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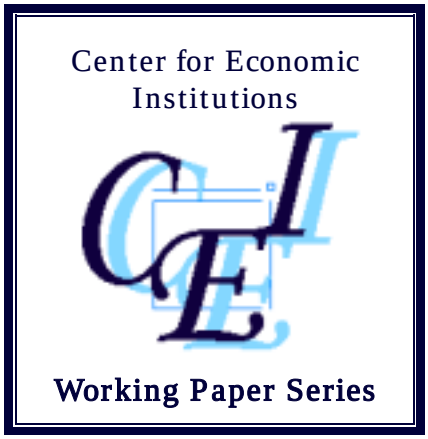

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The Permeability of Network Boundaries:
Strategic Alliances in the Japanese Electronics Industry in the 1990s

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Abstract: This paper looks at the choice of strategic partners for alliance formation in the Japanese electronics industry during the post-bubble economic period 1992-97. Results from a dyad analysis of 128 companies suggest that firms tend to look for partners within their existing vertical *keiretsu* networks of organizations for alliances that target the creation of resources that build on existing knowledge (production or distribution) but that this common *keiretsu* effect disappears for alliances that involve new knowledge creation (new product or technology development). The role of corporate networks, environmental uncertainty and their implications for our understanding of strategic alliance formation and the dynamics of social networks are discussed.

INTRODUCTION

The prevalence of strategic alliances, defined as voluntary durable agreements for exchange, co-development, production, or distribution of new products and technologies between industrial firms has naturally attracted the attention of students of organization. Why firms enter these close collaborations and whom they choose as their strategic partners are major questions for organizational research. As for the former, there is no shortage of theory. Transaction cost theorists have argued that strategic alliances are hybrid forms that enable firms to exploit the incentive benefits of market-based exchange while reaping the learning and coordination benefits of internalization within a corporate hierarchy (Williamson, 1985, 1996). Corporate strategy theorists have highlighted the benefits of alliance formation for acquiring new knowledge and gaining or maintaining strategic position (Kogut, 1988). Finally, institutional theorists see alliance formation as driven in part by "mimetic isomorphism," the tendency for firms to "follow the leader" in an effort to gain legitimacy (Sharfman, Gray, and Yan, 1991).

As to the choice of a strategic partner, a number of arguments have been advanced. First, some reseach demonstrates a positive effect of strategic interdependence between two organizations on their propensity to form an alliance. Firms' interdependencies with respect to financial resources, technological capabilities, supply chain location, and strategic position are relatively well-studied causes of alliance formation (Hage and Aiken, 1967; Pfeffer and Salancik, 1978; Eisenhardt and Schoonhoven, 1996; Kogut, Shan, and Walker, 1992).

Yet firms do not learn about potential partners only through past strategic alliances. Companies are embedded in interorganizational networks of a variety of types, which endow them with information about the suitability of others (Granovetter, 1985). Research on interlocking directorships, for instance, demonstrates the role of these kinds of ties in the diffusion of a diverse set of organizational practices (Davis and Greve, 1992; Haunschild, 1994). As companies learn about other firms' technological or financial capabilities through an array of economic transactions and governance relationships, they are apt to select alliance partners from the pool of firms participating in these networks.

Second, recent research on interorganizational networks points to the importance of an organization's centrality in networks and its track record of previous alliances on its rate of new strategic alliance formation (Gulati, 1995). A firm's high density of direct and indirect relationships with other firms signals: (a) experience and expertise in navigating networks; (b) broad access to resources such as information (e.g., on strategic capabilities) that are distributed in networks (Burt, 1992a; Powell and Koput); general reputation, visibility, status, and power (Podolny, 1993). Thus, it stands to reason that

firms with a history of being "plugged-in" will display a strong propensity to form new alliances (Gulati and Gargiulo, 1999).

Japan provides an interesting context for the study of the formation of strategic alliances within and across networks of firms. The clustering of Japanese economic relationships in stable groupings of firms known as *keiretsu* has drawn much attention from scholars, policy makers, and business practitioners (e.g. see Gerlach, 1992). This literature describes the structure of these interorganizational networks and assesses their consequences for corporate strategic behavior and performance (Fruin, 1992; Lincoln, Gerlach, Takahashi, 1992; Nakatani, 1984; Nishiguchi, 1996). Reliance on a stable set of partners has enabled Japanese firms in industries such as autos and electronics to build competitive advantage and to achieve competence at the leading edge of technology (Ahmadjian and Lincoln, 2001; Ritschev and Cole, 1999). However, the highly uncertain economic downturn since the collapse of the bubble economy in the early 1990s and the discontinuity in the technological cycle created by the spread of internet and wireless technologies are severely testing the effectiveness of Japanese firms' internal and interorganizational routines (Anderson and Tushman, 1990).

Building on these ideas, this paper examines the dynamics of alliance formation in the Japanese electronics industry between 1992 and 1997 by testing competing hypotheses about the creation of *keiretsu* boundary- spanning strategic ties. In measuring the effects of membership in established interorganizaitonal networks on Japanese firms' choices of strategic alliance partners, we hope to contribute to knowledge and practice in an area of considerable scholarly and managerial concern. In examining the issue of stability or restructuring of Japan's corporate networks during the current period of change and uncertainty, we also wish to make a contribution to organizational theory relating to the dynamics of network evolution (DiMaggio, 1995).

CORPORATE NETWORKS, UNCERTAINTY, AND STRATEGIC ALLIANCES IN JAPAN

Firms create strategic alliances with other organizations to manage the acquisition of resources than they cannot generate internally (Pfeffer and Salancik, 1978) or because there are efficiencies and synergies to be gained through external contracting with an alliance partner (Williamson, 1985, 1996). But how do organizations acquire information about the availability of suitable partners, and what is the process whereby they go about one? How do they identify firms in possession of resources and capabilities that complement their own? Many strategic alliances fail because these processes of learning and selection were poorly managed. Of course, becoming good at picking partners, aligning structures and processes with them, and otherwise achieving efficiency and synergy in an alliance are skills that organizations can learn. Some recent research on interorganizational networks demonstrates a strong

effect of past collaborations on the likelihood that new strategic ties will form between a pair of firms (Gulati and Gargiulo, 1999). Because the network of prior alliances represents a vector of experience and information about the capabilities of potential partners, a history of close dealings and mutual commitments with other firms is an important predictor of the likelihood and potential for success of new strategic collaboration with those same firms (Burt, 1992). Some companies are more centrally positioned in networks than others and thus have built up a greater reservoir of partnering skills and experiences to draw on in forging new alliances. These networks are also channels of communication whereby companies learn about other firms' technological or financial capabilities through their previous direct or indirect ties. Centrality in such networks gives a firm maximum access to information and other resources and confers upon it visibility and status that it can leverage in the search for suitable alliance partners (Podolny, 1993).

Thus, past strategic alliances are an obvious way that firms learn about and experience-test potential future partners. Firms' records of involvement in other interorganizational networks may be similarly useful in this regard. Stable customer-supplier relationships, common third-party ties—e.g., to the same bank, trading company or consulting firm-- joint membership in the same industry association or government-sponsored consortium, and interlocking director and equity relationships are all ways companies discover and connect with one and thus facilitate the strategic partner search process.[1]

Strategic alliances are fragile things.[2] The forces that attract two firms to one another at one point in time may very well disappear at a later point, rendering the partnership useless to one or both. A key reason for the rapid obsolescence of alliances is they are very often vehicles for short-term and highly-focused programs of learning (Powell and Brantley, 1992). Once there is no more to be learned, there remains no rationale for the continuance of the alliance. Company A, for example, might aim to expand into a new region or line of business, so pursues a partnership with company B, which is already established in that sector, as a means of learning the territory and gaining access to B's distribution channels, supply network, and labor pool. Over time, A acquires the expertise and connections necessary to operate in B's region, decides there is no more value to be gleaned from the partnership, and elects to drop B. Another familiar case is that A is motivated to ally with B because B has a specialized

[1] The large empirical literature on interlocking directorates reports a positive effect of interlocks on the diffusion of a variety of organizational practices such as the adoption of a poison pill to protect against hostile takeovers (Davis and Greve, 1992) or the premium paid for acquisitions (Haunschild, 1994).

[2] A very large number of joint ventures and other strategic alliances fail. It would seem that managers either do not know the essential ingredients for success, or they know but are unable to succeed in assembling them.

competency in the design or manufacture of a product that A seeks to acquire. As A accumulates B's knowledge through its association with and study of B's organization and practices, the value to A of continuing the relationship ends, and A terminates it.

From a transaction costs perspective, alliances are hybrid forms of organization—more structured and permanent than a licensing agreement or other long-term contractual arrangement—yet lacking the monitoring and control mechanisms for aligning incentives and foreclosing opportunism that full internal organization (e.g., through vertical or horizontal integration) might provide (Williamson, 1985). Of course, the attractiveness of the alliance form for these purposes depends on the availability of alternatives. In the Japanese economic context, where neither formal legal contracting with strong court enforcement nor merger and acquisition have been easily implemented, a flexible alliance form supported by equity holdings and a "culture" of reciprocity and commitment may be the only realistic choice.

In general, firms pursue alliances because the partners perceive that joining forces in some area of endeavor is likely to create more value than if each pursued it on its own and, further, that alternative ways of combining their efforts are unattractive. Often the assets or skills that one brings to the partnership and are coveted by the other are "intangible" – hard to observe and copy—and inseparable—dependent for their effectiveness on a unique mix with other assets or a particular supportive context. Copying or buying or contracting for a narrow set of capabilities while failing to acquire or recreate the context within which they can be effective is a mistake that far too many firms, particularly in the knowledge-based industries, repeat. Perhaps the most familiar example is the company that succeeeds in hiring away a set of talented engineers or managers, only to discover that it cannot integrate them into its structure or culture, so that the value the same people gave to the previous employer cannot be realized.

It is a pervasive theme in much recent organization theory that what gives a company its distinctive "core" competency or strategic capabilities its latent, hard-to-observe and context-dependent "routines" (Nelson and Winter, 1984), "invisible assets" (Itami) or "tacit" knowledge (Nonaka and Takeuchi, 1995). The broad label subsuming all such intangible and hard-to-copy qualities of organizatons is "culture:" norms and values, beliefs and symbols, traditions and customs that provide direction and motivation to the cooperative efforts of its people. For a joint venture to succeed, these cultural assets of the partnering firms must be complementary at the outset or soon made to be so.

David Mowery's (p. 9) specific concern in the following quote is with technology licensing but his observations on the superiority of collaborative ventures hold for other kinds of long-term contracts as well.

> "Many of the contractual limitations and transaction costs of licensing for the exploitation of technological capabilities can be avoided within a collaborative venture. The noncodified, "inseparable" character of firm-specific assets that makes their exploitation through licensing so difficult need not prevent the pooling of such assets by several firms within a joint venture or the effective sale of such assets by one firm to another within a joint venture."

We suggest that long-standing *keiretsu* allegiances may function to enable companies to get together easily in a new area of endeavor and combine complementary assets to create "synergy," hence new value. Commonly discussed in Japanese business circles, though subject to little systematic research of which we are aware, is that is that *keiretsu* groupings develop certain elements of common culture in terms of the work and cooperation styles of employees, the nature of competitive strategy, and so on. In Japan, these cultural qualities are sometimes regional in origin (e.g., the concentration of the Toyota *keiretsu* in Aichi Prefecture or Sumitomo's long history in Osaka).[3] Or they may flow from the strong corporate culture of the dominant parent firm. Although Matsushita Electric claims not to have a *keiretsu* supply network of the Toyota or or Nissan sort, our interviews with several Matsushita suppliers impressed us with the extent to which their management was in awe of and familiar with the teachings of charismatic founder Konosuke Matsushita (Lincoln, Ahmadjian, and Mason, 1998).

The power of strong network ties and network culture in motivating and directing collaborative effort has been widely studied by researchers and journalists fascinated with the smooth, trusting, and cooperative relationships that, in contrast with Anglo-American supplier relations (Helper; Sako), appear to have existed between Japanese customer and supplier firms. One of the most striking examples, recently documented in a paper by Nishiguchi and Beaudet, was the rapid response of the Toyota supply network to a fire in an Aisin Seiki plant that cut off supplies of a critical brake component and thus shut down most Toyota automobile production in Japan.

Ronald Dore (1983) has written that Japanese business networks tend to be infused with qualities of trust and "good will"—that lubricate business dealings and thus reduce transaction costs (see also Lincoln, 1990). Consequently, the kinds of "hard" governance solutions outlined by Oliver Williamson—formal long-term contarcts and vertical integration through merger and acquisition—are less essential. Such cultural qualities, Dore implies, have contributed to the spread and effectiveness of

[3] At an interview we conducted with a prominent Mitsui group company on March 29, 2001, high-level managers spoke of this attractions of this *keiretsu*; specifically, how it tended to ensure that the collaborations between companies from the same group would able to mesh their routines and styles in productive ways. Even in the 2000's, when many observers are claiming that *keiretsu* are dead, these managers told us that, if everything else of a business nature was equal, they would prefer to do business with a firm from the same *keiretsu* group.

keiretsu-type networks as a mode of organizing in Japan. They may also account for some of the difficulty Japanese business has had in recent years in shifting quickly under the pressure of the weak economy to more transparent and contractual styles of doing business. Given the numerous costs and uncertainties involved in two firms researching one another to assess complementarity of assets and the potential for synergy, the option of turning to a well-known *keiretsu* partner is understandably attractive.

Yet the downside to strategic alliance partners selecting each other from same *keiretsu* is not hard to discern, particularly given the general skepticism, now pervasive even in Japan, of the value of *keiretsu* networks in the changing Japanese economy. While mutual trust, familiarity, and the prospect of easy alignment may prompt companies in the same group to choose each other for new business partnerships, there may be insufficient difference between them in capabilities, processes, and strategies to yield an alliance with real synergy. Obviously, there are unavoidable tradeoffs here—tough going at the outset in terms of molding a productive partnership may pay dividends down the road in building long-term capabilities that neither partner could achieve of its own.

Rtishchev and Cole (2000) state this case well. While they do not discount the benefits that partnering within a *keiretsu* group may provide Japanese firms in search of innovative collaborations, they also see significant costs. They find over-reliance on *keiretsu*-based partnerships in R&D to be just one indication of a general reluctance in Japan to embrace the kinds of "organizational discontinuities" that in Silicon Valley, for example, enable breakthrough innovation and commercialization to proceed.

> "We do not argue, however, that alliances (by which they mean *keiretsu*) in the Japanese economy always hinder innovation. In some cases, intra-alliance R&D projects benefit from effective combination of technological capabilities and low transaction costs. For example, Kodana's (1995: Ch. 5) analysis of technology fusion across industry borders as a basis for innovation in Japan attributes success in fiber-optics to collaboration among three firms within the Sumitomo group. Nevertheless, Kodama concludes that intra-*keiretsu* R&D is neither a necessary nor even a primary factor for successful technology fusion (p. 203). We go further to claim that sometimes the predilection toward intra-*keiretsu* R&D in Japan precludes potentially more beneficial fusion across alliance boundaries."

Forms of *keiretsu*

The organization of much economic activity in Japan in terms of interfirm networks (*keiretsu*) of trading and lending relationships, cross-shareholdings, and personnel transfers has been well documented

(e.g. Gerlach, 1992b; Miyashita and Russell, 1999). For our purposes, two primary *keiretsu* forms are important: (1) the horizontal intermarket corporate groups or *kigyo shudan* (hereafter horizontal *keiretsu*) and the vertical manufacturing *keiretsu* (hereafter vertical *keiretsu*) (Gerlach, 1992; Shimotani, 1991).[4] The horizontal groups are loosely coupled associations of large firms from diverse industries. They typically include a bank, an insurance company, a trading firm and a number of large manufacturing companies. Of the six major horizontal *keiretsu*, three originated as the prewar family-centered zaibatsu (Mitsui, Mitsubishi, and Sumitomo), whereas the other three—the bank-centered groups-- were formed after World War II (Fuyo, Sanwa, Dai-ichi Kangyo; see, e.g., Morikawa, 19x; Shimotani, 1991). The vertical *keiretsu* are relatively tight, hierarchically-structured associations centered on a major manufacturing firm and containing smaller satellites companies in the same or related industries

The two types of *keiretsu* are organized differently and perform different functions. Accordingly, their implications for strategic alliance patterns are different. The vertical *keiretsu* are typically formed within manufacturing industries and are centered on large manufacturing firms. These networks arose in response to problems of manufacturing procurement and supply in key industries after the war and to regulatory and capital market limitations on the scale and scope of corporations that at the time were possible to attain (Odaka, Ono, and Aachi, 1988). In other instances, vertical *keiretsu* have enabled large manufacturers to launch new businesses and to diversify into related industries by spinning-off divisions to become affiliates or subsidiaries (Gerlach and Lincoln, 2000). Another rationale for the existence of verticval *keiretsu* in industries such as autos and electronics was that they gave Japanese firms the necessary scale and support networks to compete effectively in global export markets (Nishiguchi, 1994).

While such close collaboration along the supply chain between core manufacturers and their *keiretsu* subsidiaries and satellite firms in the electronics industry might not be as strong as it is in the automobile industry (Asanuma, 1989; Lincoln and Ahmadjian, 2001), such vertical interorganizational clusters have nevertheless enabled large electronics firms to build competitive advantage through technical cooperation and reliance on stable supply and distribution networks (Sako, 1992). Of particular interest to this paper is that the vertical *keiretsu* themselves conform to our definition of a strategic alliance as "…a voluntary durable agreements for exchange, co-development, production, or distribution of new products and technologies." Because Japanese electronics firms have a rather lengthy history behind them of working with strategic partners, the industry has developed strong communication networks, both vertically between parent manufacturers and suppliers and horizontally between parts manufacturers organized in supplier associations or *kyoryoku-kai* (Sako, 1995; Nishiguchi, 1996).

[4] We do not deal here with such the vertical distribution groups such as Tokyuu or Seibu-Seisan.

The horizontal *keiretsu* or kigyo shudan are configured differently. Because member firms are large companies, each representing a single industry sector (the "one-set" principle), with a large commercial ("city") bank, general trading company, and heavy industry firm at the core, their raison d'etre is less the exchange of products or technologies (although this happens) than the formation of stable and mutually-supportive capital and governance linkages (Aoki, 1992; Lincoln, Gerlach, Takahashi, 1992). Some scholars see them as functional counterparts to the highly diversified and divisionalized American corporation, operating as an "internal capital market" to allocate financial resources among member firms (Chandler, 1982; Goto, 1982). An early school of thought cast such groups as "monopolists' clubs" colluding on prices and extracting profit-maximizing rents in their joint transactions with outsiders (Caves and Uekusa). The evidence for such profit-maximing rents, however, has generally been elusive (Nakatani, 1984; Lincoln, Gerlach, and Ahmadjian, 1996). In the heyday of Japanese global economic expansion—the 1980's-- a widely-held view was that the horizontal groupings economized on agency and transaction costs by providing better monitoring of incumbent management than was possible under the system of dispersed shareownership that existed in the United States.

A principal consequence of both types of *keiretsu* networks for the fortunes of member firms is protection against takeover and the sharing of risks (e.g., the "convoy" system) to enable member firms to weather times of business adversity. There is evidence, for instance, that affiliation with a *keiretsu* smoothes earnings and sales over time and accelerates the speed of recovery for firms in financial distress, thanks to restructurings of payments of loans to main banks, of supply to customers, of deliveries by suppliers, and so on (Hoshi, Scharfstein, and Kashyap, 1992; Nakatani, 1984; Lincoln, Gerlach, and Ahmadjian, 1996).

Because these horizontal intermarket networks comprise mostly large, integrated corporations, firms from a single industry having the same *keiretsu* membership are somewhat less likely to be complementary in terms of supply chain transactions than is true of the vertical *keiretsu*. Since many strategic alliances involve extensions to or consolidations of supply and distribution channels, we should expect them to be drawn more from the vertical groups than from the horizontal groups. Conversely, the large engineering and R&D staffs of horizontal group companies, as the Sumitomo example cited by Rtischev and Cole suggests, may equip them for alliances aimed at developing or applying new technologies. (Kester, 1989).

While the clustering of Japanese firms within stable cooperative networks may, as we have argued, be efficient for the diffusion of innovations and technologies *within keiretsu* networks, it has posed obstacles to the transmission of knowledge across the boundaries of such groups (Nishiguchi,

1994). Research on R&D consortia, for example, has revealed that firms are often reluctant to cooperate with members of other *keiretsu*. MITI (Ministry of International Trade and Industry) was forced to create two distinct research laboratories in the 1970s in order to encourage firms to join the VLS (Very Large Scale Integrators) project (Fransman, 1975; Sakakibara, 1992). MITI also had difficulty persuading Japanese electronics firms to collaborate in the Fifth Generation Computer Projects in the 1980s (Guillot, Mowery, Spencer, 2000).

By most accounts, the *keiretsu* structuring of transactions in a variety of industries contributed importantly to the growth of the Japanese economy after WWII (Aoki, Caves and Uekusa; Roehl). Mutually supportive banking and trading relationships, backed up by the guidance and assistance of government ministries, enabled the rapid expansion of the Japanese economy from the 1950's into the 1970's. In the 80's, the highly cooperative relations between manufacturers and *keiretsu*-linked suppliers were heralded as a key ingredient in the improvements of Japanese manufacturing productivity and quality in critical export sectors such as autos, electronics, and machine tools. Thus, a persuasive argument can be made that *keiretsu* alignments played an instrumental role in the Japanese economic expansion over the last 50 years, a period in which Japan's dominant global competitive strategy was playing catch-up to the West.

The situation today, of course, is very different. Due to weak domestic demand, price deflation, overcapacity, a depressed stock market, and a wave of downsizing and restructuring in key industries, Japanese firms are less able than in the past to rely on internal resources in developing new capabilities. Moreover, the liberal financing and other forms of assistance from Japanese banks that once enabled industrial corporations to invest heavily in R&D and plant and equipment has been sharply scaled down, as financial institutions have yet to recover from the economic crisis of the mid-90s and are still struggling under huge bad debt loads. The depressed stock market offers no alternative source of investment capital. (On the other hand, because of deregulation in the 1980's, direct corporate bond issues are a much more important source of capital than in the past). On the technological side, the emergence of the internet and e-business has jeopardized the leadership position that Japanese high-tech industries built up over the 70s and 80s. Now that many Japanese firms are themselves positioned on the leading edge of new technologies and no longer have the option of following the West, they must deal with a much more stringent and uncertain environment than they have experienced at any time in the postwar period.

Such high economic and technological uncertainty is not unique in Japanese economic history. The post-bubble restructuring of the Japanese economy can be compared with the periods of great change following the Meiji restoration in the late 1900-century and the post-WWII years. Large-scale alliances

among corporations, financial institutions, and government agencies served in both periods to get the country through difficult times (Gerlach, 1992). One of the more entrenched business traditions in Japan is to turn in time of trouble to trusted partners whom a company knows and with whom it has collaborated successfully in the past.

Because the uncertain economic environment that has persisted since the early 1990s forces firms to rely on alliances rather than on internal divisions and resources to manage the production and distribution of new products, and because major discontinuities in the evolution of strategic technologies pressures companies to collaborate in sharing the costs and risks of new research and development projects, we can hypothesize that Japanese electronics firms will tend to form strategic alliances with an established set of partners whom they know and trust. Thus, our prediction is that companies from the same horizontal or vertical *keiretsu* will be the most likely to enter into strategic alliances.

> *Hypothesis 1 (H1): Two Japanese firms are more likely to form a strategic alliance if they are in the same vertical keiretsu than if they are in different ones, or if one is in a vertical keiretsu and the other is not, or if both are independent from vertical keiretsu.*

We make a similar argument for firms that share membership in the same horizontal *keiretsu*. In part because of their loose organization and their broad diversification across industry sectors, the horizontal *keiretsu* are not based on the same kind of functional economic logic that underlies the vertical groups. For that reason, they would seem to offer fewer information and other resource advantages for launching industry-based strategic alliances. Still, in terms of our arguments that a shared business culture and experience-tested relationships are important to the formation and survival of a new strategic venture, the horizontal groups, too, may be fertile soil for the cultivation of new partnerships. Also like the vertical *keiretsu*, the large horizontal groups linked member firms to one another through a number of channels of communication, e.g., the exchange of directors, reliance on the same financial institutions, Presidents' Council (Shacho-kai) meetings, etc. These may serve to diffuse information about other companies' technological and organizational capabilities. Moreover, the bailouts and restructurings for which the horizontal *keiretsu* are renowned may take the form of strategic alliances through which the rescuing firms might transmit their expertise to the bailout target.

> *Hypothesis 2 (H2): Two firms are more likely to form a strategic alliance if they are in the same horizontal keiretsu than if they are in different ones, or if one is in a horizontal keiretsu and the other is not, or if both are independent from horizontal keiretsu.*

TYPES OF STRATEGIC ALLIANCE:

BUILDING ON EXISTING KNOWLEDGE OR CREATING NEW KNOWLEDGE

The choice of a partner for a strategic alliance will vary with the type of resource a firm targets. Because established networks of organizations are based on previous rounds of resource exchange (Gulati and Gargiulo, 1999), firms within the network are likely to have considerable information about the assets, invisible or not, that might be leveraged in a new venture. For example, two firms that have previously cooperated in the distribution of a product have a shared pool of experience and learning to draw on. They may have also devised a set of routines for working with another that does not have to be built from scratch. Should one of these two firms later develop a product and contract to an agent to handle its distribution, it would make sense to choose the former partner because of the precedents in trust, familiarity, and cooperation established between the two.

On the other hand, there are strategic alliances that firms pursue in order to acquire resources that deviate substantially, not only from their own knowledge base and skill set, but also from those available within their *keiretsu* networks. For example, because the vertical *keiretsu* are largely, if not exclusively, organized in a vertical division of labor, which requires tight coordination and communication, each firm is likely to have good information on the capabilities of others, such as who can be counted on to improve process or product technology at a given cost and within a fixed span of time. Such information, which only incrementally exceeds every other firm's extant knowledge base, can be readily digested and quickly acted upon. Thus, selecting a partner from the same vertical *keiretsu* may speed up the processes of search and agreement upon a division of responsibility and a set of productive routines. However, in a period marked by significant discontinuity in the technological cycle (Anderson and Tushman, 1990), as is true of the electronics industry presently, firms might be better advised to tie up with a new and untested set of partners for alliances designed to produce altogether new knowledge, as contrasted with alliances designed to build incrementally on an existing knowledge pool.

We therefore consider the possibility that rational firms will go outside established *keiretsu* networks in search of alliance partners when the purpose of the new venture is the development of research and development—the creation of new technology. If they do not, we are reminded of Ritschev and Cole's concern: that Japanese manufacturing firms are perhaps too averse to new ways of organizing to take the kind of aggressive commercial advantage of new technological opportunities that the Japanese economy presently needs. For these reasons, we hypothesize that new R&D strategic alliance partners are less likely to be found within vertical *keiretsu* than is true of other kinds of alliances.

Hypothesis 3 (H3): As contrasted with other alliances, common vertical keiretsu membership will have no effect or even a negative effect on the likelihood of that two firms will form an R&D alliance

Does the same general reasoning apply to the horizontal *keiretsu*? If the objective of the alliance is to combine resources to maximize the creation of new knowledge, the most rational strategy might be to include in the the pool of potential partners independent companies and even companies from competing horizontal groups. On the other hand, because the functional integration of companies in the horizontal groups is less than that of the vertical *keiretsu*, the cost of intra-group selection is likely to be less in this case. Moreover, there is still the point that the success of an alliance, even one that is R&D-based, is not only a function of the partners' complementarity capabilities but also depends on their ability to work effectively together. The chances of that may in some significant measure be increased when the two firms share a common heritage, thus some degree of common culture, by virtue of their membership in the same horizontal group.

Thus, we believe that R&D tie-ups of firms in the same horizontal *keiretsu* are not necessarily disadvantageous. Two firms in the same industry belonging to the same horizontal *keiretsu* are competitors who possess information about each other through various communication channels. They are also part of a mutually supportive community of organizations. Because they are both large end-product manufacturers, their businesses are not as intertwined with one another as would be true of firms in the same vertical *keiretsu*. They have pursued growth through internal expansion or through cooperation with vertical *keiretsu* partners. However, when the next stage of growth requires collaboration with new partners for achieving the discontinuous innovations that the changing business environment requires, a selection from within the same horizontal *keiretsu* might appear rational: sufficiently different to add more than merely incremental new knowledge but sufficiently familiar to allay concerns about "fit." Thus, we let H2 stand without qualification in the case of R&D alliances.

Finally, a history of prior strategic (as opposed to *keiretsu*) alliances and a central position in the the network of those alliances may provide a firm with a significant advantage as it pursues new strategic partnerships. However, in line with our view that vertical *keiretsu* partners are a bad choice for R&D partnerships, we predict that a history of strategic tie-ups or even "third party" ties beween a pair of firms will be less important for new R&D partnerships than it willl for other alliance types. "Organizational inertia"—the tendency to stick with the same partners and the same routines in venture after venture—cannot be a rational strategy when the aim is major and possibly discontinuous innovation. On the other hand, a firm's centrality in the overall network of prior alliances sends a reputational signal to the business community that it is a desirable and competent partner. Centrality comes from active past

participation in the alliance formation process. The concept also implies that the partners of such a firm are themselves actively involved in numerous other alliances. Centrality is thus a resource in its own right that firms can exploit to increase the pool of potential new partners. A firm that has its pick of partners from a large pool is well positioned to enter into a variety of highly innovative alliances.

Hypothesis 4a (H4a): Past alliances and third-party alliances between a pair of firms will have smaller positive effect on the likelihood that the pair will form a new R&D allliances as compared with other types of alliance.

Hypothesis 4b (H4b): The centrality of two firms in the extant network of strategic alliances has a smaller positive effect on the likelihood that the pair will form a new R&D alliance as compared with other types of alliance

DATA AND METHODS

We tested these hypotheses with a longitudinal data set on strategic alliances among Japanese electronics firms between 1992 and 1997. We collected data on a sample of 128 large publicly-held companies. The population from which we drew this sample was the entire set of Tokyo, Nagoya, and Osaka stock exchange-listed electronic industry. In 1992, there were 164 firms in this population. In 1997, due to new listings, there were 178. Our sample of 128 firms includes every such company that had entered into at least one alliance, be it domestic or international, over the 11-year period.

This study examined the factors that affect the likelihood that a pair of firms—a dyad-- will enter an alliance in a given year. The unit of observation was therefore the dyad-year. The information on alliances between these firms was coded from press reports published in the five largest economic/industrial Japanese newspapers over an 11 year-period from 1987 to 1997 (Japanese Economic Newspaper, Japanese Industrial Newspaper, Daily Industrial Newspaper, Japanese Economy and Industry Newspaper, Japanese Distribution Newspaper). Table 1 presents three examples of strategic alliances.

<Table 1: about here>

The data pertaining to *keiretsu* affiliation was coded from *Kigyo Keiretsu Soran*, an annual publication that records such relationships for Japanese organizations and provides information on the structure of each *keiretsu*. The financial data used in this analysis are derived primarily from the JDB (Japan Development Bank) Corporate Finance Data Bank, which records both the unconsolidated and consolidated accounting data of companies (excluding finance and insurance companies) currently listed on the first and second sections of the Tokyo, Osaka, and Nagoya Stock Exchanges. This data bank compiles data from the annual securities reports originally submitted to the Ministry of Finance by the companies covered by the data bank.

The data were used to construct an event history for each year studied (1992-97). The data structure is therefore a cross-sectional time-series panel in which the units are unique dyads. For each year, the dyad data are configured as follows: C1,C2; C1,C3;....; C1,CN; C2,C3; C2,C4;...C2,CN;...CN-1, CN, where C1 = firm 1, C2 = firm2, .., CN = firm N. Thus, for every year there are N(N-1)/2 = 8,192 dyads or 48,768 year-dyads across all years (N=48,768 i.e. ([128*127]/2)*6). We used a random effects probit to model the probability that an alliance would be reported for a pair of firms in any year. To include every firm (or dyad in our case) that is "at risk" of entering an alliance is necessary in order to produce unbiased results.

Variables

The dependent variable in this study is a dichotomous variable coded 1 if a given pair of firms entered into an alliance in a given year, 0 otherwise. Each dyad-year record included various attributes of both firms in the dyad, as well as a number of social structural measures based on cumulative alliance activity and on whether each firm belonged to a *keiretsu* group.

The alliances were also divided into two distinct groups in order to be able to test the hypotheses about the effect of the type of alliance on the choice of a partner. Those involving the joint development of a new product or a new technology were coded as R&D alliances. The remaining alliances were generally cases of collaboration in production, distribution, marketing, or supply of a new product or technology.

We measured *keiretsu* membership as follows using the classification provided by *Kigyo Keiretsu Soran*. Firms with a seat on the Presidents' Council (Shacho-kai) of one of the big-six intermarket groups (Mitsui, Mitsubishi, Sumitomo, Sanwa, Fuyo, Dai-Ichi Kangyo) were coded as belonging to a horizontal *keiretsu*. Shacho-kai membership is the most definitive measure of whether a firm is or is not in a horizontal group. It is, however, a conservative measure, since many noncouncil firms have close dealings with the group (e.g., Mazda and the Sumitomo group). Because our unit of analysis is the dyad or pair, we created four dummy variables to tap horizontal *keiretsu* affiliation. "Same horizontal *keiretsu*" was coded "1" when both firms in the dyad were in the same Presidents' Council. "Different horizontal *keiretsu*" was coded "1" when the firms were in different Presidents' Councils. "Both non horizontal *keiretsu*" was coded "1" when the two firms in the pair were independent (noncouncil) firms; and "horizontal *keiretsu* and independent" was coded "1" when one firm was a council member but the other was not.

Similarly, we coded four variables to measure the affiliation of each firm with a vertical *keiretsu* in the electrical machinery and electronics industry. The following 11 vertical networks were considered because at least one of the 128 firms in the sample was a member: Hitachi, Toshiba, NEC, Fujitsu, Sony,

Matsushita, Oki Electric, Mitsubishi Electric, Kobe Heavy Industry, Sumitomo Electric, Yaskawa Electric. "Same vertical *keiretsu*" was coded as 1 when both firms were in the same vertical *keiretsu*. "Different vertical *keiretsu*" was coded 1 when firms were in different vertical *keiretsu*. "Both non vertical *keiretsu*" was coded 1 when the two firms in the dyad were independent firms, i.e. not a member of any of the 11 vertical industrial networks, and "vertical *keiretsu* and independent" was coded 1 when one firm was a member and the other was not.

To produce measures of a firm's position in the network of past alliances, we first constructed for each year an adjacency matrix (an NxN binary matrix) describing all alliance activity among the 128 firms in our panel through the year prior to the current year. We used UCINET IV to compute various network statistics from the raw adjacency matrices. The number of prior strategic alliances between 2 firms is the variable labeled "prior tie". "Common tie" was coded 1 if the 2 firms in the pair (AB) had a common third partner (C); i.e., AC is an alliance and BC is an alliance. To measure joint centrality, we used the mean of the two firms' scores in each year on the Bonacich (1987) eigenvector measure of centrality in the network of past alliances. The larger this score, the more the two firms occupied a central role in the network. We also computed the ratio of the smaller to the larger of the two centrality measures to capture the similarity in centrality in the dyad (Gulati and Gargiulo, 1999).

Strategic interdependence between any given pair of firms might also be an important element leading to the creation of a tie (Nohria and Garcia-Pont, 1991). Following previous research on strategic alliance formations, we used a sub-industry classification to identify potential interdependence or similarity in the resource base of every firm (Gulati and Gargiulo, 1999). We identified 5 sub-segments in the Japanese electronics industry (Electric Industrial Apparatus, Electronic Equipment, Communication Equipment, Household electronic Equipment, Miscellaneous Electric Equipment). We created a measure called "interdependence" that was coded 1 when the 2 firms in the dyad were in different sub-segment of the industry, 0 otherwise.

To control for unobserved temporal factors that might influence alliance creation, we included 6 dummy variables, one for each year in our panel. We also controlled for unobserved firm-level factors by entering in the regression the cumulative number of past alliances entered by each partner to the dyad over the previous 5 years.

Finally, we included the following indicators of the financial composition and performance of each organization in the pair in each year. Size was measured as total sales. Performance was measured with the return-on-asset ratio. Liquidity was calculated using the "quick ratio" defined as current assets minus inventory, divided by current liabilities (Gulati and Gargiulo, 1999, Dooley, 1969). Solvency was measured as the ratio of long-term debt to current assets.

RESULTS

Table 2 and 3 presents respectively the descriptive statistics and first-order correlations among the variables we consider.

<Table 2: about here>

<Table 3: about here>

We use a distinctive modeling strategy to get at the effects of firm-level variables such as sales volume or financial standing (Lincoln, 1984; Lincoln, Gerlach, and Takahashi, 1992). We enter in the regression the variable for Ci , the first firm of the pair, the same variable for Cj, the second firm in the pair, and Ci*Cj, the product of the two. The first two terms capture the "main effects" whereas the third term captures the interaction effect. This is an important distinction in a dyad analysis, albeit one that is often ignored. The main effects measure the role of e.g., size in determining the general propensities of firms to pursue alliances. The interaction effect taps the degree to which the particular *combination* of attributes of Ci and Cj makes a unique contribution to the likelihood of an alliance above and beyond the main effects. Difference or ratio scores computed on some attribute of the two parties to the dyad confound main and interaction effects and therefore obscure the causal mechanisms at work.

Another troublesome issue in dyad analysis in the problem of statistical nonindependence of observations due to the repetition of the same firms across different dyads (Lincoln, 1984). The problem is exactly analogous to the familiar case of panel data where repetition of units over time periods and time periods over units constitutes an unmeasured source of similarity in the data. The consequence in both cases is the same: standard errors are underestimated and t-statistics are therefore overestimated. As we have panel data on dyads, we encounter all three kinds of nonindependence in the same analysis. We deal with the problem as follows. We use a random effects probit model that specifies and measures separate error components for unit and for time, thus adjusting standard error estimates upward. In addition, we use the robust standard error option available in *Stata 6* to adjust dyads for clustering on firm. These combined procedures give us reasonable confidence in our hypothesis tests and significance levels. *Stata*, unfortunately, does not offer a routine that enables us to simultaneously adjust for the time and cross-section effects in the panel data *and* the clustering of dyads due to common firms. Thus, we had to do these analyses sequentially. The results were very similar, however, so we are inclined to conclude that the significance levels reported in our tables of regressions are not strongly biased.

The probit estimates from the random-effect statistical models are presented in table 4 and 5. Models in table 4 were run using all the alliances as the dependent variable. Model 1 is the base model. Model 2 introduces the measures of vertical *keiretsu* affiliation. Model 3 adds the measures of horizontal *keiretsu* affiliation. And Model 4 combines all terms in a complete regression equation. For the last three models, the variable "different vertical *keiretsu*" and "different horizontal *keiretsu*" serve as base categories.

<Table 4: about here>

As predicted by Hypothesis 1, firms in the same vertical *keiretsu* are more likely to form an alliance than are firms in different *keiretsu* or pairs of firms in which one or both companies have no *keiretsu* affiliation. All three dummy variables representing alternatives to the baseline category of "same vertical *keiretsu*" have negative coefficients that are significant at high levels of confidence.

The effects of the dummies representing the horizontal *keiretsu* affiliations of the dyad are also negative and significant in two out of three cases. However, the pattern here is notably different from that of the vertical *keiretsu*. The effects of the vertical *keiretsu* categories make it clear that two firms in the *same* vertical *keiretsu* are more likely to form an alliance than is true of *all three* alternatives: (1) different *keiretsu*; (2) one *keiretsu*, one independent; (3) both independent. This is a genuine "homophily" effect, as it is referred to in network theory: relationships are most probable between actors who share a common attribute; i.e., affiliation with the same *keiretsu* group. But in the case of the horizontal *keiretsu*, we detect no difference between the baseline excluded category (same horizontal group) and the first dummy—different horizontal groups. The next type of pair—one firm a group member, the other not—is less likely to form an alliance; and the final type—both independent—is least likely to produce an alliance. In network theory terms, this is a *centrality* pattern, not a *homophily* pattern. It indicates that the population of companies belonging to the big-six horizontal groups have a high propensity to join alliances. They are most likely to partner with other big-six companies, but that is only because big-six firms form alliances at higher rates-- *it does not matter whether the partner is from the same group or a different group*. A partnership between a big-six firm and an independent is less likely—and between two independents least likely—because independents as a population are less active in alliances.

As in Gulati's (1999) studies of alliance formation, we find positive and significant effects of prior ties and third party ties on alliance formation. However, the joint centrality and centrality ratio effects are nonsignificant. Thus, the history of alliances *of the particular pair* is an important predictor of the likelihood that the same pair will form a new alliance, but each *firm's* own centrality in the network

of extant alliances is not relevant. Thus, contrary to our reasoning, it appears that centrality is not a generalized resource making a firm more desirable as an alliance partner. Two firms may occupy central positions in the alliance network "space," yet be no more prone to allying with one another than if they were both on the periphery, or one was central and the other was not. However, we should not over interpret the centrality results to this point, for the picture changes in the analysis of R&D alliances to which we turn next.

As our hypotheses predicted, the results are transformed when we confine our attention to the subset of alliance events that have an R&D focus (Table 5). First, we note that

<Table5: about here>

Hypothesis 3 is confirmed: the vertical *keiretsu* effects vanish totally. The horizontal *keiretsu* effects (the "centrality" pattern) are approximately the same as they were.

As Hypotheses 4a and 4b proposed, prior ties, be they direct or indirect, no longer condition the likelihood of alliance formation. On the other hand, the contribution of the centrality measures to the likelihood of R&D alliances becomes positive and highly significant. Firms that are central in the extant network of alliances are more likely to tie up with firms that are similarly centrally positioned. In network theory terms, this evidence suggests that "structural equivalence" (two firms occupy a common structural position in the network) counts more than "connectivity" (two firms are directly or indirectly linked to each other) in explaining new alliances that have an R&D focus. This finding is consistent with prior research on the relative roles of structural equivalence and connectivity in the diffusion of technological innovations (Burt, 1992b).

The pattern displayed by the strategic interdependence variable is surprising. Its effect is negative in all models. In other words, firms in different sub-segments of the electronic industry are less likely to form a strategic alliance than is true of firms in the same sub-segment. It would appear that the alliances on which we have data are highly specific to a fairly narrow set of industry categories. There may well be interdependence effects of the sort we hypothesize, but the industry classification we use here is too coarse to capture them. The results we obtain point to a kind of "industry homophily": alliances are more probable within rather than across industry sub-segments.

DISCUSSION

The process whereby Japanese electronics firms in the 1990s choose alliance partners differs with the purpose of the alliance. For activities that build on existing pools of knowledge, firms rely on partners affiliated with the same vertical *keiretsu* clusters and with whom they had prior direct or indirect alliances. This is a pattern that is generally consistent with other strategic alliance research (Kogut, 1989;

Gulati, 1995; Gulati and Gargiulo, 1999) and on the network character of Japanese corporate organization and strategy (Gerlach, 1992; Nishiguchi, 1996). Faced with a very critical period of uncertainty following the collapse of the bubble economy and the emergence of radically different technologies (I.T. and the internet), Japanese firms seem to be acting in much the way they have done in the previous periods of economic turmoil and restructuring. That is, they turn to close and trusted partners and forge stronger ties within their existing *keiretsu* networks.

Yet for R&D activities that rely less on an installed knowledge base but instead demand a significant shift in organizational routines and technologies, Japanese electronics firms look for partners, not only within, but also across and outside vertical *keiretsu* boundaries. The reputation and status associated with membership in a big-six *keiretsu* grouping, however, makes such firms attractive partners whether the alliance has an R& D focus or not.

What lessons can we take from these findings about networks and alliances in a knowledge-intensive industry in Japan? The most general is that the established *keiretsu* networks, both vertical and horizontal, figure importantly in the formation of new strategic alliances by Japanese electronics firms. This pattern is consistent with a good deal of network theory. Such theory holds that networks provide channels through which flow information and other resources essential to the creation of new business. Access to and skill in navigating networks endows a firm with "social capital," increasing its ability to launch strategic ventures and to make them succeed. Finally, it is generally in the nature of networks that their members become bound to one another to some degree in trust, commitment, and shared culture, all of which work to smooth the process of strategic collaboration.

However, when Japanese electronics firms aim at serious technological innovation, the picture changes. Quick access to information about others and ease at combining forces and meshing organizational routines become less salient than finding a partner whose capabilities genuinely complement one's own. This is the familiar "strong tie/weak tie" conundrum of network theory. Strong ties, such as those comprising vertical keiretsu networks, are easily accessed and mobilized, but they connect firms to others who are rather similar to themselves. Weak ties, by contrast, are harder to access and exploit, this being both cause and consequence of the fact that they connect a highly diverse set of actors. When the new venture contemplated is an enterprise requiring tight top-to-bottom coupling of two organizations' core processes, it makes sense to take advantage of strong ties. But when the goal is real innovation, ease of integration takes a back seat to complementarity and synergy—the risk that the marriage may be rocky pales against the risk that nothing new or interesting will come of it.

However, our evidence on the effects of horizontal keiretsu affiliation suggests a second logic whereby keiretsu may have significance for strategic alliance formation in Japanese electronics. Being in the same big-six horizontal group contributes nothing to the probability that two firms will forge an alliance: there is essentially no difference in this probability between the cases of: (1) the two firms are in the same group; (2) the two firms are in different groups. But it is clear from our evidence that group firms are more likely than independents to participate in alliances, whether or not they involve other group firms. We referred to this as a centrality effect and contrasted it with the homophily effect that common vertical keiretsu membership has on non-R&D alliances. Unlike the latter, this centrality effect of horizontal group membership is apparent both in regard to R&D and nonR&D alliances. Strong ties between a pair of firms of the vertical keiretsu sort are perceived by Japanese electronics firms to be no particular asset in picking R&D alliance partners. But if the two firms are both centrally positioned in the network, it means that each has maximum access to the resources of the population as whole, and it sends a signal that the population regards the firm as a desirable alliance partner.

We also see our research having some implications for the question of whether and how rapidly *keiretsu* networks in the Japanese economy are dissolving. Articles in the Japanese and Western business press proclaiming the "death of *keiretsu*" appear almost daily. Our and similar evidence shows that Japanese firms tend to leverage *keiretsu* allegiances in crafting new network structures that are more strategically oriented than is generallty true of the *keiretsu* themselves (Lincoln, Ahmadjian, and Mason, 1998). It also shows, however, that when the purpose of the new alliance is the creation of new knowledge through technological innovation, as opposed to pooling existing knowledge in a somewhat different way, Japanese firms do not hesitate to abandon *keiretsu* commitments and link up with new partners, even if such tie-ups span the boundaries of historically competing *keiretsu* groups. Another question worth of subsequent research is whether the alliances crafted with non-*keiretsu* (not to mention nonJapanese) partners will survive and multiply once Japan emerges from its sustained period of economic stagnation or whether, with the pressure in a sense off, old ways and familiar partners will find favor once again.

Extensions on this research will be as follows. We will do similar analyses of the entire population of Japanese firms in the electronics industry in order to assess the generality of the results obtained here. Second, we will proceed to consider inter-industry alliances. It is rather artificial to confine the scope of our study to partnerships between firms within a single industry such as electronics. In such a major and strategic industry, many of the alliances in which electronics makers participate cut across industry boundaries. With the convergence and integration of technologies in different industrial sectors, these inter-industry strategic alliances are increasing rapidly and are of great interest. However,

researching them with the methodology used here faces some significant obstacles. As our own analysis shows, a relatively small population of firms corresponds to a very large population of potential relationships between those firms, creating some rather substantial challenges in measurement and analysis.

CONCLUSIONS

The research literatures on strategic alliance and on *keiretsu* networks in Japan overlap in topic and methodology at a number of junctures, yet thus far have not spoken to each other in a very significant way. On the one hand, strategic alliance research has demonstrated the importance of the structural position of an organization in a network of interfirm ties in determining choice of alliance partner and the alliance formation process (e.g. Gulati, 1995; Gulati and Gargiulo, 1999). On the other hand, students of Japanese economic organization have often described the organization of the Japanese economy in terms of close partnerships and networks of firms (Gerlach, 1992) and have sought to understand how such embeddedness in networks impacts the behavior and performance of firms (Hoshi et al; Nakatani, 1984); Lincoln, Gerlach, Takahashi, 1992; Lincoln et al., 1996). To the extent of our knowledge, no quantitative study has directly focused on the effects of *keiretsu* affiliations on the strategic alliance formation process and how the partners select one another. In this study, we have attempted to shed some light on the issue.

Our argument is that trust, familiarity, and experience in the meshing of organizational routines created by common *keiretsu* membership makes complementary assets more transparent to the parties and reduces the transaction costs and risks of strategic partnering. Our results provide general support for this hypothesis with some important qualifications. First, it does not apply to the case of horizontal *keiretsu* groups. We do find some evidence that horizontal group firms are more central—more involved-- than other electronics firms in strategic alliance networks. But there is no evidence that strategic partnerships are more likely to be formed *within* horizontal group boundaries than *across* them. By contrast, Japanese firms do favor the selection of strategic partners from the same vertical *keiretsu* for a variety of ventures. In this case, alliances that cross *keiretsu* lines are significantly less likely. However, this tendency to select partners from the same group disappears when the alliance has an R&D focus. This would seem to be a rational and judicious policy on the part of Japanese firms pursuing alliances. Partnerships formed to create new technology or new commercial applications of technology require "organizational discontinuities:" a willingness to abandon old allegiances and old organizational forms for new models, despite some the initial costs and risks involved in getting to know a different kind of partner.

Japanese companies, of course, have accumulated considerable experience and expertise in recent years in their partnerships with foreign firms, where no *keiretsu*-based barriers or advantages exist. Clearly, the ability to ally or network effectively with relatively unknown partners whose style of business is very different from one's own is a skill that can be learned (Ahmadjian and Lincoln, 2001). If Japanese companies are indeed careful to discriminate between alliances that benefit from renewing old

partnerships and alliances that are best enacted with new ones, it is to their credit and bodes well for the Japanese economy's ability to implement some necessary organizational discontinuities and thus bridge to a future that in some ways is configured rather differently from the past. We caution, however, that our results are preliminary, and further investigation of these data and issues is certainly called for.

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TABLE 1
Examples of alliances

Type of strategic alliance	Example
R&D	"Oki Electric and Sony announced on Dec. 7 that they have agreed to collaborate on the development of new technologies for the production of 256 mb DRAM. The two firms will invest about 100 billion yen.[…]" (Nihon Kogyo Shinbun – Dec. 8, 1995)
Production/OEM	"Sharp announced on April 15 that its new cellular phone to be commercialize will be manufactured by Nihon Musen Co. […]" (Nihon Kogyo Shinbun – April 16, 1995)
Joint-Venture	"Matsushita Denshi and Matsushita Electric Industrial announced on Nov. 30 that they will establish this month a Joint-Venture to produce nickel and nickel-cadmium batteries. The total investment will be $2 billion, 60% from Matsushita Denshi, 40% from Matsushita Electric Industrial […]" (Nihon Kogyo Shinbun – December 1, 1994)

TABLE 2
Descriptive Statistics

Variable	Mean	Std Dev.	Min.	Max.
1 Alliance	.005	.071	0	1
2 Same vertical *keiretsu*	.018	.133	0	1
3 Different vertical *keiretsu*	.145	.352	0	1
4 Vertical *keiretsu* and Independent	.486	.500	0	1
5 Both non vertical *keiretsu*	.351	.477	0	1
6 Horizontal *keiretsu*	.003	.053	0	1
7 Different horizontal *keiretsu*	.008	.091	0	1
8 Horizontal *keiretsu* and independent	.196	.397	0	1
9 Both non horizontal *keiretsu*	.792	.406	0	1
10 Strategic interdependence	.766	.423	0	1
11 Prior tie	.031	.347	0	15
12 Common tie	.044	.204	0	1
13 Joint centrality	.001	.011	0	.299
14 Centrality ratio	.003	.046	0	.977
15 Sales 1	320,427	761,245	2335	4,994,719
16 Sales 2	263,387	732,246	2335	4,994,719
17 ROA 1	.025	.039	-.254	.181
18 ROA 2	.025	.039	-.254	.181
19 Liquidity 1	1.844	1.478	.236	16.54
20 Liquidity 2	2.108	1.933	.236	16.54
21 Solvency 1	.077	.108	0	.84
22 Solvency 2	.062	.101	0	.84
23 Year	94.5	1.71	92	97
24 Density	.015	.005	.01	.02
25 Alliance history 1	1.76	4.593	0	31
26 Alliance history 2	1.35	3.711	0	31

TABLE 3
Correlation matrix

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1 Alliance	-											
2 Same vertical *keiretsu*	.079	-										
3 Different vertical *keiretsu*	.003	-.056	-									
4 Vertical *keiretsu* and independent	-.003	-.131	-.401	-								
5 Both non vertical *keiretsu*	-.021	-.099	-.303	-.715	-							
6 Same Horizontal *keiretsu*	.009	-.007	-.015	-.015	.028	-						
7 Different horizontal *keiretsu*	.161	-.012	-.019	-.003	.02	-.005	-					
8 Horizontal *keiretsu* and independent	.045	-.023	-.052	-.02	.065	-.026	-.045	-				
9 Both non horizontal *keiretsu*	-.094	.026	.057	.022	-.072	-.104	-.179	-.97	-			
10 Strategic Interdependence	-.030	-.035	.05	.017	-.045	.002	.003	.036	-.037	-		
11 Prior tie	.39	.078	.013	-.003	-.028	.21	.235	.034	-.114	-.038	-	
12 Common tie	.045	.058	.062	.003	-.065	.04	.118	.169	-.198	-.01	-.016	-
13 Joint centrality	.024	.008	-.011	-.001	.007	-.006	.041	.043	-.051	-.006	.033	.11
14 Centrality ratio	.005	.012	-.012	.002	.004	-.004	.016	-.002	-.001	-.008	.022	.04
15 Sales 1	.156	.015	-.027	.018	-.044	.085	.159	.382	-.421	.03	.204	.213
16 Sales 2	.163	.021	.049	.011	-.054	.063	.105	.236	-.263	.024	.229	.186
17 ROA 1	-.02	-.003	-.014	-.006	.017	-.018	-.019	-.043	.049	-.021	-.001	-.031
18 ROA 2	-.011	.014	-.026	-.006	.021	.006	.004	.005	-.007	-.023	.006	.014
19 Liquidity 1	-.029	.027	-.065	-.026	.068	-.022	-.041	-.085	.096	-.02	-.035	-.045
20 Liquidity 2	-.02	-.017	-.064	-.017	.07	-.008	-.013	-.04	.043	.02	-.017	.02
21 Solvency 1	-.019	-.05	-.059	-.022	.081	.014	-.016	-.059	.064	-.019	-.025	-.036
22 Solvency 2	-.03	-.014	.013	-.002	-.003	-.026	-.003	-.072	.081	-.023	-.031	-.06
23 Year	-.014	.00	.00	.00	.00	.00	.00	.00	.00	.00	.038	.091
24 Density	-.027	.00	.00	.00	.00	.00	.00	.00	.00	.00	.037	.085
25 Alliance history 1	.144	.02	.062	.089	-.081	.106	.148	.376	-.415	.044	.23	.242
26 Alliance history 2	.14	.017	.052	.012	-.055	.082	.098	.25	-.278	.044	.261	.227

	13	14	15	16	17	18	19	20	21	22	23	24	25
14 Centrality ratio	.376	-											
15 Sales 1	.049	.009	-										
16 Sales 2	.099	.014	-.006	-									
17 ROA 1	.026	.03	-.01	.009	-								
18 ROA 2	.001	.002	.003	.034	.034	-							
19 Liquidity 1	.019	.029	-.14	-.002	.199	-.005	-						
20 Liquidity 2	-.017	.001	-.004	-.107	-.026	.208	.003	-					
21 Solvency 1	-.042	-.042	-.116	.009	-.236	-027	-.234	-.001	-				
22 Solvency 2	-.009	.001	-.006	-.125	-.002	-.186	.008	-.26	.01	-			
23 Year	-.002	.013	.018	.01	.092	-.008	-.027	-.036	-.023	.001	-		
24 Density	-.003	.012	.016	.01	.13	.024	-.04	-.049	-.051	-.03	.878	-	
25 Alliance history 1	.043	.009	.889	-.003	-.06	-003	-.134	-083	-.094	.001	.081	.077	-
26 Alliance history 2	.111	.024	-.005	.876	.015	.013	-.002	-016	.008	-.127	.076	.066	.001

TABLE 4

Random-effects panel probit estimates° of the likelihood of alliance formation for each dyad of Japanese electronics firms for each year of the period 1992-97.

Variable	1	2	3	4
Constant	-16.53***	-14.94***	-16.95***	-15.43***
	(3.74)	(3.88)	(3.77)	(3.93)
Interdependence	-.45***	-.37***	-.49***	-.45***
	(.07)	(.07)	(.07)	(.08)
Prior tie	.25***	.22***	.23***	.18***
	(.04)	(.04)	(.04)	(.04)
Common tie	.41***	.39***	.36***	.29**
	(.09)	(.09)	(.09)	(.09)
Joint centrality	1.88	1.68	1.84	1.56
	(1.48)	(1.54)	(1.51)	(1.59)
Centrality Ratio	-.18	-.07	-.32	-.31
	(.79)	(.76)	(.84)	(.84)
Different vertical *keiretsu*	-	-1.15***	-	-1.16***
		(.14)		(.14)
Vertical *keiretsu* and independent	-	-1.04***	-	-1.19***
		(.11)		(.12)
Both non vertical *keiretsu*	-	-1.08***	-	-1.38***
		(.12)		(.14)
Different horizontal *keiretsu*	-	-	-.09	-.18
			(.22)	(.22)
Horizontal *keiretsu* and independent	-	-	-.41*	-.62**
			(.20)	(.20)
Both non horizontal *keiretsu*	-	-	-.67***	-1.08***
			(.21)	(.22)
Sales 1	2.34 e^{-07}***	2.12 e^{-07}***	2.05 e^{-07}***	1.90 e^{-07}***
	(4.53 e^{-08})	(4.77 e^{-08})	(4.67 e^{-08})	(4.95 e^{-08})
Sales 2	2.85 e^{-07}***	2.69 e^{-07}***	2.86 e^{-07}***	2.67 e^{-07}***
	(4.77 e-^{08})	(5.01 e^{-08})	(4.84 e^{-08})	(5.15 e^{-08})
Sales 1 x Sales 2	6.30 e^{-14}**	7.81e^{-14}***	6.31 e^{-14}**	8.12 e^{-14}***
	(2.02 e^{-14})	(2.08 e^{-14})	(2.06 e^{-14})	(2.13 e^{-14})
ROA 1	-1.85	-1.71	-2.03*	-2.17*
	(.98)	(1.01)	(1.01)	(1.10)
ROA 2	-1.74*	-2.11*	-1.83*	-2.41**
	(.81)	(.83)	(.84)	(.90)
ROA 1 x ROA 2	-9.77	-11.61	-10.74	-15.49
	(19.5)	(19.94)	(20.55)	(22.52)
Solvency 1	-1.77***	-1.46*	-1.92***	-1.66*
	(.56)	(.59)	(.59)	(.70)
Solvency 2	-2.87***	-2.01**	-2.97***	-2.99**
	(.78)	(.88)	(.82)	(1.03)
Solvency 1 x Solvency 2	5.86	2.20	6.64	1.06
	(5.68)	(9.01)	(5.89)	(12.44)
Liquidity 1	-.21***	-.30***	-.19***	-.25***
	(.06)	(.07)	(.06)	(.07)
Liquidity 2	-1.12***	-.15***	-.11***	-.13***
	(.03)	(.03)	(.03)	(.03)
Liquidity 1 x Liquidity 2	0.3***	.04***	.03***	.04***
	(.01)	(.01)	(.01)	(.01)
N	48768	48768	48768	48768
Chi square	372.85	417.42	381.31	413.98

° Standard errors in parentheses, * p<.05, ** p<.01, *** p<.001 (two-tailed test)

Base category is "Same vertical *keiretsu*" (models 2 and 4) and "Same horizontal *keiretsu*" (models 3 and 4). Also included in the models: a year dummy, total number of alliances of each partner, density of the network of past alliances.

TABLE 5

Random-effects panel probit estimates of the likelihood of R&D alliance formation for each dyad of Japanese electronics firms for each year of the period 1992-97.

Variable	1	2	3	4
Constant	-12.88***	-13.45***	-11.55**	-12.39**
	(4.04)	(4.18)	(4.08)	(4.25)
Interdependence	-.20	-.19	-.19	-.17
	(.12)	(.13)	(.13)	(.12)
Prior tie	.05	.06	-.02	-.03
	(.06)	(.06)	(.06)	(.06)
Common tie	-.22	-.22	-.17	-.14
	(.27)	(.25)	(.23)	(.24)
Joint centrality	7.12***	7.1***	7.13***	7.22***
	(1.64)	(1.67)	(1.73)	(1.7)
Centrality Ratio	1.52***	1.52***	1.50***	1.51***
	(.30)	(.30)	(.30)	(.3)
Different vertical *keiretsu*	-	.004	-	-.04
		(.57)		(.54)
Vertical *keiretsu* and independent	-	.25	-	.19
		(.53)		(.51)
Both non vertical *keiretsu*	-	.51	-	.45
		(.53)		(.51)
Different horizontal *keiretsu*	-	-	-.06	-.34
			(.48)	(.47)
Horizontal *keiretsu* and independent	-	-	-.95*	-.81*
			(.47)	(.46)
Both non horizontal *keiretsu*	-	-	-.82	-.59
			(.46)	(.47)
Sales 1	$9.69\ e^{-09}$	$-1.23\ e^{-08}$	$-5.01\ e^{-08}$	$-6.18\ e^{-08}$
	($1.12\ e^{-07}$)	($1.16\ e^{-07}$)	($1.26\ e^{-07}$)	($1.29\ e^{-07}$)
Sales 2	$2.18\ e^{-07}$**	$2.42\ e^{-07}$**	$2.03\ e^{-07}$*	$2.33\ e^{-07}$**
	($8.03\ e^{-08}$)	($8.31\ e^{-08}$)	($8.59\ e^{-08}$)	($8.86\ e^{-08}$)
Sales 1 x Sales 2	$1.12\ e^{-13}$**	$1.09\ e^{-13}$**	$1.07\ e^{-13}$*	$1.01\ e^{-13}$*
	($3.89\ e^{-14}$)	($3.93\ e^{-14}$)	($4.25\ e^{-14}$)	($4.26\ e^{-14}$)
ROA 1	9.58	.92	1.05	1.02
	(1.51)	(1.52)	(1.54)	(1.55)
ROA 2	1.04*	1.05	1.16	1.13
	(1.51)	(1.53)	(1.57)	(1.58)
ROA 1 x ROA 2	9.02	7.15	7.84	6.71
	(29.2)	(29.20)	(29.81)	(29.66)
Solvency 1	-.97	-1.50	-1.49	-1.55
	(.86)	(.83)	(1.01)	(.97)
Solvency 2	.91*	.87*	.91*	.86
	(.44)	(.44)	(.44)	(.44)
Solvency 1 x Solvency 2	6.67	-6.11	-5.92	-5.83
	(7.37)	(7.01)	(7.9)	(7.67)
Liquidity 1	.12	.006	.02	.01
	(.05)	(.05)	(.04)	(.05)
Liquidity 2	.003	-.003	.01	.002
	(.04)	(.05)	(.04)	(.05)
Liquidity 1 x Liquidity 2	0.01	.001*	-.001	-.001
	(.01)	(.02)	(.01)	(.01)
N	48768	48768	48768	48768
Chi square	100.56	102.55	105.5	113.68

° Standard errors in parentheses, * p<.05, ** p<.01, *** p<.001 (two-tailed test)

Base category is "Same vertical *keiretsu*" (models 2 and 4) and "Same horizontal *keiretsu*" (models 3 and 4). Also included in the models: a year dummy, total number of alliances of each partner, density of the network of past alliances.