups, revitalization through acquisition becomes increasingly necessary, and, as demonstrated by the authors, more likely. However, Vermeulen and Barkema do not examine previous ties between two identified firms. Gulati (1999) studies the effect of previous alliance activities on a firm's decision to form a new alliance, and finds a positive effect of having a central position in the existing network. However, Gulati looks only at alliances, not at acquisitions. Hagedoorn and Sadowski (1999) study the transformation of strategic alliances into mergers and acquisitions. Their most relevant conclusion in the context of this paper is that strategic technology partnering plays hardly any direct role in acquisition behavior (based on the observation that only 2.6% of the strategic alliances led to a subsequent acquisition). This finding contrasts with Kogut's (1988a) data, in which 25% of the joint ventures were acquired by either partner during the following years. Also, Bleeke and Ernst (1993) found that 75% of alliances end with one of the partners acquiring the cooperation unit, and Garette and Dussauge (2000) found that 28% of "complementary alliances" in Europe end with acquisition by one of the partners.

An important difference between Hagedoorn and Sadowski (1999) and our study is that these authors only look at the *first* strategic alliance between two firms and subsequent acquisitions. Possible later strategic alliances between the same partners, paving the way for an eventual acquisition, are not taken into consideration. Arguably, it is better to look at the cumulative effect of prior ties on subsequent external actions of firms—all the more so because repeated prior alliances may indicate important synergies. Thus, testing our Hypothesis 1 may lead to different findings than those found by Hagedoorn and Sadowski (1999).

Network Distance Between the Partner Firms

Two firms with no direct connection can be linked indirectly by a common partner or by a set of common partners interconnected by a chain of alliances. Even in the absence of direct ties, proximity in the alliance network provides firms with information about each other through indirect experiences (Gulati 1998). Network distance refers to the shortest geodesic path between two actors. The expression *geodesic path* is used to denote the shortest path between two points in the network. The shorter the geodesic path, the closer two firms are in the alliance network.

Expectedly, information exchanged through indirect ties will be qualitatively different from firsthand information obtained within a strategic alliance. Strong ties offer three kinds of informational advantages: access to information about current or potential partners as to their capabilities and trustworthiness, timely information about threats and opportunities—including alliance opportunities—and referral to and from potential partners (Gulati 1999). Of these three kinds of informational advantage, referral is clearly a benefit associated with indirect ties. However, it is plausible that timely access to information regarding the capabilities and trustworthiness of a firm is promoted more by direct than by indirect ties. In the interaction within a strategic alliance, a firm learns both about the other's management processes and about his know-how and technological capabilities (Tsang 1999). Firm-specific management processes and know-how are characterized by tacitness, and learning about these may be possible only through close observation of and interaction with the partner's staff (Tsang 1999).

From this perspective, existing indirect ties are unlikely to mitigate information asymmetry problems to the extent that an acquisition becomes more likely when a direct link is considered. Indirect ties may help a firm to form a rough idea about the capabilities and trustworthiness of a potential partner, but a steady exchange of fine-grained information in direct interactions is necessary for a firm to be able to evaluate more effectively the value of the technological know-how of the other firm, as well as the compatibility of management styles, in case of an acquisition. On the other hand, the information exchanged

through indirect network connections makes it more likely that two unconnected companies become aware of mutual alliance opportunities, and hence increases the probability of such an alliance taking place. Embeddedness of interfirm relations in a dense network of common ties in an industry may, moreover, encourage certain trust and reputation effects. These, in turn, help firms gain a higher level of control over their alliance partners than would otherwise be possible (Raub and Weesie 1990, Uzzi 1996), making ownership less necessary for control reasons.

In terms of the arguments based on transaction-cost theory, we propose that unlike direct ties, indirect ties do not significantly mitigate information asymmetry and indigestibility problems. However, to the extent that embeddedness in a network strengthens reliance on trust and reputation effects, the formation and maintenance of strategic alliances is facilitated. Assuming constant indigestibility and information asymmetry problems, the use of this form of external technology sourcing is made relatively more attractive than acquisitions. Hence:

HYPOTHESIS 2. *A smaller network distance between firms in the network of existing strategic alliances increases the probability that a direct link, when formed, will take the form of a strategic alliance, and decreases the probability that a direct link, when formed, takes the form of an acquisition.*

Intraindustry and Interindustry Ties

The similarity or complementarity of products or technologies may influence the firm's decision as to whether external sourcing of technology takes the form of a strategic alliance or an acquisition. Some authors (Gomes-Casseres 1996, Roberts and Berry 1985) argue that a firm has the propensity to acquire the other company if it has similar technological competencies, i.e., when it is a member of the same industry or industry segment (see also Chi 1994, Teece 1986). When the partner has complementary or completely new technologies to offer, strategic alliances are considered to be the best way to cooperate (Hagedoorn and Sadowski 1999). This coincides with the information asymmetry argument: It is more difficult to assess the value of assets of firms in other industries or industry segments than in one's own industry or segment (Balakrishnan and Koza 1993). It is also consistent with the indigestibility argument, as firms operating within the same industry or industry segment are less likely to hold substantial "indigestible" assets (Hennart and Reddy 1997).

HYPOTHESIS 3. *The probability that ties between firms operating within the same industry or industry segment take the form of a strategic alliance is smaller, and the probability that these intraindustry/segment ties take the form of an acquisition is greater than in the case of interindustry ties.*

Domestic and International Ties

Strategic alliances and acquisitions can take place within a particular country or across national borders. From a transaction-cost theory perspective, it could be reasoned that the higher level of uncertainty associated with international contacts is expected to lead to an increased need for control. Because the costs of monitoring and maintaining control over a long-distance strategic alliance are high, there is greater probability of a link taking the form of an acquisition rather than a strategic alliance (Hagedoorn and Sadowski 1999). However, we believe that there are countervailing arguments that carry more weight. On the basis of the information asymmetry argument, acquisitions would be expected to be more difficult between partners located in different countries, as international premerger inspections are even more problematic than domestic ones due to geographic and language barriers.

Cultural differences may also be expected to play a role. The transparency of the other firm may be more restricted when that firm is from another culture (Larsson et al. 1998). Cultural differences also make the managerial indigestibility problem more serious in international linkages. Kogut and Singh (1988), studying the choice between joint ventures and acquisitions of firms entering the United States, found that joint ventures (in our terminology a specific type of strategic alliance) were preferred to acquisitions when the entrant's home country was culturally distant from the United States. The reason for reticence with regard to international acquisitions is that cultural differences hamper integration and compound the management problem even after integration (Hennart 1991). In line with this reasoning, the results of Hagedoorn and Sadowski (1999) did not support their hypothesis that international strategic alliances would tend strongly to transform into acquisitions, based on the firm's assumed greater need for control in cross-border ties.

Another argument, which leads to the same prediction as the information asymmetry and indigestibility arguments, is that in case of domestic ties acquisitions are more likely because potential collaborators are also potential competitors (Kay 1991). This argument is of particular importance in the context of high-tech industries. An innovating firm risks leakage of valuable technological know-how through the learning processes of the ally within the strategic alliance, possibly leading to erosion of home-market share.

In sum, most of the arguments point in the same direction. A firm needing more control, due to stronger uncertainties in cross-border ties, may choose a type of strategic alliance that allows a reasonable degree of control. Research by Gulati (1995b) and Hagedoorn and Narula (1996) shows that international strategic alliances are more equity oriented, and that domestic strategic alliances are more often of a contractual nature. Since this study lumps together all these different kinds of alliances, we cannot make these distinctions.

HYPOTHESIS 4. *The probability that international ties between firms take the form of a strategic alliance is greater, and the probability that these international ties take the form of an acquisition is smaller than in the case of ties within national borders.*

Who Acquires Whom?

The hypotheses developed above all focus on the question of which form of external link between firms is more likely: a strategic alliance or an acquisition. This section focuses on a different question: Given that the form of the external link is that of an acquisition, can we predict who acquires whom? In common with the previous discussion (of the influence of prior ties on the probability of a new link taking the form of an acquisition), this discussion will also concentrate on the effect of the existing network of interfirm ties. Whereas we have thus far assessed the impact of dyad characteristics, we will now concentrate on the level of the individual firm.

Firms that entered into numerous strategic alliances in the past were probably also the ones that were more vigorously seeking access to new technology. Experience in collaboration allows a firm to establish itself in information-rich positions (Powell et al. 1996); a firm with this essential ability will be able to obtain access to and exploit leading-edge technology. More experienced firms—i.e., those that entered into a large number of strategic alliances—are therefore likely to be more centrally located in the network of strategic alliances, and consequently are more likely to get timely access to new technologies that are necessary to create a competitive advantage (Gulati 1998). As a consequence, a firm that has moved into a central position within the network of alliances has built a strong technological position, presumably leading to increased growth potential, and enhancing that firm's chance of becoming an acquirer rather than being acquired. In the terminology of Ronald Burt, these firms are more likely to have built a network of relationships containing many "structural holes," giving them more entrepreneurial opportunities and making them more likely to play an active rather than a passive role in acquisitions (Burt 1992).

The firm characteristic we are interested in here—the capacity to gain access to new technological know-how in a timely way and to take the initiative in acquisitions—can be expressed in the number of alliances a firm has entered into previously (*alliance history*), or in terms of ties with other firms that are, in turn, only indirectly linked to each other (*network centrality*). Network centrality refers to the importance of a specific organization for the overall structure of a network. In an information network, a company that has a high degree of centrality has the potential to control the flows of information between those other companies (Freeman 1979). Firms that are more centrally positioned in the network of interfirm alliances have better access to and control over information, and are therefore more likely to play a proactive strategic role (Vanhaverbeke and Noorderhaven 2001).

HYPOTHESIS 5. *Firms that are more centrally positioned in the network of strategic alliances within an industry are, in case of an acquisition, more likely to be the acquirer and less likely to be acquired.*

HYPOTHESIS 6. *Firms that have formed more alliances in the past and as a consequence have many network ties are, in case of an acquisition, more likely to be the acquirer and less likely to be acquired.*

Other Factors Influencing the Choice Between Strategic Alliances and Acquisitions

This paper focuses on the influence of previous strategic alliances on a firm's choice between a strategic alliance and an acquisition in case a new interfirm linkage is formed. However, this decision is also influenced by other factors that are not of primary interest here, but for which we will have to control in our empirical analysis.

A first obvious factor that may influence the choice between strategic alliances and acquisition is the size of the firms involved. Controlling for size is necessary because of the particular role that large firms play in forming strategic alliances and in acquisition activities (Ghemawhat et al. 1986). Foray (1991) and Duysters and Hagedoorn (2002) argue that large firms possess a high degree of strategic freedom to pursue strategies that lead to a mix of integration and cooperation. As smaller firms do not have this freedom to choose their strategies, the way in which small and large firms acquire new technological capabilities may differ significantly. Obviously, the relative size of firms may also be expected to influence the question of who acquires whom. Therefore, we will control for firm size in our empirical study.

Secondly, particular forms of interfirm ties may occur in waves. This may apply to strategic alliances as well as

to acquisitions. One possible explanation for this phenomenon is that strategic alliances may become fashionable, and that an initial series of strategic alliances creates a bandwagon effect. The same reasoning applies to acquisitions (Hay and Morris 1991, Van Wegberg 1994a). Alternatively, the occurrence of waves can be caused by changes in the environment (technological breakthroughs, for example) that impact all firms within an industry (Amburgey and Miner 1992, Stigler 1950). In order to control for these effects—which may mask the trade-offs based on transaction costs that we are interested in—we will include in our analysis a measure of the share of strategic alliances in all interfirm ties that are formed in the previous year.

Finally, the role and incidence of strategic alliances and acquisitions may change over the life cycle of an industry. Harrigan (1985, 1986, 1988) argues that cooperative agreements are transitional strategies, and that the period in which they are most appropriate is short. In young industries, technology is still in a fluid state, entailing a lot of uncertainty. Firms then often engage in short-lived technology-based cooperative agreements to keep up with the quickly changing environment by means of relatively small investments. As an industry matures, the rate of technological change slows down, and technological uncertainty diminishes, leading to a decline in the relative importance of technology-based strategic alliances. At the same time, opportunities for internal growth shrink as the industry growth rate slows down. To consolidate their sales, firms may opt for expansion strategies through acquisitions (Hagedoorn and Sadowski 1999). As we test our hypotheses on data from a relatively young industry (the ASIC industry) over a 10-year period, we must control for industry life-cycle effects. Therefore, we include a variable measuring the annual growth rate of the ASIC market, which is expected to capture the maturation of the industry.

Methodology

In our empirical study we examined how companies choose between strategic technology alliances and acquisitions, using the dyad-year as the unit of analysis. We focused our research on the Application Specific Integrated Circuits industry (or ASIC industry). As in other branches of the IC industry, technology acquisition is by far the most important reason why firms team up with each other or why companies with interesting technical knowledge are acquired. The ASIC industry can also be divided into three segments—gate and linear arrays, standard cells and full custom ICs, and programmable logic devices (PLDs)—offering competing technologies for different niche-applications: The ongoing technological changes in these segments lead to intersegment competition which in turn is the basis for the establishment of numerous alliances and acquisitions.

Data on strategic alliances and mergers and acquisitions were collected in which at least one ASIC producer was involved during the period 1985–1994, a period that was characterized by strong industry turbulence due to the establishment of numerous strategic alliances and acquisitions. This cross-sectional time-series panel enabled us to assess the influence of several factors on the choice between strategic alliances and acquisitions.

Following the research method of Gulati (1995b), we constructed adjacency matrices representing the relationships between the firms in the strategic alliance network. We computed matrices including all alliance activity among the panel members prior to each year. Various network measures were calculated using UCINET (Borgatti et al. 1999). In constructing network measures of past alliances, a number of choices have been made concerning the treatment of alliances. Alliances vary from equity joint ventures and minority holdings with a strong organizational commitment and interdependence between allies to nonequity joint ventures which imply only moderate levels of organizational commitment (although stronger than arm's length licensing agreements). Some authors weigh each type of strategic alliance according to the strength of their relationship (see Contractor and Lorange 1988, Gulati 1995b, Nohria and Garcia-Pont 1991). Because we are interested in the choice between strategic alliances and acquisitions, we have in our analysis compared acquisitions with all types of alliances taken together. However, to test for robustness, we have also performed an analysis in which acquisitions are compared with equity and nonequity alliances, as these three forms can be assumed to lie on a continuum of decreasing levels of organizational control. Furthermore, we simply added the number of ties between two firms over the observed time period. Gulati (1995b) mentions two alternatives—adding the number of ties and normalizing them by the maximum score possible in that year on the one hand and the use of a Gutman scale on the other hand—but we are not making use of them for this study. The third choice relates to the length of the period during which prior strategic alliances are likely to have an influence on the current choice between strategic alliances and acquisitions. One can include all past alliances into the calculation of the social network variables, assuming that all prior ties, no matter how long ago they were established, have an impact on current firm behavior. However, we chose a moving window approach, assuming that only ongoing alliances have an impact on the choice

between strategic alliances and acquisitions. We have an indication about the termination of the alliance for 62 (29.0%) strategic alliances in the sample. For these strategic alliances we assumed that they have an impact on the current choice between strategic alliances and acquisitions as long as they were not terminated. For the other strategic alliances we assume the life span of alliances is usually no more than five years (Kogut 1988b, 1989).

Data

The sample includes 140 mergers and acquisitions and 145 strategic alliances which were established in the ASIC industry in the period 1985–1994. ASIC—application-specific integrated circuits—are a special type of ICs (integrated circuits) accounting for about 16% of worldwide IC sales in 1994 (the final year in the period studied in this paper). The development and production of ASICs requires the interplay between different economic agents. The most important participants are the ASIC design houses, IC manufacturing facilities, electronic system houses, and CAD-tool vendors. Most strategic alliances and merger and acquisition activities in the ASIC industry are likely to have the purpose of external technology sourcing. In a turbulent high-tech environment like the ASIC industry, firms are likely to link up with each other in order to keep up with the newest technologies (Duysters and Hagedoorn 2002, Osborn and Hagedoorn 1997). Stand alone strategies become increasingly inviable, even for the largest companies. The high pace of technological development and the multitude of strategic alliances and mergers and acquisitions make the ASIC industry a particularly attractive field for studying the phenomenon of technology sourcing through alliances and mergers/acquisitions.

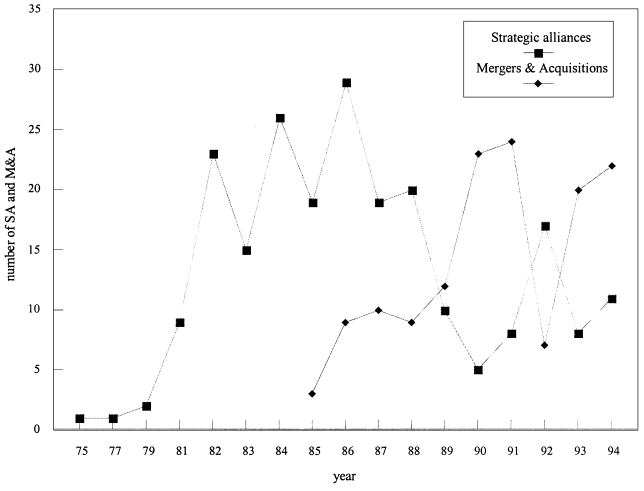
The agreements between firms were entered as dyads. Strategic alliances were considered to be nondirectional so that reversed-ordered dyads were not included. Acquisitions are, of course, directional: There is an acquirer and an acquired firm. As a result, the data structure is a cross-sectional time-series panel, in which each dyad includes the dependent variable, indicating if the dyad is an acquisition or a strategic alliance, and time-varying and time-constant covariates characterizing the dyad-year.

To find out to what extent prior strategic technology alliances influence the choice between newly established strategic alliances or acquisitions, we combined data from two sources. The first is the MERIT-CATI databank on strategic technology alliances (Duysters and Hagedoorn 1993). Strategic technology alliances include joint research projects, joint development agreements, cross licensing, (mutual) second-source agreements, technology sharing, R&D consortia, minority holdings, and joint ventures, but no licensing agreements or production and marketing agreements. The second is the securities data dataset on mergers and acquisitions. A selection was made of strategic alliances and mergers and acquisitions whose major focus was on the ASIC industry. The MERIT-CATI databank covers the period between 1975 and 1994: For that period 222 strategic technology alliances were detected. The Securities Data dataset listed 140 acquisitions for the period 1985–1994. Information on acquisitions announced before 1984 was not available. There were 145 strategic alliances established in the period 1985–1994. As a result, there is an almost equal distribution between strategic alliances (50.9%) and acquisitions (49.1%) for the period included.

There were 52 acquirers and 120 firms that were acquired in the period 1985–1994. There were 118 different firms involved in the strategic alliances. A considerable number of firms were active in both strategic alliances and acquisitions; 31 (59.6%) acquirers were also establishing one or more strategic alliances in 1985–1994 and 28 (23.3%) acquired firms were involved in prior strategic alliances. The distribution between strategic alliances and acquisitions varies considerably over time. Figure 1 suggests that strategic alliances and acquisitions tend to come in waves. The literature provides different theoretical explanations for this phenomenon: The occurrence of merger waves has been explained by institutional changes (Stigler 1950), business cycles (Town 1992, Van Wegberg 1994b), or by a bandwagon effect (Hay and Morris 1991).

A sharp increase in strategic alliances occurred in the early and mid-1980s. Their popularity diminished in the

Figure 1 Announcement of Strategic Alliances and Mergers and Acquisitions



late 1980s and the early 1990s. During that period mergers and acquisitions became relatively more important. The strategic alliances are mainly nonequity agreements (80.0%), of which the majority are joint development agreements (62.1% of all strategic alliances). Other types of nonequity alliances—in decreasing order of importance—are joint research programs, technology sharing, cross-licensing, and second-source agreements. Joint ventures are the most important form of equity alliances (11.7% of all strategic alliances), followed by minority holdings (8.3%)

Left censoring is a frequently occurring problem in longitudinal analysis because most of the sample firms existed before the start of the observation period in 1985. Because data back to 1975 were available for strategic alliances but not for acquisitions, we circumvented the left-censoring problem by restricting our attention to the possible impact of prior strategic alliances on the choice between strategic alliances and acquisitions. The possible impact of a firm's history in acquiring other firms is an issue that cannot be analyzed here.

Variables

The unit of analysis is the dyad-year, the pair of companies involved in the establishment of an alliance or an acquisition. No observation (dyad-year) appeared twice in a given year. Each dyad record includes a number of characteristics of the external technology acquisition action—of both firms, and of the industry as a whole at that point in time. Different aspects of prior cumulative alliance activities until a given year are also included as explanatory variables.

Dependent Variables. The dependent variable in a first set of models is a binary choice variable, indicating whether the pair of firms entered a strategic alliance or an acquisition in a particular year. A strategic alliance was coded 0 and an acquisition 1. Next, in a second set of models testing for a possible effect of different types of strategic alliances, we coded nonequity alliances 0, equity alliances 1, and acquisitions 2.

Explanatory Variables. Some hypothesized effects have to be measured by social network variables. The first variable, called *prior ties,* is the number of prior strategic alliances concluded between the dyad partners in the past. As explained in the argumentation leading to Hypothesis 1, these prior ties are indicators of how well the two firms know each other, and the extent to which information asymmetry and indigestibility problems may be assumed to be alleviated. Hypothesis 1 suggests that prior ties between the companies in the dyad increase the probability of an acquisition compared to companies that have no prior ties. Therefore, we expect a positive sign for this variable.

The second variable is called *network distance.* It stands for the shortest path between two firms in the network of prior strategic alliances (Wasserman and Faust 1994). We only take into consideration the shortest possible path between two firms in the network because of the diminishing value of indirect referrals. The shortest path between two firms in the network was calculated using the distance routine in UCINET based on the number of edges in the geodesic. We took the natural logarithm of this measure, for two reasons. First, a change in distance between two firms matters more when this distance is small compared to the case where this distance is already large. Second, a logarithm mitigates the effect of the distance value for firms that are not indirectly linked to each other by means of a path of strategic alliances.[1] As network distance is an inverse metric of the strength of indirect ties, we expect a positive coefficient according to Hypothesis 2.

A third dyad characteristic refers to the industry to which both firms in the dyad belong. As the ASIC industry can be split up into three major segments—gate and linear arrays, standard cells and full custom ICs, and programmable logic devices (PLDs)—dyads can belong to three categories. The first possibility is a strategic alliance or acquisition between an ASIC producer and a firm which is not an ASIC producer. Next, the two firms may both be ASIC producers, but they belong to two different segments within the ASIC industry. Finally, companies can be ASIC producers belonging to the same segment. We used two dummy variables; the default is a dyad including an ASIC producer and a company that belongs to another industry. *Intraindustry* is a first dummy variable indicating that allies or acquirer and acquired firms are both ASIC producers of which the (major) ASIC sales come from a different segment, e.g., a gate array producer and a PLD producer. *Intrasegment* is another dummy variable indicating that both firms realize (the largest share of) their ASIC sales in the same segment, e.g., two PLD producers. According to Hypothesis 3 we expect that the coefficients of both dummy variables will be positive. Moreover, we expect that the coefficient of the intrasegment variable should be higher than the intraindustry variable because the preference for acquisitions will be more pronounced when the dyad partners are competitors in the same segment.

The last dyad characteristic is the nationality of the two dyad partners. Are they located in the same economic block (Europe, America, Asia) or not? We included a dummy variable *intertriad* to indicate that strategic alliances or acquisitions took place between two firms from

different blocks (as opposed to intratriad ties). We expect a negative sign for the coefficient of the intertriad variable according to Hypothesis 4, indicating that companies from different economic blocks prefer strategic alliances compared to firms that belong to the same block.

Besides dyad characteristics we also included firm characteristics as explanatory variables to test Hypotheses 5 and 6. We focused on two variables that are related to the prior cumulative strategic alliance experience of each partnering firm in the dyad. The first variable was the number of past strategic alliances entered by each firm in the dyad prior to the given year. This variable is called the *alliance history* of the partnering firms in the dyad. The second variable is *network centrality*. This variable measures how well connected, or active, a firm is in the overall network of past alliances. Centrality can be operationalized in different ways. We choose to operationalize centrality by means of "betweenness centrality," measuring the potential control of a firm over other firms that have no direct ties to each other. Betweenness refers to the number of times an actor is located on the shortest geodesic path between two other actors in the prior strategic alliance network. The expression geodesic path is used to denote the shortest path between two points in the network. If a certain actor is directly linked to two other actors who are not directly linked to each other, then the first actor is said to be "between" the other actors. We used normalized centrality measures, controlling for the overall network size, to make centrality measures of a firm comparable across different years.

The inclusion of the alliance history of firms and the centrality measures controls for firm-level heterogeneity (Heckman and Borjas 1980). However, these variables are highly correlated. To deal with the problems of collinearity we estimated their effect on the choice between strategic alliances and acquisitions separately in two models. As alliance history and network centrality are firm characteristics, we have two values per dyad. In case a dyad represents an acquisition, *alliance history 1* and *network centrality 1* refer to the characteristics of the acquired firm. *alliance history 2* and *network centrality 2* refer to those of the acquiring firm. In the case of (nondirectional) strategic alliances, such distinction between both partners makes no sense. To test the hypothesis in an orderly fashion, allies were randomly assigned to either of the two variables in such a way that the mean and variance were the same for both variables for the sample of companies involved in alliances.

Control Variables. The choice between strategic alliances and mergers and acquisitions can also be influenced by factors other than the dyad and firm characteristics we focus on in this paper. We inserted a few variables to capture firm-specific characteristics. First, the internal technological strength of a company was measured by the *number of ASIC-related patents* that were granted during the previous five years. *R&D-intensity* on the corporate level is another indicator measuring the relative efforts spent on technology.[2] Next, the *natural logarithm of "corporate sales"* was introduced as a measure for firm size.[3] Similarly, ASIC sales indicate the involvement of companies in the ASIC industry. As R&D expenditures and corporate sales were not available for a range of non-ASIC producers and a few privately owned ASIC producers, we chose to proxy R&D intensity and firm size by averaging the available figures of the dyad partners and treating the variable as a dyad characteristic. Finally, *captive,* is another dummy variable to control for possible effects of the fact that some large companies produce ASICs only for their internal needs (captive market). These captive producers are a small minority of ASIC-producing companies, but are nonetheless important in terms of technological capabilities and external technology acquisition activities (e.g., IBM and DEC).

We also controlled for two industry variables, the *annual growth rate of the industry* and the *alliance share* in the total number of alliances and acquisitions in the previous year. We mentioned already that the role and incidence of strategic alliances and acquisitions may change over the life cycle of an industry. In early, fluid stages of the industry, strategic alliances are appropriate mechanisms to acquire technology. As an industry matures, the relative importance of mergers and acquisitions increases (Hagedoorn and Sadowski 1999). As we test our hypotheses on data from a relatively young industry (the ASIC industry) over a 10-year period, we must control for industry life-cycle effects. Therefore, we include the annual growth rate of the ASIC market, as growth rates gradually drop when the industry matures. We expect that high growth rates will be associated with a preference for alliances over acquisitions. As a result, we expect a positive coefficient for that variable.

Figure 1 suggests that strategic alliances and acquisitions occur in waves. Several explanations have been provided in the theoretical part of the paper. Waves over several years might imply that firms are prone to mimetic behavior and that, consequently, the choice between alliances and acquisitions cannot be explained by the dyad and firm characteristics alone. To control for this effect we include in our analysis the *share of strategic alliances* in all interfirm ties that are formed in the previous year. This variable is the aggregate result of firms' choices made in the previous year: If there is any mimetic behavior, we expect a negative and significant coefficient for this variable.

Descriptive statistics of the variables are in Table 1. Table 2 presents a correlation matrix for the variables. The correlation matrix indicates that there are problems of collinearity between the alliance history variable and the network centrality variable. Therefore, we estimated their effect on the choice between alliances and acquisitions separately in two models. The matrix further shows that the alliance history could be approximated by the degree centrality of companies (97 and 95% for the two variables) and that there is a fairly strong correlation between betweenness centrality and closeness centrality (53 and 58%).

Analytical Techniques

We modelled the choice between strategic alliances and alliances using the following random effects probit model:

$$y_{ijt} = \Phi(a + b.x_{ij} + c.x_{ijt} + \alpha_{ij} + u_{ijt})$$

with

$$E\alpha_{ij} = Eu_{ijt} = 0.$$

Where y_{ijt} is the probability at time t that the announcement of an external action—i.e., strategic alliance or acquisition—between firms i and j takes the form of a strategic alliance; x_{ij} is a time-constant vector of explanatory variables or covariates characterizing the dyad between firms i and j; x_{ijt} is a time-varying vector of explanatory variables or covariates characterizing the dyad between firms i and j. The error term v_{ijt} is decomposed into two terms: α_{ij} reflects the unobserved time-constant effects, which are not captured by the independent effects, and u_{ijt} is the usual error term, which is independently distributed over the dyads ij, with arbitrary serial correlation. Finally, Φ is the cumulative normal distribution function. The model accounts for unobserved heterogeneity using a random-effects approach (Butler and Moffitt 1982). This random-effects technique is computed by means of a routine available in LIMDEP 7.0 (Greene 1996).

When analyzing on a time series of cross-sections, "unobserved heterogeneity" or unobserved time-invariant effects may occur. Firms may differ in their propensity to establish alliances or to acquire other firms because of unobserved factors which are not captured by any of the independent variables. "If this noise were systematic for the same unit over time, it could lead to serial correlation among the error terms for those observations, which would lead to consistent but inefficient coefficients" (Gulati 1999, p. 409). Standard probit models cannot cope with unobserved heterogeneity. The random-effects panel probit model (Butler and Moffitt 1982), on the contrary, tackles this statistical problem. It generates a coefficient ρ, which stands for the proportion of the variance of the

Table 1 Descriptive Statistics

	Mean	Std.Dev.	Minimum	Maximum	Number of Cases
Choice; alliance (0), acquisition (1)	0.4877	0.5007	0.000	1.000	285
Choice; nonequity alliance (0), acquisition (1)	1.0842	0.9457	0.000	2.000	285
Alliance history firm 1	2.5404	4.5132	0.000	23.000	285
Alliance history firm 2	2.4105	3.7777	0.000	23.000	285
Degree centrality firm 1	2.9814	4.9576	0.000	23.96	285
Degree centrality firm 2	3.0511	4.4355	0.000	23.96	285
Closeness centrality firm 1	1.3173	1.5071	0.000	5.910	285
Closeness centrality firm 2	1.6742	1.7478	0.000	6.190	285
Betweenness centrality firm 1	2.2478	4.8622	0.000	25.010	285
Betweenness centrality firm 2	2.7218	5.9511	0.000	32.150	285
ln (network distance)	3.6293	1.4646	0.000	4.635	285
Prior ties	0.0807	0.2729	0.000	1.000	285
Growth rate of ASIC industry	0.1993	0.0709	0.120	0.320	285
Intertriad dummy variable	0.4246	0.4951	0.000	1.000	285
Intrasegment dummy variable	0.1614	0.3686	0.000	1.000	285
Intraindustry dummy variable	0.3649	0.4823	0.000	1.000	285
Share of alliances at $t - 1$	0.6152	0.2323	0.179	0.897	285
Captive producers (dummy var.)	0.1158	0.3205	0.000	1.000	285
ln (corporate sales)	7.8851	2.7004	0.000	11.079	285
ln (ASIC sales)	0.3259	0.3466	0.000	0.693	285

Table 2 Correlation Matrix

	1	2	3	4	5	6	7					
1 Choice; alliance/acquisition												
2 Choice; noneq. all./eq. all./acq.	0.94656											
3 Alliance history firm 1	−0.37723	−0.34850										
4 Alliance history firm 2	0.00361	−0.05674	0.15299									
5 Degree centrality firm 1	−0.39072	−0.35599	0.97883	0.12563								
6 Degree centrality firm 2	0.05624	−0.00538	0.09539	0.95549	0.08254							
7 Closeness centrality firm 1	−0.39896	−0.38445	0.52250	0.12894	0.60232	0.12105						
8 Closeness centrality firm 2	0.15890	0.09703	−0.05245	0.47908	−0.03654	0.60833	0.01454					
9 Betweenness centrality firm 1	−0.32382	−0.31157	0.81732	0.13103	0.86510	0.09131	0.53257					
10 Betweenness centrality firm 2	0.13065	0.08977	−0.00139	0.66144	−0.00693	0.79781	0.08271					
11 ln (network distance)	0.18567	0.27065	−0.36768	−0.48671	−0.37329	−0.44583	−0.48430					
12 Prior ties	−0.06024	−0.14782	0.33582	0.34681	0.32761	0.30359	0.28867					
13 Growth rate of ASIC industry	−0.31945	−0.25911	0.25580	0.05324	0.19340	−0.02455	0.10931					
14 Intertriad	−0.25583	−0.24929	0.09709	0.00250	0.10211	0.00488	0.04599					
15 Intrasegment	0.01078	−0.04354	0.07863	0.04076	0.07952	0.02106	0.08180					
16 Intraindustry	−0.37508	−0.33764	0.35883	0.05664	0.38457	0.01981	0.44552					
17 Share of alliances	−0.23970	−0.23311	0.13949	0.12102	0.08702	0.07220	0.11906					
18 Captive producers	0.10761	0.09746	−0.08721	−0.01322	−0.08865	−0.00970	−0.01714					
19 ln (corporate sales)	−0.21740	−0.24987	0.22404	0.32753	0.23764	0.34741	0.29040					
20 ln (ASIC sales)	−0.23001	−0.26118	0.38010	0.14912	0.41006	0.11176	0.47814					
	8	9	10	11	12	13	14	15	16	17	18	19
9 Betweenness centrality firm 1	0.02842											
10 Betweenness centrality firm 2	0.57724	0.00714										
11 ln (network distance)	−0.36854	−0.36244	−0.30637									
12 Prior ties	0.19299	0.32778	0.24281	−0.69375								
13 Growth rate of ASIC industry	−0.17402	0.05999	−0.08887	−0.04153	0.05969							
14 Intertriad	−0.00366	0.05359	0.02503	−0.05306	0.00229	0.01352						
15 Intrasegment	−0.01740	0.09744	0.00249	−0.16249	0.13180	0.03263	0.04766					
16 Intraindustry	−0.14135	0.31036	−0.03675	−0.18859	0.14889	0.14750	0.07145	−0.33255				
17 Share of alliances	−0.03445	−0.00042	0.05999	−0.10502	0.09726	0.51211	0.09706	0.03408	0.03721			
18 Captive producers	0.06022	−0.04118	−0.05163	0.00557	0.02386	−0.08623	−0.19990	−0.09915	0.04460	−0.15193		
19 ln (corporate sales)	0.31519	0.21358	0.25370	−0.29003	0.14816	−0.06657	0.20763	−0.00342	0.23878	−0.04230	0.19968	
20 ln (ASIC sales)	−0.05099	0.36380	0.03035	−0.31987	0.19176	0.07883	0.14378	0.46571	0.46879	0.01893	0.01064	0.25586

error term generated by unobservable firm-specific variables.

Results

The estimated parameters are reported in Tables 3 and 4. Table 3 represents the results for the firms' choice between strategic alliances and merger/acquisitions. Table 4 takes into account that companies also have more choices when appropriating external technology: We make a simple distinction between nonequity and equity alliances as the first two options to acquire technology, while an acquisition is the third option. We estimated three models each time. The first model reports the impact of the covariates included as controls. The second and third models include the hypothesized effects. The second model takes the betweenness centrality of firms as a measure of the network positioning of a firm in the past. This variable is replaced in Model 3 by the alliance history of a company. The regressions are estimated by means of a random-effects (ordered) probit model.

Several conclusions can be drawn from Model 1 in Table 3. The negative and significant sign for the *firm size* variable in the first model indicates strategic alliances are more likely to occur when the dyad is composed of large firms.[4] Second, there is a significant effect of the *growth rate of the ASIC industry* particular year on the choice between strategic alliances or acquisitions. The negative and highly significant coefficient confirms our expectation that as the ASIC industry matures, acquisitions as forms of external technology sourcing become relatively more prominent compared to strategic alliances.

The coefficient of the variable "*strategic alliances share"* is negative (as expected) but not significant. This indicates that there is no clear evidence for the mimetic behaviour of companies in their choice between alliances and acquisitions once strategic alliances or acquisitions become fashionable. The same holds for the variable *captive ASIC producers*. These captive producers seem to have a slight preference for acquisitions over alliances, but the results are inconclusive. The coefficients of the control variables remain unchanged in Models 2 and 3.

The existence of prior alliances between two partners (*prior ties*) increases the chances that one acquires the other—See Models 2 and 3. This finding supports the existence of incremental strategies in which firms use alliances as vehicles for dealing with initial problems of information asymmetry and mitigating problems of managerial indigestibility, eventually leading to acquisition (Hypothesis 1). This puts into perspective the conclusion drawn by Hagedoorn and Sadowski (1999) that transformation of strategic alliances into acquisitions hardly plays a role. If repeated strategic alliances between the same partners over time are taken into account, the phenomenon turns out not to be insignificant.

Table 3 Determinants of the Choice Between Strategic Alliances and Mergers and Acquisitions

Variable[a]	Model 1[b]	Model 2	Model 3
Constant	3.307**	2.597*	2.631*
	(3.792)	(2.472)	(2.324)
Controls:			
Firm size (log sales)	−0.193**	−0.120*	−0.114†
	(−3.163)	(−2.044)	(−1.830)
ASIC industry growth	−7.703**	−6.725**	−6.939**
	(−3.090)	(−2.687)	(−2.597)
SA-share	−0.556	−0.987	−0.856
	(−0.983)	(−1.270)	(−1.053)
Captive	0.760†	0.597	0.510
	(1.739)	(1.293)	(1.091)
Independent variables:			
Prior ties		1.010*	0.967*
		(2.048)	(1.994)
Network distance		0.262*	0.243*
		(2.342)	(2.153)
Intraindustry tie		−1.051*	−1.002*
		(−2.513)	(−2.233)
Intrasegment tie		–0.082	−0.052
		(−0.254)	(−0.156)
Intertriad tie		−0.759*	−0.781*
		(−2.527)	(−2.439)
Prior experience with strategic alliances:			
Network centrality firm 1		−0.102*	
		(−2.276)	
Network centrality firm 2		0.067*	
		(2.141)	
Alliance history firm 1			−0.166*
			(−2.208)
Alliance history firm 2			0.084*
			(2.179)
ρ	0.423†	0.444†	0.479†
	(1.678)	(1.806)	(1.905)
Number of observations	285	285	285
Log-Likelihood	−167.95	−134.81	−135.48
Number of unique dyads	215	215	215

Note. a: Dependent variable (strategic alliance = 0; merger or acquisition = 1).

b: The three models use random effects probit estimates.

** $p < 0.01$.

* $0.01 < p < 0.05$.

† $0.05 < p < 0.10$.

t-statistics are in parentheses.

Table 4 Determinants of the Choice Between Nonequity Strategic Alliances, Equity Strategic Alliances, and Mergers and Acquisitions

Variable[a]	Model 1[b]	Model 2	Model 3
Constant	3.352**	2.354**	2.286**
	(4.949)	(3.307)	(2.830)
Controls:			
Firm size (log sales)	−0.195**	−0.131**	−0.121*
	(−3.931)	(−2.647)	(−2.344)
ASIC industry growth	−6.210**	−4.980*	−5.152*
	(3.191)	(−2.516)	(−2.432)
SA-share	−0.434	−0.683	−0.547
	(−0.843)	(−1.167)	(−0.897)
Captive	0.819*	0.693†	0.612
	(2.160)	(1.788)	(1.537)
Independent variables:			
Prior ties		1.041*	1.108*
		(2.006)	(2.019)
Network distance		0.246*	0.278**
		(2.179)	(2.846)
Intraindustry tie		−0.821**	−0.943**
		(−2.592)	(−3.191)
Intrasegment tie		–0.173	−0.189
		(−0.602)	(−0.699)
Intertriad tie		−0.456*	−0.560*
		(−1.980)	(−2.511)
Prior experience with strategic alliances:			
Network centrality firm 1		−0.068*	
		(−2.199)	
Network centrality firm 2		0.061*	
		(2.419)	
Alliance history firm 1			−0.073*
			(−1.998)
Alliance history firm 2			0.057
			(1.614)
μ	0.378**	0.442**	0.450**
	(4.766)	(4.104)	(3.885)
σ	0.776*	0.782*	0.861*
	(2.460)	(2.411)	(2.468)
Number of observation	285	285	285
Variance explained by σ	37.6	38.0	42.6
Log-Likelihood	−242.46	−213.74	−216.87
Number of unique dyads	215	215	215

Note. a: Dependent variable (nonequity alliance = 0; equity alliance = 1; merger or acquisition = 2).

b: The three models use random-effects-ordered probit estimates.

** $p < 0.01$.

* $0.01 < p < 0.05$.

† $0.05 < p < 0.10$.

t-statistics are in parentheses.

The variable *network distance* is an inverse metric of the strength of indirect ties between firms. Thus, the positive coefficient in Table 3 indicates that the existence of indirect ties in the network of alliances increases the likelihood that two firms establish a strategic alliance rather than an acquisition. This suggests that in contrast with direct ties, indirect ties do not appear to play a role in incrementally dealing with information asymmetry, with the ultimate goal of an acquisition, but increase the probability that external acquisition of technology will take the form of a strategic alliance. Hypothesis 2 is confirmed.

The dummy variables *intraindustry tie* and *intrasegment tie* are introduced to test Hypothesis 3—The default is an interindustry tie, i.e., between an ASIC producer and a firm from another industry. According to the hypothesis, we expect first that the coefficients for these two variables are positive and, second, that the coefficient of "intrasegment tie" has in its turn a significantly higher value than the "intraindustry variable." The results in Table 3 indicate that ties within the same industry, but within different segments (*intraindustry*), make strategic alliances more likely when compared with ties across industries. There is also a positive, but not significant effect of ties within the same segment (*intrasegment*). These findings run counter to the predictions based on Hypothesis 3. Both the indigestibility argument and the information asymmetry argument point in the direction of a larger probability of an acquisition if the firms are more alike, so the finding for *intraindustry* is striking. However, our finding is comparable to that of Hennart and Reddy (1997), who found that acquisitions were more likely (than greenfield joint ventures) if the partners were in different industries. Hennart and Reddy explain their observation, assuming that there is a strong connection between a diversification strategy and a preference of acquisitions over other external actions, since acquisitions allow entrants to purchase going firms. This explanation points at firm strategy as a possible factor influencing the choice between strategic alliances and acquisitions not included in our study.

The coefficient of the "intrasegment" variable is significantly higher than that of the "intraindustry" variable, indicating that acquisitions are more likely to occur when two ASIC producers belong to the same industry segment compared to the case where they belong to different segments.

The dummy variable *intertriad tie* has a negative and significant coefficient. This means that external sourcing of technology in the ASIC industry tends to take the form of acquisitions in the case of intratriad dyads and strategic alliances in the case of intertriad dyads, as was predicted by Hypothesis 4.

The position in the prior strategic alliance network of

the two firms in a dyad also seems to be an important explanatory variable. The negative and significant coefficient of *network centrality firm 1* (calculated as the betweenness centrality) indicates that firms that were centrally located in the prior SA network are less likely to become acquired by other firms. Similarly, the positive and significant coefficient of *network centrality firm 2* indicates that firms with a prominent role in the prior SA network are more likely to become acquirers. Similar results were obtained when betweenness centrality was replaced by other measures of centrality (not reported in the table) or by the alliance history of the firms (see Model 3). These results support Hypotheses 5 and 6. As mentioned before, these variables also control for firm-level heterogeneity, which can occur if individual companies display time-constant propensities to engage in strategic alliances or acquisitions that are not captured by any of the explanatory variables.

Besides firm-level heterogeneity there is also a potential for dyad-level heterogeneity. This concern is addressed by the random-effects probit model. A random-effect probit routine generates a parameter ρ, which is an indicator of the presence or absence of dyad-level heterogeneity. The estimate is weakly significant, indicating that there is some evidence that dyads may display a time-independence preference for alliances or acquisitions that cannot be explained by the independent variables in the model. We could think of organizational and managerial routines that are developed as companies got acquainted with managing alliances or acquisitions so that they stick to that one particular way to acquire technology.

Table 4 presents the results from the random-effects-ordered models where the dependent variable represents an ordering of the degree of control and level of financial and managerial involvement associated with each type of external technology sourcing. Nonequity alliances, equity alliances, and acquisitions are ordered according to increasing levels of control and involvement. We ordered the options in such a way that nonequity alliances have the lowest value and equity alliances have an intermediate position. For reasons of brevity, we will only comment on selected results.

The most important result is that the coefficients of the independent variables are quite similar to those reported in Table 3, and by and large consistent with the hypothesized effects. The high degree of consistency across the results in the two tables highlights the fact that the original choice between alliances and acquisitions can be refined by introducing more options and ordering them according to their strength, as has been suggested by Contractor and Lorange (1988), Gulati (1995b), or Nohria and Garcia-Pont (1991).

Finally, σ represents the effect of the dyad-level heterogeneity, i.e., the time-invariant propensity of pairs of firms to choose for one of the three technology acquisition modes. We can recalculate the effect of this variable as the proportion of the total variance in the dependent variable explained by the unobservable dyad-level heterogeneity[5] and compare it with the values of ρ in Table 3. This variable is responsible for 42–48% of the total variance in Table 3 and 38–43% in Table 4.

Conclusions and Suggestions for Further Research

An extensive literature on strategic alliances and mergers and acquisitions exists, but it tells us little about how firms choose between technology-based strategic alliances and acquisitions. This study makes an attempt to fill this void by examining the circumstances under which firms prefer strategic alliances to acquisitions as a mode of external technology sourcing.

By focusing on the dyad as the unit of analysis, this study provides empirical support for the effect of prior direct and indirect ties on the current choice between strategic alliances and acquisitions. Prior alliances between two companies increase the probability that one will ultimately acquire the other. In contrast, indirect ties in the prior network of strategic alliances increase the probability that a subsequent direct link between the two firms will take the form of a strategic alliance. This finding suggests a qualitative difference between the effects of direct and indirect ties. While direct ties help to dissolve information asymmetry and mitigate (managerial) indigestibility, the effect of indirect ties cannot be explained in the same way. Indirect ties, while helpful in providing information concerning potential alliance partners (Gulati 1999), do not provide the fine-grained information desirable for an acquisition. Because proximity in the network of previous alliances promotes stronger reliance on trust and reputation in a strategic alliance, this form of external technology sourcing becomes relatively more attractive than acquisitions.

The finding with regard to the effect of intra- versus interindustry/segment ties runs counter to the logic of both the indigestibility and the information asymmetry arguments. This indicates that the explanatory framework employed in this study, transaction-cost theory, is incomplete. The decision to opt for a strategic alliance or an acquisition is guided not only by considerations of transaction costs (in a broad sense), but also by strategic considerations that cannot be reduced to transaction-cost arguments. Previous research shows that the level of ownership taken in a subsidiary depends significantly on the strategy of the parent (Gomes-Casseres 1989). The same

may be true of the decision to create a strategic alliance or to perform a merger or acquisition.

The findings with regard to differences between intra- and intertriad ties do indeed correspond to expectations based on transaction-cost theory, however. Partnering within a particular economic block is relatively more likely to take the form of an acquisition, and intertriad ties are relatively more likely to be strategic alliances. This is in line with the managerial indigestibility argument based on transaction-cost reasoning.

The positions in the network of alliances of the two companies in a dyad influence the direction of the link—if this has the form of an acquisition. Firms that have positioned themselves in the center of the industry network of alliances have secured timely and flexible access to new technologies. They are in the position to take the initiative, thereby diminishing their probability of being acquired by another firm and increasing their chances of themselves becoming acquirers. Furthermore, the preference of the companies for strategic alliances or acquisitions is not homogeneous over the industry cycle. In the early stages, firms prefer strategic alliances, switching towards acquisitions as the industry matures. Finally, the results did not support the idea of mimetic behavior of firms leading to waves of either strategic alliances or acquisitions.

Overall, our findings confirm the importance of transaction-cost-related factors like information asymmetry and indigestibility in the trade-off between different forms of external technology sourcing.

Although the results of our study are interesting, the study is limited in its scope. The study focuses narrowly on the ASIC industry, and further studies are needed to generalize these findings. In the paper we focused on the choice between alliances and acquisitions, but one could easily subdivide strategic alliances in different types. In Table 4, we made a distinction between equity alliances and nonequity contractual agreements. If ordered in terms of the strength of interorganizational control they allow for, acquisitions are assumed to offer the strongest control, followed by equity alliances and nonequity alliances. In our empirical analysis we found strong support for this assumption. Differentiating between these different types of alliances (e.g., Contractor and Lorange 1988) may result in an even more accurate picture.

There are a number of fruitful directions for future research. Including more detailed financial data for each firm mentioned could enrich the study. In a dyadic context, we could measure how differences in financial characteristics of firms impact their choice between strategic alliances and acquisitions. In this study we compared only strategic alliances and acquisitions, and we excluded implicitly the nonoccurrence of either form of external technology sourcing. Making the three options explicit, however, was not possible because the borders of the relevant network are hard to define and the financial data for a number of partner companies outside the ASIC industry were not available.

Finally, taking the dyad as the unit of analysis also has its limitations and drawbacks. In order to have a complete picture of a company's choice between strategic alliance and acquisition, another study taking the firm as the unit of analysis should complement this one. This would give us a better understanding of a firm's choice between different forms of external technology-sourcing by relating it to its portfolio of prior external technology sourcing activities and other firm characteristics, such as indicators of its strategic intent and posture.

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Endnotes

[1]UCINET sets the distance between firms which are not linked to one another by at least one path of any distance, i.e., disconnected subgroups, equal to the number of firms in the network.

[2]Neither variable—ASIC related patents or R&D intensity—generated any effect on the choice between alliances and acquisitions. Therefore, they were dropped from the models in Tables 3 and 4.

[3]Corporate sales are a good proxy for R&D expenditures: For the companies for whom figures where available, the correlation between sales and R&D expenditure was 0.91.

[4]We could replace corporate sales by the ASIC sales, but we preferred corporate sales because both are measures of company size and ASIC sales interferes to a considerable extent with the sector dummy variables.

[5]$\sigma^2/(1 + \sigma^2)$

References

Amburgey, T., A. Miner. 1992. Strategic momentum: The effects of repetitive, positional, and contextual momentum on merger activity. *Strategic Management J.* **13** 335–348.

Auster, E. R. 1987. International corporate linkages: Dynamic forms in changing environments. *Columbia J. World Bus.* **22**(2) 3–6.

Balakrishnan, S., M. P. Koza. 1993. Information asymmetry, adverse selection and joint-ventures: Theory and evidence. *J. Econom. Behavior and Organ.* **20** 99–117.

Bleeke, J., D. Ernst, eds. 1993. *Collaborating to Compete: Using Strategic Alliances and Acquisitions in the Global Marketplace*. Wiley, New York.

Borgatti, S., M. G. Everett, L. C. Freeman. 1999. *UCINET 5 for Windows: Software for Social Network Analysis.* Analytic Technologies, Natick.

Bowman, E., D. Hurry. 1993. Strategy through the option lens: An integrated view of resource investments and the incremental-choice process. *Acad. Management Rev.* **18** 760–782.

Bresman, H., J. Birkinshaw, R. Nobel. 1999. Knowledge transfer in international acquisitions. *J. International Bus. Stud.* **30** 439–462.

Burt, R. S. 1992. *Structural Holes: The Social Structure of Competition.* Harvard University Press, Cambridge, MA.

Butler, J., R. Moffitt. 1982. A computationally efficient quadrature procedure for the one-factor multinomial probit model. *Econometrica* **50** 761–764.

Chakrabarti, A, J. Hauschildt, C. Sueverkruep. 1994. Does it pay to acquire technological firms? *R&D Management* **24** 47–56.

Chesnais, F. 1988. Multinational enterprises and the international diffusion of technology. G. Dosi, C. Freeman, R. Nelson, G. Silverberg, and L. Soete, eds. *Technical Change and Economic Theory.* Pinter, London, U.K., 496–527.

Chi, T. 1994. Trading in strategic resources: Necessary conditions, transaction cost problems, and choice of exchange structure. *Strategic Management J.* **7** 119–139.

Cohen, W., D. Levinthal. 1989. Innovation and learning: The two faces of learning. *Economic J.* **99** 569–596.

——, ——. 1990. Absorptive capacity: A new perspective on learning and innovation. *Admin. Sci. Quart.* **35** 128–152.

Contractor, F., P. Lorange, eds. 1988. *Cooperative Strategies in International Business.* Lexington Books, Lexington, MA.

Das, S., P. K. Sen, S. Sengupta. 1998. Impact of strategic alliances on firm valuation. *Acad. Management J.* **41** 27–41.

Doz, Y. L. 1996. The evolution of cooperation in strategic alliances: Initial conditions or learning processes? *Strategic Management J.* **17** (Special Issue) 55–84.

Duysters, G., J. Hagedoorn. 1993. *The Cooperative Agreements and Technology Indicators (CATI) Information System*. MERIT, Maastricht.

——, ——. 2000. A note on organizational modes of strategic technology partnering. *J. Sci. Indust. Res.* **58** (August-September) 640–649.

——, ——. 2002. External appropriation of innovative capabilities: The choice between strategic partnering and mergers and acquisitions. *J. Management Stud.* **39** 167–188.

Foray, D. 1991. The secrets of industry are in the air: Industrial cooperation and the organizational dynamics of the innovative firm. *Res. Policy* **20** 393–405.

Franko, L. 1989. Global corporate competition: Who's winning, who's losing, and the R&D factor as one reason why. *Strat. Management J.* **10** 449–474.

Freeman, L. C. 1979. Centrality in social networks: Conceptual clarification. *Soc. Networks* **1** 215–239.

Garette, B., P. Dussauge. 2000. Alliances versus acquisitions: Choosing the right option. *Eur. Management J.* **18** 63–69.

Gerpott, T. J. 1995. Succesful integration of R&D functions after acquisition: An exploratory empirical study. *R&D Management* **25** 161–178.

Ghemawat, P., M. Porter, R. Rawlinson. 1986. Patterns of international coalition activity. M. Porter, ed. *Competition in Global Industries.* Harvard Business School Press, Boston, MA.

Gomes-Casseres, B. 1989. Ownership structures of foreign subsidiaries: Theory and evidence. *J. Econom. Behavior and Organ.* **11** 1–25.

——. 1996. *The Alliance Revolution: The New Shape of Business Rivalry.* Harvard University Press, Cambridge, MA.

Granstrand, O., E. Bohlin, C. Oskarsson, N. Sjöberg. 1992. External technology acquisition in large multi-technology corporations. *R&D Management* **2** 111–133.

Greene, W. 1996. *LIMDEP Version 7.0 User's Manual.* Econometric Software, Plainview, NY.

Gulati, R. 1995a. Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. *Acad. Management J.* **38** 85–112.

——. 1995b. Social structure and alliance formation patterns: A longitudinal analysis. *Admin. Sci. Quart.* **40** 619–652.

——. 1998. Alliances and networks. *Strategic Management J.* **19** 293–317.

——. 1999. Network location and learning: The influence of network resources and firm capabilities on alliance formation. *Strategic Management J.* **20** 397–420.

Hagedoorn, J. 1993. Understanding the rationale of strategic technology partnering: Inter-organizational modes of cooperation and sectoral differences. *Strategic Management J.* **14** 371–385.

——, G. Duysters. 2002. External appropriation of innovative capabilities: The choice between strategic partnering and mergers and acquisitions. *J. Management Stud.* **39**(2) 167–188.

——, R. Narula. 1996. Choosing organizational modes of strategic technology partnering: International and sectoral differences. *J. Internat. Bus. Stud.* **27** 265–284.

——, B. Sadowski. 1999. The transition from strategic technology alliances to mergers and acquisitions: An exploratory study. *J. Management Stud.* **36** 87–107.

——, J. Schakenraad. 1990. Inter-firm partnerships and cooperative strategies in core technologies. C. Freeman and L. Soete, eds. *New Explorations in the Economics of Technological Change*. Pinter Publishers, London, U.K., 3–37.

——, A. Link, N. Vonortas. 2000. Research partnerships. *Res. Policy* **29** 567–586.

Hamel, G. 1991. Competition for competence and inter-partner learning within international strategic alliances. *Strategic Management J.* **12** 83–103.

Harberger, A. 1984. *World Economic Growth: Case Studies of Developed and Developing Nations.* ICS Press, San Francisco, CA.

Harrigan, K. 1985. *Strategies for Joint Ventures.* Lexington Books, Lexington, MA.

——. 1986. *Managing for Joint Venture Success.* Lexington Books, Lexington, MA.

——. 1988. Joint ventures and competitive strategy. *Strategic Management J.* **9** 141–158.

Harrison, J. S., M. A. Hitt, R. E. Hoskisson, R. D. Ireland. 2001. Resource complementarity in business combinations: Extending the logic to organizational alliances. *J. Management* **27** 679–690.

Haspeslagh, P., D. Jemison. 1991. *Managing Acquisitions: Creating Value Through Corporate Renewal.* Free Press, New York.

Hay, D., D. Morris. 1991. *Industrial Economics and Organization.* Oxford University Press, Oxford, U.K.

Heckman, J., G. Borjas. 1980. Does unemployment cause future unemployment: Definitions, questions, and answers from a continuous time model of heterogeneity and state dependence. *Economica* **47** 247–283.

Hennart, J.-F. 1991, The transaction costs theory of joint ventures: An empirical study of Japanese subsidiaries in the United States. *Management Sci.* **37** 483–497.

——, S. Reddy. 1997. The choice between mergers/acquisitions and joint ventures: The case of Japanese investors in the United States. *Strategic Management J.* **18** 1–12.

——, ——. 2000. Digestibility and asymmetric information in the choice between acquisitions and joint ventures: Where's the beef? *Strategic Management J.* **21** 191–193.

Hitt, M., R. Hoskisson, R. Ireland, J. Harrison. 1991. Effects of acquisitions on R&D inputs and outputs. *Acad. Management J.* **34** 693–706.

Hoffmann, W. H., W. Schaper-Rinkel. 2001. Acquire or ally?—A strategy framework for deciding between acquisition and cooperation. *Management Internat. Rev.* **41** 131–159.

Inkpen, A. 1998. Learning, knowledge acquisition, and strategic alliances. *Eur. Management J.* **16** 223–229.

——, M. Crossan. 1996. Believing is seeing: Joint ventures and organizational learning. *J. Management Stud.* **32** 595–618.

James, H. S., M. L. Weidenbaum. 1993. *When Businesses Cross International Borders: Strategic Alliances and Their Alternatives*. Praeger, Westport, CT.

Kay, N. 1991. Industrial collaborative activity and completion of the internal market. *J. Common Market Stud.* **29**(4) 347–362.

Kogut, B. 1988a. Joint ventures: Theoretical and empirical perspectives. *Strategic Management J.* **9** 319–332.

——. 1988b. A study of the life cycle of joint ventures. F. Contractor and P. Lorange, eds. *Cooperative Strategies in International Business.* Lexington, Books, Lexington, MA, 169–186.

——. 1989. The stability of joint ventures: reciprocity and competitive rivalry. *J. Indust. Econom.* **38** 183–198.

——, H. Singh. 1988. The effect of national culture on the choice of entry mode. *J. Internat. Bus. Stud.* **19** 411–432.

Koza, M. P., A. Y. Lewin. 1998. The coevolution of strategic alliances. *Organ. Sci.* **9** 255–264.

Lambe, C. J., R. E. Spekman. 1997. Alliances, external technology acquisition, and discontinuous technological change. *J. Product Innovation Management* **14** 102–116.

Larsson, R., L. Bengtsson, K. Henriksson, J. Sparks. 1998. The interorganizational learning dilemma: Collective knowledge development in strategic alliances. *Organ. Sci.* **9** 285–305.

Leonard-Barton, D. 1994. *The Wellsprings of Knowledge.* Harvard Business School Press, Boston, MA.

Link, A. N. 1988. Acquisitions as sources of technological innovation, *Mergers and Acquisitions* **23**(3) 36–39.

Mowery, D. C. 1988. *International Collaborative Ventures in U.S. Manufacturing.* Ballinger, Cambridge, MA.

——, J. Oxley, B. S. Silverman. 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management J.* **17** 77–91.

Mytelka, L., ed. 1991. *Strategic Partnerships and the World Economy.* Pinter, London, U.K.

Nohria, Nitin, Carlos Garcia-Pont. 1991. Global strategic linkages and industry structure. *Strategic Management J.* **12** 105–124.

Nordberg, M., A. J. Campbell, A. Verbeke. 1996. Can market-based contracts substitute for alliances in high technology markets? *J. Internat. Bus. Stud.* **27** 963–979.

Osborn, R. N., J. Hagedoorn. 1997. The institutionalization and evolutionary dynamics of interorganizational alliances and networks. *Acad. Management J.* **40** 261–278.

——, ——, J. G. Denekamp, G. Duysters, Ch. Baughn. 1998. Embedded patterns of international alliance formation. *Organ. Stud.* **19** 617–638.

Poppo, L., T. Zenger. 1998. Testing alternative theories of the firm: Transaction cost, knowledge-based, and measurement explanations for make-or-buy decisions in information services. *Strategic Management J.* **19** 853–877.

Porter, M. 1990. *The Competitive Advantage of Nations.* The Free Press, New York.

——, M. Fuller. 1986. Coalitions and global strategy. M. Porter, ed. *Competition in Global Industries.* Harvard Business School Press, Boston, MA, 315–344.

Powell, W., K. Koput, L. Smitt-Doerr. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Admin. Sci. Quart.* **41** 116–145.

Raub, W., J. Weesie. 1990. Reputation and efficiency in social interactions: An example of network effects. *Amer. J. Sociology.* **96** 626–654.

Ravenscraft, D. J., F. M. Scherer. 1987. *Mergers, Sell-Offs, and Economic Efficiency.* Brooking Institutions, Washington, DC.

Reuer, J. J., M. P. Koza. 2000. Asymmetric information and joint venture performance: Theory and evidence for domestic and international joint ventures. *Strategic Management J.* **21** 81–88.

Roberts, E., C. Berry. 1985. Entering new business: Selecting strategies for success. *Sloan Management Rev.* **26** 3–17.

Stigler, G. 1950. Monopoly and oligopoly by merger. *Amer. Econom. Rev. Proc.* **40** 51–70.

Stuart, T. E. 2000. Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management J.* **21** 791–811.

Teece, D. 1986. Profiting from technological innovation. *Res. Policy* **15** 286–305.

——. 1992. Competition, cooperation and innovation: Organizational arrangements for regimes of rapid technological progress. *J. Econom. Behavior and Organ.* **18** 1–25.

Town, R. 1992. Merger waves and the structure of merger and acquisitions time-series. *J. Appl. Econometrics* **7** 83–100.

Tsang, E. W. K. 1999. A preliminary typology of learning in international strategic alliances. *J. World Bus.* **34**(3) 211–229.

Uzzi, B. 1996. The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *Amer. Sociological Rev.* **61** 674–698.

Vanhaverbeke, W., N. G. Noorderhaven. 2001. Competition between alliance blocks: The case of the RISC-microprocessor technology. *Organ. Stud.* **22** 1–30.

Van Wegberg, M. 1994a. *Merger Waves, Their Historical and Structural Causes: A Survey of Views in Industrial Economics.* Research Memorandum/0/94–024, METEOR, Maastricht.

——. 1994b. *Why Do Mergers Occur in Waves? Business Cycles, Bandwagons and the Merger for Market Power Paradox*. Research Memorandum/0/94–022, METEOR, Maastricht.

Vermeulen, F., H. G. Barkema. 2001. Learning through acquisitions. *Acad. Management J.* **44** 457–476.

Wasserman, S., K. Faust. 1994. *Social Network Analysis: Methods and Applications*. Cambridge University Press, Cambridge, U.K.

Williamson, O. E. 1985. *The Economic Institutions of Capitalism.* Free Press, New York.

——. 1991. Comparative economic organization: The analysis of discrete structural alternatives. *Admin. Sci. Quart.* **36** 269–296.

Young-Ybarra, C., M. Wiersema. 1999. Strategic flexibility in information technology alliances: The influence of transaction cost economics and social exchange theory. *Organ. Sci.* **10** 439–459.