

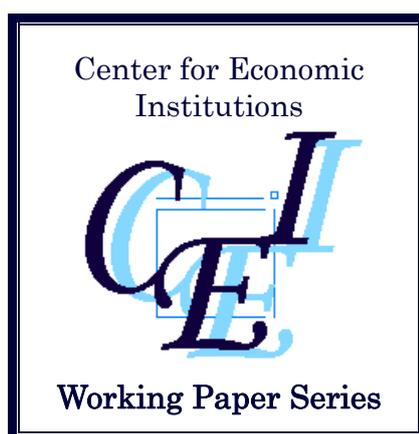
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*"Innovation and Change in the Process of
Alliance Formation in the Japanese
Electronics Industry"*

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James R. Lincoln



Institute of Economic Research
Hitotsubashi University
2-1 Naka, Kunitachi, Tokyo, 186-8603 JAPAN
Tel: +81-42-580-8405
Fax: +81-42-580-8333

**INNOVATION AND CHANGE IN THE PROCESS OF ALLIANCE FORMATION
IN THE JAPANESE ELECTRONICS INDUSTRY**

James R. Lincoln

Walter A. Haas School of Business

University of California, Berkeley

Berkeley, CA 94720

(lincoln@haas.berkeley.edu)

Didier Guillot

INSEAD

(guillot@haas.Berkeley.edu)

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ABSTRACT

This paper examines the changing process of strategic alliance formation in the Japanese electronics industry between 1985 and 1998. With data on 128 Japanese electronics/electrical machinery makers, we use a dyad panel regression methodology to address a series of hypotheses drawn from embeddedness and strong/weak tie theory on how *keiretsu* and prior alliance networks have constrained partner choice in new R&D and nonR&D alliances. We argue and find that the *keiretsu* effect is smaller on R&D than nonR&D alliances, and that this is truer of the “weaker-tie” horizontal *keiretsu* than the “stronger-tie” vertical *keiretsu*. Dividing our time series into four periods (1984-88, 89-90, 91-94, 95-98), however, reveals some important variations in the *keiretsu* role over time. The horizontal and vertical *keiretsu* effects on R&D alliances had vanished by 1991-94 (the post-bubble recession era), but they continued in the nonR&D case, in part, we believe, because these provided a means of reducing costs and capacity in a stringent macroeconomic environment. Following previous strategic alliance research, we further examine how the prior alliance network conditioned strategic alliance formation in Japanese electronics and how those patterns varied over time. The data suggest that, as the strategic alliance founding process became “disembedded” from Japan’s legacy *keiretsu* networks, it was driven increasingly by prior direct and indirect alliance ties.

INTRODUCTION

The causes and consequences of strategic alliance, defined as voluntary durable interfirm agreements for exchange, development, production, or distribution of products and technologies, have drawn wide scholarly attention. Why organizations enter into such collaborations and how they go about selecting partners remain important problems for research.

How *do* firms acquire information on partner prospects, and how do they go about negotiating with and committing to a particular one? How do they assess whether the resources and skills of others productively complement their own? And, finally, how do they build trust and navigate the risks and hazards to which cooperative strategic undertakings so often fall victim? Alliances regularly fail because these processes of search, selection, trust-building, resource-blending, and coordination are misunderstood and mismanaged. Moreover, a partnership that looks good today may be viewed quite differently tomorrow. Strategic alliances are fragile and often fleeting affairs. The qualities that incline two companies toward one another at t_1 may have dissipated by t_2 , rendering the tie-up useless to one or both.

The principal answer to these questions given by one important stream of research is that organizations pursue strategic alliance with those to whom they are or have been tied in other ways.¹ Most prominently featured in such studies is networks formed by prior alliance. In exploring new alliance opportunities, firms gravitate to past partners. Even when the firms themselves have no direct alliance tie, the new joint undertaking may be facilitated by the efforts of third parties in the alliance network to broker, underwrite, and monitor it. Beyond the web of past alliance ties, networks of board interlocking, CEO acquaintance, technological interdependence, and the like have been shown to be the templates on

¹ By contrast, strategic alliance research within the “resource-based view of the firm,” writes Gulati (1999), “presents organizations as “atomistic” actors engaging in strategic actions in an asocial context...” and there is “...limited consideration of the fact that the opportunity set a firm may perceive for strategic actions can be influenced in important ways by the social structural context in which it is placed.”

which new strategic partnerships are forged.

Such network “embeddedness” is argued to mitigate the contracting/partnering problems of opportunism, trust, and information impactedness (e.g., due to knowledge hoarding) that afflict strategic alliance processes and thereby function as facilitative governance structure. Yet in so channeling alliance activity-- confining the pool of strategic partner eligibles to the companies a firm knows and trusts (and its existing partners know and trust) --such networks thereby constrain it, perhaps severely, limiting choice and erecting barriers to alternative partnerships such that opportunities for new and creative combinations are foregone.

This paper addresses the structure and functioning of a set of deeply institutionalized interfirm networks that have constrained as well as facilitated strategic business partnering in Japanese industry-- the *keiretsu*. Over the postwar period, large numbers of Japanese companies have been enmeshed to varying degrees in these far-flung webs. The *keiretsu* question has drawn broad attention from scholars, policy makers, and business practitioners (Lincoln and Gerlach, 2004). A sizable interdisciplinary literature examines, at a macro level, the configuring of the *keiretsu* as a distinctive organizational form, and, at a micro one, the consequences of *keiretsu* alignment or nonalignment for the behavior and performance of individual firms (Lincoln, Gerlach, and Ahmadjian, 1996). The general role such networks play in channeling collaborative effort between and within Japanese companies also has been of interest. The vaunted flexibility and efficiency of procurement transactions in Japanese producer goods markets is routinely contrasted with the historically arms-length and adversarial flavor of Anglo-American supply chain practices (Helper and Sako, 1995). Further well-documented is the *keiretsu* role in absorbing the risks of member firms by, for example, sheltering them from takeover or shepherding them through spells of business adversity. It appears that firms in the same group vary less both over time and among themselves in earnings, sales, and stock prices. The group assists its members in distress by adjusting: loan repayments to banks, prices to customers, executive team composition, and the like (Hoshi, Kashyap, and Scharfstein, 1991a; Lincoln and Gerlach, 2004: Ch. 5; Nakatani, 1984; Pascale and

Rohlen, 1983). Evidence we later present suggests that intra-group alliances probably aimed at cost- and capacity-reduction appear to help member firms weather business cycle downturns.

Firms affiliated with the same *keiretsu* exhibit similarities in management style, problem-solving mode, operational process, strategic orientation, and, most generally, corporate culture. These may derive from shared history (the Mitsui group's origin as a 17th Century Edo-era merchant house) or common location (e.g., the concentration of the Toyota supply *keiretsu* in Aichi Prefecture or Sumitomo's centuries-old base in Osaka).² They may also stem from the leadership and culture of a core firm such as Mitsubishi Bank, Toyota, Hitachi, or Nippon Steel. In an interview we conducted at Matsushita Electric, executives took some pains to stress the absence at their company of a *keiretsu* supplier network of the Toyota or Nissan sort. Yet our discussions with Matsushita suppliers impressed us with the degree to which their managers drew inspiration and guidance from founder Konosuke Matsushita's charismatic vision and teachings (Guillot and Lincoln, 2005).

Are the *keiretsu* themselves strategic alliances such that our study becomes another in how past alliance networks configure future alliance ties? While researchers do at times refer to *keiretsu* as "alliances" (Ritshchev and Cole, 2003; Perrow, 1990), and Japan's network-ridden economy as a whole as "alliance capitalism" (Gerlach, 1992), the two forms differ in fundamental ways. Strategic alliances are best understood as tie-ups firms pursue out of rational calculations of payoff and advantage. They are easily abandoned, often abruptly, when the payoff stream runs dry and the strategic purpose is no longer served. The *keiretsu*, by contrast, may be cast as "strong tie" networks (in the sense of stability, homophily, multiplexity, reciprocity, and the like) in which many Japanese firms are deeply and, for the most part, inextricably embedded (Granovetter, 1985). Companies do not opt in or out of them at will, nor

² At an interview we conducted with a prominent Mitsui group company on March 29, 2001, high-level managers spoke of the attractions of *keiretsu* affiliation; specifically, how it ensured that companies of the same group could mesh their routines and styles in productive ways. Even in the 2000's, with many observers concluding that the *keiretsu* are dead, everything else being equal, these managers said, they preferred doing business with a member of the group.

with very few exceptions do the groups expel member firms whose performance is subpar or whose behavior is otherwise deemed problematic (Gerlach,1992). To the contrary, interventionism by the group to reverse the fortunes of a troubled or errant member-- by, for example, dispatching directors, hiking equity stakes, and extending credit—entangle the latter even deeper in the bramble of *keiretsu* ties.

The analysis we report below demonstrates strong *keiretsu* effects on Japanese firms' selection of strategic alliance partners, although the form and strength of those effects varies with the *keiretsu* type (vertical versus horizontal) and strategic alliance goal (R&D or not). We further show that the *keiretsu* constraint on the strategic alliance formation process—R&D-based in particular—has relaxed over time as Japan's economy evolved away from a tightly configured network regime to a fluidly structured, market-driven one.

CORPORATE NETWORKS AND STRATEGIC ALLIANCES IN JAPAN

The *keiretsu* effect: facilitation and constraint

Organizations join hands in strategic alliances in order to manage the acquisition of resources that they cannot generate on their own (Pfeffer and Salancik, 1978) or because efficiencies and synergies can be achieved by doing so (Williamson, 1996). The strategic alliance form is further an attractive option in enabling a degree of tacit knowledge-sharing and process-meshing that harder contract forms do not permit. As Mowery (1988: 9) observes:

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 ..."

Indeed, a central theme of much recent organization theory is that what endows a firm with a distinctive competency or strategic capability is its hard-to-observe and situation-dependent routines

(Nelson and Winter, 1984), invisible assets (Itami and Roehl, 1987), or tacit knowledge (Nonaka and Takeuchi, 1995). What is true of firms may be even truer of alliances. The potential for synergy is maximized when the assets pooled are intangible and context-specific, contingent for their realization on the trust and good will, easy familiarity, and cultural compatibility of the partners. Often the qualities that one firm brings to the mix and the other needs and seeks are difficult to observe and copy. They are also indecomposable—contingent for their utility on a unique configuration with other assets or supportive conditions. Copying or buying or contracting for a set of capabilities while neglecting the soil they need to germinate and flourish is a failing that companies, particularly in the knowledge-based industries, routinely repeat.

In Japan, the *keiretsu* have supplied a substantial portion of that fertile soil. Ronald Dore (1983) has made the case that patterns of exchange and collaboration within the *keiretsu* and other interfirm clusters (such as the textiles-making small firm enclave he studied) are infused with “goodwill,” his term for a mix of trust, reciprocity, obligation, and commitment to do right by transaction partners. Such qualities, which Dore sees as distinctively Japanese but others view as part and parcel of the network form (Podolny and Page, 1998), are argued to lower transaction and agency costs and so grease the wheels of exchange. In consequence, the bureaucratic and market governance solutions favored by organizational economists—formal contracting, court adjudication, full-blown acquisition, and the like—are less needed and less used. *Keiretsu* networks are thus supportive infrastructure for productive partnerships—whether they be long-term procurement contracts or strategic alliances. The trust, knowledge-sharing, and third-party backing they provide render new partnerships easy to form and low in risk, as hazards of opportunism and defection are minimized and little formal governance is required beyond that given by the group. That Japanese firms are less inclined than American counterparts to organize strategic alliances as formal equity joint ventures is a well-documented fact (Gulati and Singh, 1998).³

³ Surprisingly, perhaps, Williamson (1985:122) is on record as agreeing with Dore: “The hazards of trading are less severe in Japan than in the United States because of cultural and institutional checks on opportunism.”

Dore's arguments, again, converge with some broader conceptualizations of network structure and process; most notably, Granovetter's (1985) theory of embedded exchange. "The embeddedness argument," Granovetter writes, "... stresses...the role of concrete personal relations and structures (or "networks") of such relations in generating trust and discouraging malfeasance." In a less optimistic vein, they also recall his "strength of weak ties" perspective: that "strong" ties bind actors into tight-knit cliques such that the information circulating within them becomes redundant and stale. A contributing factor here is *homophily*: strong ties form among similar actors, and, once in place, render them more similar (Granovetter, 1973: 1362). The evidence is considerable that diversity in networks, whether of individuals or organizations, enriches information and accelerates its flow—with consequent gains in innovation and performance -- while homogeneity does the opposite (Baum et al., 2000; Podolny et al., 1996; Reagans and Zuckerman, 2001). Intra-*keiretsu* partnering, then, may have some adverse implications for R&D strategic alliances, a key question for this paper that we take up in later sections. For now we offer the following broad hypotheses on how the *keiretsu* have molded strategic alliance formation in Japan.

H1a: Two Japanese firms are more likely to form a strategic alliance if they are in the same keiretsu than if they are in different keiretsu or if one or both are independents.

H1b: Two Japanese firms are less likely to form a strategic alliance if they are in different keiretsu than if they are in the same keiretsu or if one or both are independents

We refer to H1a as "positive homophily": same-group strategic partnering is facilitated by the attractions of compatible cultures, high trust, reciprocity, and third-party monitoring. H1b, by contrast, posits "negative homophily." Alliances concentrate within *keiretsu* groups less from the advantages firms thereby derive than from the perceived negatives of intergroup partnering (e.g., knowledge spillovers to competitors). Empirically, the difference turns on the placement of independent firms. H1a juxtaposes same-group pairs with different-group pairs, group-independent pairs, and independent-independent pairs. H1b casts cross-group pairs as the least alliance-prone of all *keiretsu*-independent combinations.

An extension of H1a posits homophily, not only of group firms, but also of independents (nonaffiliates). This hypothesis has a logical symmetry but little substantive merit that we can see. Our discussion of the constraints and opportunities afforded by *keiretsu* comembership identified good reasons—trust, third-party brokerage and monitoring, experience-testing-- why two members of the same group might join hands in a new strategic endeavor. No such reasons apply to the both-independent case where all the dyad has in common is that neither firm is in a group. On the other hand, this pattern could arise from a broader form of negative homophily: group firms shun both cross-group alliances *and* alliances with independents, rendering same-group and both-independent alliances the most likely.

H1a': Two Japanese firms are more likely to form a strategic alliance if they are in the same keiretsu or if both are independents than if they are in different keiretsu or if one is independent and the other in a group.

Vertical and horizontal keiretsu

Two *keiretsu* forms may be identified (Lincoln and Gerlach, 2004: Ch. 1): (1) the vertical manufacturing *keiretsu* (hereafter vertical *keiretsu*) and (2) the horizontal corporate groups (*yoko keiretsu* or *kigyo shudan*). They differ in organization and function. Accordingly, their roles in partner choice and strategic alliance formation contrast as well.

The vertical *keiretsu* are relatively tight-knit, hierarchically-ordered networks pivoting on a major manufacturer and branching out to an array of satellite businesses in the same or complementary industries. Most arose after the war as a solution to problems of procurement and supply in critical industries and to regulatory and capital market strictures on corporate scale and scope (Odaka, Ono, and Adachi, 1988). In other settings, the vertical groups were the vehicle whereby large manufacturers launched new ventures and diversified by spinning-off divisions as satellite operations in closely related industries (Gerlach and Lincoln, 2000). Vertical *keiretsu* in industries such as autos and electronics gave Japanese manufacturers the requisite scale and support systems to compete in global export markets (Womack, Jones, and Roos, 1990).

While ties between electronics makers and their *keiretsu* satellites were generally less cozy than the automobile industry norm (Asanuma, 1989; Lincoln and Ahmadjian, 2001), they nonetheless facilitated technical cooperation, cost reduction, and flexibility, thus fostering competitive advantage (Sako, 1992). Indeed, the industry's history of strategic collaboration bred rich communication networks, both vertically among parent producers and suppliers and horizontally among the parts manufacturers themselves (Nishiguchi, 1994).

In the way they divide labor in the development, manufacture, or distribution of a product line and in their centering on one lead firm, the vertical *keiretsu* appear more “strategically” organized than the horizontal groups. Yet they, too, exhibit: durability of membership, reciprocal obligation, a commitment to risk-pooling, and shared community of fate. The manufacturers do business year after year with the same suppliers and distributors; they organize them in associations such as Matsushita's *kyoei-kai* (Guillot and Lincoln, 2004; Sako, 1996); they take (generally small) equity stakes in them and transfer employees to them; they extend trade credits, and they secure bank loans. However, the affiliate firms for the most part remained independently managed and owned.

The horizontal *keiretsu* are loosely-linked clusters of large firms drawn from diverse industries. Of the six major horizontal *keiretsu*, three descended from the prewar family-centered zaibatsu (Mitsui, Mitsubishi, and Sumitomo), whereas the other three—the bank-centered groups—appeared postwar (Fuyo, Sanwa, Dai-ichi Kangyo; see, e.g., Morikawa, 1993; Shimotani, 1991). At the core of each is a bank, an insurance company, a trading firm and several large manufacturers. Thus, the *raison d'être* for the horizontal *keiretsu* is less the exchange of products or technologies than the maintenance of stable, mutually-supportive capital and governance ties (Aoki, 1992; Lincoln, Gerlach, and Takahashi, 1992). Some cast them as functional counterpart to the diversified and divisionalized U. S. corporation, acting as “internal capital market” to allocate financial resources among the participating firms (Chandler, 1982; Kester, 1990). An early school of thought portrayed them as monopolists' clubs, colluding on price and extracting profit-maximizing rents in their transactions with outsiders (Caves and Uekusa, 1976). In the heyday of Japanese global economic expansion—the late 1980's-- an ascendant view was that the

horizontal *keiretsu* economized on agency and transaction costs in providing strong monitoring of incumbent management (Goto, 1982). Evidence for such rents or cost savings, however, has been thin to nonexistent (Lincoln and Gerlach, 2004: Ch. 4).

Given the horizontal groups' broad diversification and loose organization, member firms are less interdependent in a functional division of labor than in the vertical *keiretsu*. They thus offer fewer information and support advantages to an industry-based alliance, often designed to achieve production scale economies or extend or consolidate supply and distribution channels.

H2a: The homophily (positive or negative) effects of horizontal keiretsu on strategic alliance foundings are smaller than the vertical keiretsu effects.

Still, if shared corporate history and culture, reciprocal commitment, and third-party ties facilitate the launch and survival of a strategic alliance, the horizontal groups, too, can be said to provide supportive infrastructure. Both *keiretsu* forms may be cast as "strong tie" networks, an indicator of which is the above-noted multiplexity of their constituent ties (cross-shareholdings, preferential trade and lending, cooperative associations, and the like (Kester, 1990: 219-20; Lincoln, Gerlach, and Ahmadjian, 1996).

The horizontal *keiretsu* effect: homophily or centrality?

As we apply it here, strong tie theory is a tale of *dyadic* attraction: the likelihood that two firms will form a new strategic pact varies with their preexisting ties and distinctive mix of attributes. Another perspective on the partner choice problem takes as unit of analysis, not the pair, but the *node* (here firm) and asks about the attributes that make it a desirable partner and enhance its access to others and they to it (Gulati and Singh, 1998; Stuart, 1998). Consistent with the resource-based or strategic capabilities view, a firm's size, knowledge base, cultural values, and management skills are salient in this regard, but so are "positional" attributes—centrality, brokerage, third-party roles—that describe how it is situated in networks (Eisenhardt and Schoonhoven, 1996). Centrality signals: (a) experience and expertise in

navigating networks; (b) success at tapping others' resources such as knowledge (e.g., Burt, 1992; 1996; Powell et al., 1996); (c) reputation, visibility, legitimacy, status, and power (Podolny et al, 1996). Being good at picking partners, meshing structures and processes with them, and cultivating trust and reciprocity are competencies that organizations learn by doing. Firms with histories of many and close ties to others thereby acquire partnering and networking skills that can be tapped again in crafting new alliances. Companies already well "plugged-into" networks tend to be the most active in the search for new partners and the launch of new pacts (Gulati and Gargiulo, 1999; Walker, Kogut, and Shan, 1997).⁴

Centrality—proximity to the network as a whole—might better describe the horizontal *keiretsu* constraint on strategic alliance activity than *homophily*—the formation of alliances at higher rates within groups and lower rates between them. The two have a complicated interdependence that network research mostly ignores. High variance in centrality implies a network with a core-periphery structure, such that its core— here, horizontal *keiretsu* firms—have more and closer ties to others than its periphery—here, horizontal group independents. Core members (those with presidents' council or *shacho-kai* affiliations) command high status, legitimacy, and the support of banks, ministries, and the group. The horizontal groups thus historically comprised a set of partner candidates attractive to any firm in search of alliance. In this scenario, horizontal *keiretsu* companies are disproportionately represented in strategic alliances but only because of their centrality in the (network) economy as a whole. *Keiretsu* firms are favored over independents— hence independent-independent pairings are the *least* generative of alliances— but whether the matches are intra- versus inter-group matters not.

H2b. The horizontal keiretsu effect on strategic alliance foundings has been one of centrality, not homophily; i.e., same-group pairings and cross-group pairings are

⁴ Network researchers sometimes distinguish between resources such as scale as "attributes" and others such as centrality as "position," but both in fact enter the analysis as attributes of individuals, not pairs or higher-level aggregates (e.g., triads, etc.)

productive of foundings in equal degree; group and independent pairings are less so; and pairings of independent firms are least so.

Critics of the *keiretsu* form in general and horizontal groups in particular will find this portrait dated. Most observers of the Japanese economy now view the big-six as dinosaurs verging on extinction, no pool of suitable partners for any savvy corporate strategist bent on competitive success in 21st Century Japan. This suggests that the centrality in alliance networks of horizontal group firms has declined over time, a prediction that our later analysis of period differences strongly supports.

STRATEGIC ALLIANCE TYPES: INNOVATIVE AND OTHERWISE

We have thus far stressed the positives in terms of trust, communication, and cooperation of embedding the strategic alliance process in “goodwill”-laden networks of the sort constituted by Japan’s horizontal and vertical *keiretsu* groups. We are also, however, mindful of the flip side to strong tie exchange: that in facilitating *intragroup* cooperation, *intergroup* cooperation is compromised (Nishiguchi, 1994). Dore acknowledged this adverse side to *keiretsu* exchange but gave it short shrift, dwelling instead on the transaction cost economizing benefits. Yet the barriers *keiretsu* pose to economy-wide cooperation have been formidable in Japan. In a late 90’s study of Toyota’s efforts to reduce its dependence on Toyota *keiretsu* electronics supplier Denso, we asked Toyota managers why they did not source from Hitachi. “Hitachi is in the Nissan Group,” they replied. “We can’t buy from them” (Ahmadjian and Lincoln, 2001).

Thus, *keiretsu* ties not only facilitate, they also constrain or limit business cooperation, at times in unproductive ways: (1) in taking the path of least resistance and choosing for alliances those they know, trust, and are committed to, firms reduce the risks and costs of seeking out new partners and cultivating new ties; (2) a firm’s commitment to its own group and that group’s corresponding rivalries with others

deter it from boundary-spanning pacts.⁵ In returning time and again to the same tried and trusted partners, firms honor reciprocal obligations, conform to community norms, shore up group solidarity, and lower alliance costs. But they miss out on an array of tie-ups with unknown and untested alters who might bring something fresh and different to a partnership.

More specifically, whether it is in fact rational long term for a firm to confine its business to a pool of partner prospects that it knows and feels an obligation to support will depend on the alliance goal. When that goal is *implementation*-- the pooling of extant knowledge in the efficient execution of established routines-- the economies of communication and governance afforded by embeddedness take center stage. When, however, the goal is *innovation*— the creation of new knowledge—a rational firm will chart a different path, extricating itself from high-trust, high-obligation tie-ups while pursuing partnerships with less familiar alters. Strong/weak tie theory and its later variants such as Burt's (1992) "structural hole" framework assert that strong tie clusters of the *keiretsu* sort circulate redundant information. Collective action in the sense of executing known routines is easy in such networks but creative ideas come hard. The reverse is true of weak ties. These are difficult to forge, manage, and sustain, yet they expose actors to new and different information and so facilitate synergistic combinations that strong tie networks do not yield. In their study of R&D alliances among biotech firms, Powell et al. (1996) put the matter thus:

Because extensive contacts typically cross-knit ...communities, involvement in collaborative R&D expands the horizons of a firm...and increases ...awareness of additional projects that might be undertaken. Thus, R&D alliances serve as a platform for diverse network activity.

⁵ The concern about alliances with rivals may be well-founded. Baum et al. (2000) finds that strategic alliances formed with competitive rivals suffer performance shortfalls in their early years of operation.

Stuart (2000) reports corroborative evidence: a positive association between the technological distance separating a firm and its alliance partners (as indexed by low patent citation overlap) and the creativity of its inventions (as indexed by degree of difference between later and earlier inventions).

Thus, strong tie networks comprise infertile soil for the seeding and flowering of R&D alliances. In our application, intra-*keiretsu* partner selection reduces near-term search and transaction costs at the expense of innovation. Overreliance on *keiretsu* ties in crafting R&D partnerships, Ritschchev and Cole (2003) contend, is symptomatic of a general reticence on the part of Japanese companies' to embrace the "organizational discontinuities" that in Silicon Valley have enabled breakthrough innovation 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, Kodama's ... 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 We go further to claim that sometimes the predilection toward intra-keiretsu R&D in Japan precludes potentially more beneficial fusion across alliance boundaries."

Still, Kodama's (1986) suggestion that the intra-group partnering of Sumitomo companies facilitated innovative inter-industry collaboration in fiber-optics warrants attention. It accords with the H2a view of the horizontal *keiretsu* of which Sumitomo is the most cohesive case: member firms are presumed sufficiently different (by the one-set principle of one firm per industry) that innovative synergies materialize, yet the shared cultures, high trust, reciprocal obligation, and third party monitoring offered by the group render collaborations easier to initiate and sustain.

Ritschev and Cole worry that overreliance on *keiretsu* kin—the easy path to strategic alliance—may cause Japanese firms to shy away from potentially more creative partnerships with non-kin. The larger problem, however, is negative homophily: firms shun strategic tie-ups that span *keiretsu*, not only because they must then forego the advantages of embedded alliance, but also because of intergroup rivalries and fears of knowledge spillovers to competitors. The history of Japanese R&D consortia highlights the reluctance of Japanese companies to cooperate across *keiretsu* lines. In the 1970's, MITI (Ministry of International Trade and Industry) was forced to create two distinct research laboratories in order to get member firms and competing groups to join the VLS (Very Large Scale Integrators) project (Fransman, 1990; Sakakibara, 1992). The ministry faced similar difficulties in persuading electronics firms to work together in the Fifth Generation Computer Projects in the 1980s (Guillot, Mowery, and Spencer, 2000).

We have argued that the hazards of intra-group R&D alliance are most daunting when the *keiretsu* form is vertical. Ties are stronger than in the horizontal groups, owing to member firms' supply chain interdependence and the coordination of a lead firm. Consequently, knowledge redundancy is high: rapidly diffused and quickly replicated (Miyashita and Russell, 1994:167). Companies are well-informed of one another's capabilities, such as who can be counted on to improve process or product technology within particular cost and time frames. Thus, agreement on a division of responsibility and a set of productive routines is easily arrived at.

A dramatic example of the effective leveraging of common trust and knowledge by a vertical *keiretsu* network in implementing a collective action is the smooth response of Toyota suppliers to a 1997 fire in an Aisin Seiki plant that cut off supplies of a critical brake component and shut down most of Toyota's domestic production lines (Nishiguchi and Beudet, 1998). Wall Street Journal reporter Reitman (1997) concludes that:

The secret lay in Toyota's close-knit family of parts suppliers. In the corporate equivalent of an Amish barn-raising, suppliers and local companies rushed to the rescue. Within

hours, they had begun taking blueprints for the valve, improvising tooling systems and setting up makeshift production lines.

If, however, the strategic aim is innovation and knowledge creation as opposed to the replication or leveraging of an extant knowledge base, it behooves a firm, particularly in an industry such as electronics with its characteristic technological and market turbulence, to look for partners beyond its vertical group. The knowledge assets the firm seeks to secure through partnering will differ, not only from those in its possession, but also from those available for leveraging within its *keiretsu* network.

We thus predict that firms within the same vertical *keiretsu* are less likely to form R&D alliances than alliances forged for other purposes.

H3a: The homophily effects (both positive and negative) of vertical keiretsu on alliance foundings are diminished when the alliance has an R&D thrust.

As the horizontal *keiretsu* are more diversified and loosely-coupled—i.e., ties are weaker—the problem of redundancy due to intra-group selection is correspondingly reduced. Horizontal *keiretsu* R&D matches might thus diminish cooperation costs and knowledge spillovers yet still yield gains in complementarity and synergy. Accordingly, a rational firm in search of a compatible R&D partner will search first within its horizontal *keiretsu* even while it avoids such tie-ups with vertical *keiretsu* kin.⁶

⁶ This is not to say that *all* the knowledge held by a vertical *keiretsu* firm is shared and thus redundant. Ahmadjian and Lincoln (2001) discuss Toyota's efforts to learn automotive electronics in order to reduce its dependence on long-time *keiretsu* electronics supplier, Denso. But the case is exceptional for the strains it induced in a hitherto cooperative and symbiotic partnership. In general, Toyota managers told us, they fully understood the technology of the parts and materials they sourced from *keiretsu* suppliers. That was not true, however, of Toyota's largely "black-box" dependence on Denso's electronics technology. While Toyota's problem was information asymmetry, not redundancy, the outcome was that predicted by H3a: in its pursuit of electronics expertise Toyota turned to strategic partners outside the Toyota Group; namely, Matsushita and Toshiba.

H3b: The homophily effects (positive and negative) of horizontal keiretsu on alliance foundings are diminished (but less than in the vertical keiretsu case) when the alliance has an R&D thrust.

The prior alliance network: prior ties, third party ties, and centrality

To this point our discussion has examined how Japanese electronics firms' vertical and horizontal *keiretsu* ties condition their propensities to join in strategic alliances and how the *keiretsu* effect varies with the alliance type: R&D or not. Yet our arguments, stressing the relative merits of homophily, centrality, and tie strength in the formation and performance of strategic alliances, have generality beyond the *keiretsu* case. In this section, we build on other literature in theorizing how the prior alliance network conditions the alliance founding process. Moreover, in order to demonstrate that the *keiretsu* effects we find are not mere proxies for well-documented tendencies for firms to select for new partnerships those with whom they allied in the past—but also because the issues are of substantive interest in their own right—we replicate and extend here the analyses of other researchers on how the positional and structural properties of prior alliance networks condition the new alliance founding process.

Much research examines how a firm's position in present or past strategic alliance networks affects its entry into new alliances. At the dyad level (and analogous to *keiretsu* coaffiliation) the salient relational question is whether the pair has partnered in the past. Two firms that teamed up once in the development or manufacture or distribution of a product have a joint stock of experience and know-how that can be tapped again. They have routines in place for working together that need not be built from scratch. A prior alliance is thus a strong tie in the sense that issues of mesh and fit have been addressed as, presumably, have those of trust-building and knowledge-pooling. The path of least resistance for a firm in search of strategic alliance is thus to take a former partner back into its embrace. But, generalizing again from the *keiretsu* case, such prior ties should count for less when the alliance aim is R&D. Network inertia—a pair of firms' propensity to stick together or with the same third party in venture after venture—cannot be a rational or successful course of action when creative/synergistic partnership is sought.

Keiretsu comembership implies the indirect linking of corporate pairs via third party ties, two of key importance in the Japanese context being the “main bank” role of a Mitsubishi or Sumitomo and the “parent” manufacturer role of a Toyota, Hitachi, or Nippon Steel. Indirect ties of these sorts afford monitoring and support of the partnership. More generally and beyond the *keiretsu* context, third-party alliance ties constitute supportive infrastructure in the crafting of new alliances. If *IK* is an alliance, and *JK* is an alliance, the likelihood is elevated that *IJ* will be an alliance, too. Third-party ties, as Uzzi’s (1996) interviews with Manhattan garment manufacturers document, figure importantly in the production of trust within the pair. He writes:

In the firms I studied, third-party referral networks were often cited as sources of embeddedness. ...One actor with an embedded tie to each of two unconnected actors acts as their go-between by using her common link to establish trustworthiness between them. The go-between ... “calls on” the reciprocity “owed” him or her by one exchange partner and transfers it to the other.

If an (direct) alliance is a “strong” tie, an indirect (third-party) alliance tie is correspondingly a “weak” one. Again, in the search for a new alliance partner, we expect firms to favor strong over weak ties where mesh and fit are overriding concerns; the reverse where creativity and synergy are.

H4a: Two Japanese firms are more likely to form a new strategic alliance if they have prior direct and indirect (third-party) alliance ties. Direct (“strong”) ties are relatively less important and indirect (“weak”) ties are relatively more important when the alliance has an R&D thrust.

Apart from these dyad-level forces of inertial attraction, certain firm-level effects need attention as well. A firm that is central in the prior alliance network enjoys a competitive advantage in the search and competition for partners. From past rounds of partnering, companies accumulate information on and access to the resources and skills of others that can be strategically recombined and leveraged anew. In sending a reputational signal that a firm is an attractive and accomplished partner, centrality thus

functions as a resource in its own right—a form of *social capital* or *status* that can be exploited in expanding the stock of alliance prospects and forging new strategic tie-ups down the road (Podolny, Stuart, and Hannan, 1996).

Are the positional advantages of centrality of more or less importance when the alliance aim is R&D? We suggest that they are less important. Centrality effects represent network inertia-- firms that in the past had many direct and indirect alliance ties will have them again—and we expect there to be less inertia in innovation than in implementation alliance formation. More substantively, the status and reputation signaled by centrality in prior alliance networks are “old” information about networking capability and success. Firms seeking R&D alliances will discount it more heavily than firms in search of nonR&D alliances.

H4b: Two Japanese firms are more likely to form a strategic alliance if they are centrally positioned in the prior alliance network. This effect attenuates when the alliance has an R&D thrust.

Period and change

There is reason to suppose that the structuring of the Japanese corporate network has not been constant over time; specifically, that, with the delegitimation and disintegration of the *keiretsu* form, the *keiretsu* constraint on the alliance-founding process was correspondingly relaxed.

The support of *keiretsu* networks figured prominently in the efforts of companies in Japan’s globally competitive sectors (autos, electronics, machinery) to build strategic capability and competitive advantage at the frontier of product and process innovation (Dyer, 1996). Yet the morass of difficulties into which the Japanese economy descended after the “bubble economy,” coupled with the business model discontinuities spawned by the Internet and other competence-destroying technologies, subjected Japan’s legacy intra-and inter-organizational systems to rigorous test (Anderson and Tushman, 1990).

Some history

With the collapse of stock and land prices in 1991-93, Japan entered the “lost decade” of stagnation, deflation, and financial crisis. GDP growth averaged 1.5% in 1992-97 compared to 4.5% in 1985-91. Government and industry responded with restructuring and re-regulation, which by the millennium’s end had substantially altered the Japanese political economy’s institutional core. Among the changes were: tightened accounting rules (consolidated reporting; asset appraisal at market rather than book value); legalization of stock options, stock buybacks, and the holding company form (outlawed since the U. S. Occupation); corporate governance reforms (smaller boards, outside auditors); increased control by foreign investors (most prominently Renault and Ripplewood); and a merger wave unparalleled in the postwar period—first of money center banks followed by their principal industrial clients (Ahmadjian, 2003; Lincoln and Gerlach, 2004: Chapter 6).

The electronics/electrical machinery industry, in particular, was transformed. Notwithstanding strong global demand for consumer electronics and computer products, the sector struggled in the 90’s with overcapacity, product proliferation, and price deflation. Firms downsized, divested low margin business, and formed pacts to reduce capacity and streamline operations. Vertical *keiretsu* suppliers, no longer assured the business of a parent manufacturer, sought new customers abroad and in different industries (Ahmadjian and Lincoln, 2001). The signature *keiretsu* ties of minority cross-shareholdings dissolved as core firms sold off equity stakes in satellite suppliers and distributors (as did Nissan under Carlos Ghosn’s leadership), or, alternatively, hiked them, thereby converting erstwhile *keiretsu* partners into fully controlled subsidiaries. At Matsushita, the latter moves aimed to reduce overlap and better coordinate the activities of the group. At Toyota they provided a bulwark against takeover, a growing concern amid rising foreign investment and a liberalizing M&A environment (Lincoln and Gerlach, 2004: Ch. 6). All firms were under pressure to find strategies that maximized global competitiveness even at the expense of *keiretsu* commitments and, indeed, the very survival of the *keiretsu* form.

Compared to the post-bubble 90's, the mid to late 80's was a time of general systemic stability. To be sure, important changes took place. The Plaza Accord of 1985 doubled the yen against the dollar, triggering the short-lived but painful endaka slowdown of 1986. From that dip the economy rebounded to the "bubble" peak in 1989 when GDP growth neared 5% and the Nikkei Index hit 38,915. Even so, the fundamentals of Japan's network economy—vertical and horizontal *keiretsu*-based exchange with an overlay of ministry guidance—held firm. Both *keiretsu* forms were feared, admired, even emulated in the West. The smooth relations between large firms and their vertical *keiretsu* suppliers were, as noted, much celebrated for the part they played in the quality and reliability of Japanese manufacturing (Womack, Jones, and Roos, 1990). And the horizontal groups' main bank dependencies and cross-shareholdings were claimed to offer better monitoring of corporate management than American-style market capitalism allowed (Thurow, 1992)

The prototypical Japanese electronics corporation of the time—large, integrated, diversified—had its Western admirers as well. Hitachi, Matsushita, Mitsubishi Electric, NEC, Sanyo, and Toshiba boasted broad product lines that ranged from commodity "white goods" (*kaden*) such as rice cookers and air conditioners to complex semiconductors and computer systems. U. S. business scholars such as Michael Cusumano (1992) and Alfred Chandler (2001) saw American counterparts suffering from scale and scope inadequacies, rendering them unable to compete with the Japanese in product range, brand equity, quality, cost, and development speed.

The picture was markedly changed by the post-bubble 90's. The bank credit that fueled the late 80's investment boom evaporated (Gao, 2003). The stock market slump choked off equity issuance as a financing source. More stringent reporting rules forced broad sell-offs of cross-shareholdings. On the technology side, the explosive growth of the Wintel standard, the Internet, and the packaged software industry undercut the competitive position enjoyed by Japanese electronics in the 70s and 80s. Amid these and other changes, the *keiretsu* form and other pillars of Japan's postwar network economy looked to be toppling.

We thus expect to find the *keiretsu* role in strategic alliance formation in the Japanese electronics industry declining over time, particularly from the prebubble to the postbubble period. Second, while we predict diminishing effects of both *keiretsu* forms (vertical and horizontal) on both alliance types (R&D and nonR&D) from the 80's to the 90's, we expect more R&D/nonR&D divergence in the 90's. In the new era of rising competition and network decay, the electronics makers found it harder to finance innovation on their own and were thus more constrained to find the “right” partner (in a complementarity/synergy sense). Intra-*keiretsu* alliances geared to capacity reduction and manufacturing/supply chain efficiency proliferated in the 90's. These were relatively routine affairs whose top priority was the smooth orchestration of processes and personnel. Finally and consistent with the above reasoning on the dissipating *keiretsu* constraint, we expect *less* inertia in the partner selection process on the heels of the bubble economy's demise; i.e., prior alliances, third-party ties, and centrality were greater drivers of alliance foundings before the bubble's collapse (in 1991) than after.

H5a: The homophily effect of keiretsu membership on strategic alliance foundings declined over time (especially from the pre- to postbubble periods). The decline was steeper when the alliance had an R&D thrust.

H5b: The effects on strategic alliance foundings of prior alliances, third-party alliance ties, and centrality in the alliance network declined over time (primarily from the pre- to postbubble period). The declines were steeper when the alliance had an R&D thrust.

DATA AND METHODS

Studies of strategic alliances have been pitched at two levels of network analysis: dyad—the pair of organizations at risk of an alliance-- and node—the individual organization (Stuart, 1998). We argue for the dyad as unit of analysis. Firm differences (e.g., in size, knowhow, performance) in propensities to ally can be straightforwardly captured in a well-designed dyad model. A node-level analysis, by contrast,

cannot address a critical question in the strategic alliance process: how does the *combination* of partner attributes—a large pharmaceutical, for example, and a small biotech-- uniquely condition the odds that the pair will ally? While dyad analysis presents some technical challenges, we believe our strategy overcomes them while enabling insights into alliance formation not possible via firm-level analysis.

The above hypotheses were tested with a longitudinal data set on strategic alliances formed among Japanese electronics firms from 1985 to 1998. We collected data on a sample of 128 large publicly-held companies. The population sampled was the Tokyo, Nagoya, and Osaka stock exchange-listed electronic industry. In 1992, 164 firms comprised this population. In 1998, owing to new listings, 178 did. Our sample of 128 firms includes every such company that had entered into at least one alliance, whether domestic or international, over the 14-year period.

Our study examines the conditions behind the likelihood that a pair of firms—a dyad— will announce a new alliance in a given year. The unit of observation is thus the dyad-year. Our information on alliances was coded from press reports appearing in the five largest economic/industrial Japanese newspapers over the 14 year interval from 1985 to 1998 (*Japanese Economic Newspaper*, *Japanese Industrial Newspaper*, *Daily Industrial Newspaper*, *Japanese Economy and Industry Newspaper*, *Japanese Distribution Newspaper*). Table 1 presents three examples of such reported strategic alliances.

<Table 1 about here>

The data on *keiretsu* were obtained from *Kigyo keiretsu soran* (Toyo Keizai, various years), an annual publication that records and describes the *keiretsu* leanings of Japanese companies. The financial measures derive primarily from the Japan Development Bank (JDB) *Corporate Finance Data Bank*, which makes available both unconsolidated and consolidated accounting data on companies (excluding finance and insurance) listed on the first and second sections of the Tokyo, Osaka, and Nagoya Stock Exchanges. JDB compiles information from the annual securities reports submitted to the Ministry of Finance by the listed firms. Thus, every publicly-held firm in the domestic Japanese electronics industry “at risk” of entering an alliance is included in the sample.

From these data we constructed an “event history” of alliance announcements across the observation years (1985-98). The structure of the data is a panel wherein the cross-sectional units are dyads (pairings) of firms. In each year, the data are configured as follows: $C_1, C_2; C_1, C_3; \dots; C_1, C_N; C_2, C_3; C_2, C_4; \dots; C_2, C_N; \dots; C_{N-1}, C_N$, where $C_1 = \text{firm } 1, C_2 = \text{firm } 2, \dots, C_N = \text{firm } N$. Thus, there are $N(N-1)/2 = 8,128$ dyads in each year or 113,792 dyad-year observations in total.

Measurement of variables

The dependent variable is a dichotomy: coded 1 if the pair of firms announced a new alliance in the observation year, 0 otherwise. Each dyad-year record further includes attributes of both firms (size, *keiretsu* affiliation, financial composition, centrality), plus such dyad- and network-level measures as prior and third-party alliance ties; functional complementarity; and alliance network density.

To evaluate our hypotheses on how the effects of *keiretsu* and prior alliance networks condition on alliance goal, we divided alliance announcements into two classes. Those formed for the purpose of joint development of new products or technologies were coded as R&D. Non-R&D alliances were oriented to production (e.g., including capacity reduction), distribution, or supply.

Using *Kigyo keiretsu soran*'s classification, we measured *keiretsu* affiliation as follows. Firms represented on the presidents' councils (*shacho-kai*) of the big-six intermarket groups (*kigyo-shudan*)--Mitsui, Mitsubishi, Sumitomo, Sanwa, Fuyo, Dai-Ichi Kangyo--were coded as horizontal *keiretsu*. *Shacho-kai* membership is the most definitive measure of a firm's attachment to a horizontal group (Gerlach, 1992; Lincoln and Gerlach, 2004). It is, however, conservative, since a multitude of noncouncil firms align with groups via trade, lending, shareholding, board overlap, and other such ties.⁷ As our unit of analysis is the dyad, we created four dummy variables to index its horizontal *keiretsu* configuration. *DiffHK* was coded “1” if the dyad spanned two presidents' councils. *BothNonHK* was coded “1” if

⁷ A famous example is Mazda's relationship to the Sumitomo group. Mazda is not a *hikusui-kai* (Sumitomo *shacho-kai*) member, but Sumitomo was its main bank, and the Sumitomo Group rescued Mazda from bankruptcy in the early 1970's (Pascale and Rohlen, 1983).

neither was a council member; and *HK&NonHK* was coded “1” if one party to the dyad held a council seat but the other did not. *SameHK*—the excluded and therefore reference category-- obtains when both firms are on the same council.

Similarly, four dummies tap the affiliation of each sampled firm with a vertical *keiretsu*. Since at least one of the 128 sampled firms was a member, 11 vertical clusters were considered: Hitachi, Toshiba, NEC, Fujitsu, Sony, Matsushita, Oki Electric, Mitsubishi Electric, Kobe Heavy Industry, Sumitomo Electric, Yasakawa Electric. *DiffVK* was coded 1 if the dyad spanned two vertical groups. *BothNonVK* was coded 1 if neither firm was classified by *Kigyo keiretsu soran* as a vertical group affiliate, and *VK&NonVK* was coded 1 if one firm was so affiliated but the other was not. The excluded (reference) category is *SameVK*.

To measure a firm’s position in the prior alliance network, we first devised for each year an adjacency matrix (an $N \times N$ binary matrix) that captured the existing alliance ties among the 128 firms in our panel through $t-1$, the year before the current year (t). From those matrices, we calculated the following relational and positional network measures. Two are at the dyad level: (1) *PriorTie* is whether firms I and J ever had a prior alliance (=1; else=0); (2) *3rdPartyTie* is whether firms I and J were each allied with firm K in the prior year; i.e., IK_{t-1} is an alliance and JK_{t-1} is an alliance. Two more are at the firm level: (1) *Cent* is each firm’s score on the Bonacich (1987) eigenvector measure of centrality in the alliance network of the prior year; (2) *TotPrior* is the total count for each firm of all prior announced alliances. Finally, *TieDensity* is the total number of alliance announcements by all 128 firms in the prior year.

Following other strategic alliance research, we used a sub-industry classification to tap the functional complementarity or interdependence of each firm pair (Gulati and Gargiulo, 1999; Nohria and Garcia-Pont, 1991). Five segments of the Japanese electronics industry were identified: electric industrial apparatus, electronic equipment, communication equipment, household electronic equipment, miscellaneous electric equipment. “*FuncComp*” is coded 1 if the dyad spans subindustries, 0 if not. Our expectation, following Gulati and Gargiulo (1999) and our own arguments on the structuring of the

vertical *keiretsu*, is that alliances form between functionally complementary firms-- across industry segments -- not within them.

Finally, the following financial composition and performance variables were obtained for each firm in each year: *Sales* is total sales. *ROA* is return-on-assets (net earnings from operations before taxes divided by current assets). *Liquidity* is the “quick ratio:” current assets minus inventory divided by current liabilities (Dooley, 1969). *Solvency* is the ratio of long-term debt to current assets.

Modeling considerations

Keiretsu *homophily* and *centrality*

Our analysis of *keiretsu* effects on alliance foundings relies upon models of the following sort:

$$Y_{it} = \beta_0 + \beta_1 \text{DiffHK}_{it} + \beta_2 \text{HK\&NonHK}_{it} + \beta_3 \text{BothNonHK}_{it} + \sum_k \gamma_k X_{it} + \varepsilon_{it}$$

For expository purposes, we exclude discussion of the vertical *keiretsu* terms, which follow the same pattern. Again, $Y_{it} = 1$ if a pair, i , of two Japanese electronics firms announces a new strategic alliance in year t , otherwise 0; and the other terms are described above. The $\{\beta\}$ and $\{\gamma\}$ are regression coefficients to be estimated.

Below, we recast our main hypotheses in the terms of this model. Again, our baseline prediction is *positive homophily*: two electronics firms are most inclined to launch a new alliance if they are in the same *keiretsu* group. As same-group dyads are the omitted—hence reference—category, this implies:

$$\text{H1a: } \beta_1 = \beta_2 = \beta_3 < 0$$

The modification of H1a that that our analysis entertains but we decline to endorse *ex ante* is that homophily motivates *keiretsu* independents to pursue alliances with one another just as it does same-group firms. This possibility is written as:

$$\text{H1a': } \beta_1 = \beta_2 < \beta_3 = 0$$

Thus, independent-independent and same-*keiretsu* alliances are presumed equi-probable.

We do, however, consider H1b—the hypothesis of “negative homophily”—a serious contender. It holds that a pair of Japanese electronics firms is *least* likely to form an alliance if it spans two groups. We write that configuration as:

$$\text{H1b: } \beta_1 < \beta_2 = \beta_3 = 0$$

In other words, inter-group (*DiffHK*) alliances are less likely than the three alternatives of same-*keiretsu*, *keiretsu*-independent, and independent-independent.

Finally, H2b, the horizontal *keiretsu* centrality hypothesis, states that the greater the representation in the dyad of (similar or different) *keiretsu*, the greater the odds of strategic alliance. Stated algebraically:

$$\text{H2b: } \beta_3 < \beta_2 < \beta_1 = 0$$

Thus (and at odds with H1a, H1b, and H2a), cross-*keiretsu* pairs are as conducive to new alliances as same-*keiretsu* pairs (β_0) followed by *keiretsu*-independent pairs, and finally pairs of independents. So *keiretsu* firms appear in more alliances than independent firms, but within- and between-*keiretsu* pairings are the same. Homophily is not the driving process here; centrality is. All firms seek strategic tie-ups with (horizontal) *keiretsu* companies, as the latter possess the ‘social capital’ of central positioning in the network as a whole (Eisenhart and Schoonhoven, 1996).

Our other hypotheses on how these processes vary by alliance type and period are testable with straightforward modifications of the models above.

Incorporating firm-level attributes in a dyad model

We use another distinctive modeling strategy to capture the effects of attributes of firms in dyads on alliance probabilities (Lincoln, 1984; Lincoln, Gerlach, and Takahashi, 1992). To represent a continuous variable such as centrality, size, or profitability, we code for each dyad the unweighted *sum* of the two firms’ scores on that variable and the *product* of those scores. The first term captures the attribute’s *main effect*, the second taps the *interaction*. The distinction is key to dyad analysis, if one not

often maintained. The main effect represents the role of some attribute in conditioning two firms' propensities to ally. The interaction addresses whether and how I 's and J 's scores on the variable combine to contribute uniquely to the odds of an alliance event. The differences or ratios of node-level attributes often used to form dyad-level scores confound main (nodal) and interaction (dyad) effects and so obscure the causal processes at work. The interaction coefficient, a second derivative, gauges change in the angle of the slope of Y on X_i with increments in X_j (and vice versa). If positive, it is prima facie evidence for homophily; if negative, heterophily: as X_i (X_j) and X_j (X_i) move in opposite directions, the probability of an alliance goes up.

As compared with a regression of Y_{ij} on X_i , X_j , and $X_i * X_j$, the combination of X_i and X_j into a simple sum ($X_i + X_j$) constrains their slopes to equality and so reduces the number of parameters to be estimated. In a dyad analysis whose dependent variable is a symmetric tie (alliance founding), the ordering of I and J is arbitrary: an IJ alliance and JI alliance are one and the same.⁸ That is why we analyze half the asymmetric pairings of our sampled firms-- the upper off-diagonal cells of the $N \times N$ matrix. The lower off-diagonal contains the same information. One can, of course, estimate distinct effect parameters for X_i and X_j , but the small differences that materialize may be discounted as sampling error. Forcing equality of the main effects sacrifices no substantive information and, by lowering the number of terms, increases estimation efficiency.

Dyad autoregression

A second troublesome issue in dyad regression is the statistical nonindependence or autocorrelation induced by repetition of nodes (here, firms) across dyads (Krackhardt, 1988; Lincoln, 1984). The problem parallels the panel analysis case wherein recurrence of units over periods and periods over units gives rise to clustering of the data. The consequence is the same: negatively-biased standard errors, hence positively biased significance tests. As our sample is a *panel of dyads*, all three

⁸ Were the dependent variable an asymmetric tie (e.g., I 's acquisition of an equity stake in J), the ordering of I and J within the dyad obviously becomes important as an IJ pairing is distinct from a JI one.

autoregression problems are simultaneously present. To correct for dyad autocorrelation, we used Lincoln's (1984) adaptation of the network autoregression model. A variable, p_{ij} , is coded as the mean (probability) of the dependent variable (alliance announcement = 1 or 0) of all dyads having nodes in common with the dyad observed (see, e.g., Stuart, 1998). p_{ij} is then entered in the regression to absorb the autocorrelation in the y values induced by dyad overlap.⁹ The calculation is similar to a coding and inclusion in the regression of dummy variables for the rows ($i = 1, \dots, 127$) and columns ($j = 2, \dots, 128$) of the matrix whose cells define the dyads [$N(N-1)/2 = 8128$], but it necessitates just one term—the mean of the overlapped dyads—rather than $2 \times 126 = 252$ per year.¹⁰

Estimation of probit models

In the pooled regression analysis below, we use two distinct probit techniques. For each outcome variable, Equation 1 is a simple probit that combines temporal fixed-effects (13 dummy variables for calendar year) with robust standard errors adjusted for clustering on unit (i.e., dyad) using Huber's (1967) procedure as implemented in *Stata 9*.

The clustering adjustment effectively sets the number of observations for degrees of freedom purposes to the number of dyads ($N*N-1)/2$, where N is the number of firms), not the number of dyads times the number of years: $14*(N*N-1)/2$. The year fixed effects preclude the addition of covariates such as GDP growth that vary temporally but not cross-sectionally. Equation 2 is a population-averaged random effects probit (implemented in *Stata* with *Xtgee*) that combines first-order autoregression with error components for year and dyad.

⁹ An example with $N=4$ is as follows. For dependent observation y_{12} , $p_{ij} = (y_{13} + y_{14} + y_{23} + y_{24})/4$. For y_{13} , $p_{ij} = (y_{12} + y_{14} + y_{23} + y_{34})/4$. For y_{34} , $p_{ij} = (y_{13} + y_{14} + y_{23} + y_{24})/4$. And so on.

¹⁰The dummy approach is equivalent to (and better estimated by) the inclusion in the regression of two coded variables, p_i and p_j , where $i=1, \dots, N-1$; $j=2, \dots, N$; p_i is the probability of an alliance for all dyads containing node i ; and p_j is the same for dyads containing node j . In this framework, however, separate coefficients are estimated on p_i and p_j : $y_{ij} = \beta_1 p_i + \beta_2 p_j + \sum_k \gamma_k X_k + \varepsilon_{ij}$. The network autoregression approach essentially estimates one coefficient on the average of the p_i and p_j : $y_{ij} = \beta [(p_i + p_j)/2] + \sum_k \gamma_k X_k + \varepsilon_{ij}$.

RESULTS

Figure 1 plots the number of Japanese electronic industry R&D and nonR&D alliances by year and GDP growth over the period under consideration. We observe a marked tendency in these data for nonR&D alliance announcements to move against the business cycle: Spells of economic weakness map to upswings in the number of nonR&D alliances formed. Most conspicuously, the *endaka* (high yen) retrenchment of 1986 produced a sharp spike. Alliance foundings remained at low ebb through and just beyond the bubble era (1987-92) surging again in the slump years of 1993 and 1994, falling off in the 1995-96 recovery, finally trending up again as the economy nosedived in the Asian financial crisis of 1997-98. The pattern accords with our view that nonR&D alliances in this industry aimed at consolidation and coordination economies in business downturns to assist partner firms in weathering them. The R&D alliance counts move within a much tighter range and display little if any countercyclical tendency.

The pooled regression analysis

We begin with an analysis of the entire pooled data set; later we break out the results by period. Table 2 presents the descriptive statistics for all dyads across the 14 observation years.

<Table 2 about here>

Table 3 shows the Equation 1 and Equation 2 estimates to be very similar. In omitting the year fixed effects, however, Equation 2 permits estimation of the time-dependent macro-level effects: calendar year, prior alliance network density (lagged one year), and GDP growth. It corroborates the graphical evidence in Figure 1 that nonR&D alliance activity is strongly countercyclical: the coefficient on GDP growth is negative and significant. It also shows the incidence of nonR&D alliances declining secularly with time but rising and falling with fluctuations in the density of the network—the total number of new alliances—in the prior year. No such macro-level effects are evident in the R&D alliance regression.

<Table 3 about here>

Table 3 also presents for each estimator the maximum likelihood probit estimates of the nonR&D and R&D regressions. As we have devoted some space to arguing why they should differ, we are pleased to report that they do. A test of the null hypothesis of cross-equation equality of all coefficients fails at a high level of confidence [$\chi^2_{\{34\}} = 87.07$].¹¹

Keiretsu effects on R&D and nonR&D alliances

Our interest lies specifically in the *keiretsu* effects and whether and how they vary by alliance type. First, H3a fails—R&D alliances are *not* less likely than nonR&D alliances to form within vertical groups. The vertical *keiretsu* effects prove all but identical in the R&D and nonR&D regressions. Secondly, these take the (asymmetric) *positive homophily* form specified by H1a: firms in the same vertical group are much more likely to forge new alliances than is every other pairwise combination. There is no evidence here of *negative homophily* (H1a)—that inter-group alliances are the least likely outcome.

As H2a anticipates, the horizontal *keiretsu* effects are smaller and less consistently significant. Furthermore, and at odds with H3b, they appear to differ between the R&D and nonR&D regressions in the way we predicted of the vertical *keiretsu* effects but did not find: *keiretsu*-similar firms form nonR&D but not R&D alliances. However, a Wald likelihood ratio test finds the difference between these sets of coefficients to be nonsignificant. Still, the sharp contrast between the zero *DiffHK* effect in the R&D case and its sizable counterpart in the nonR&D case inclines us to believe this result. Also of note is that the horizontal *keiretsu* effects take the “symmetric” positive homophily form (H1a’): alliance formation rates do not differ between the intra-group and independent - independent pairings. Finally, there is no support here for H2b: horizontal *keiretsu* centrality.

¹¹ All such cross-equation tests are done on the regressions with fixed temporal effects (Equation 1). The Stata post-estimation *Suest* (seemingly unrelated regression estimation) command used to generate them does not support the generalized estimating equation (*Xtgee*) approach.

Prior alliance network effects

Putting aside for now the question of *keiretsu* effects, does the prior alliance network, as H4a and H4b suggest, shape alliance formation, and is that process conditioned on the alliance goal? Our broad expectation (supported in the *keiretsu* analysis by the horizontal but not the vertical group results) is less network inertia (old ties begetting new ties) in the R&D case. The evidence for that in the prior alliance analysis is strong and consistent. Of our six measures of relation and position in the prior alliance network (*PriorTie*, *3rdPartyTie*, *CentSum*, *CentProd*, *TotPriorSum*, and *TotPriorProd*), all but the last, which plays no role in either regression, have higher profiles in the nonR&D case. The likelihood ratio χ^2 test of this set of differences is 10.4 ($p < .06$).

Clearly, however, the largest R&D/nonR&D contrasts concern the centrality effects. *CentSum*, *CentProd*, *TotPriorSum*, and *TotPriorProd* contribute only to the odds of nonR&D alliance, so H4b is confirmed. The total prior ties effect is wholly at the nodal level (no interaction exists), while the Bonacich centrality effect is dyadic (a significant positive interaction exists). Thus, when both firms are central in the prior alliance network, the likelihood of a nonR&D alliance gets a boost above and beyond the additive effects of the two centralities.

The prior direct and indirect (3rd party) probit coefficients differ less between the alliance type regressions, and one might legitimately wonder if the lower density of the R&D alliance matrix (hence smaller variance and greater skewness of the outcome variable) is the cause. Yet the marginal effect of a prior tie-- the unique increment in probability— on the launch of a new nonR&D alliance is three times the corresponding effect on an R&D alliance (.0046 versus .0015; $p < .05$).¹² Likewise, the existence of a prior year third-party tie raises the probability of a nonR&D alliance by .0002, an R&D alliance by half that (.00011). Thus, H4a fails—the prediction that indirect (“weak”) ties support R&D more than nonR&D alliances while the opposite is true of direct (“strong”) ties. Prior direct and indirect alliance ties

¹² Although Tables 3 and 4 report the standard probit regression coefficients, we refer here to the marginal probability effects.

alike bear on nonR&D more than R&D alliance foundings. The period analysis suggests (Table 4), however, that over time indirect ties grew more important relative to direct ties as conducive infrastructure for R&D alliances and less important for nonR&D alliances.

Financial-industrial attributes

The financial and industry attributes serve mainly as controls, but some overview of their roles is warranted. “Functional complementarity”—the dyad spans electronics industry subsectors—proved a net positive contributor to alliance creation in Gulati and Gargiulo’s (1999) analysis. The alliances we study, however, fall *within* electronics sub-sectors, not across them. That is, the estimated coefficient is strongly negative, somewhat more so in the nonR&D case, a difference just shy of significance at the 10% level [$\chi^2_{(1)} = 2.69$]. This is weakly consistent with the conjecture that innovative alliances tolerate/require more partner diversity than nonR&D alliances do.

Solvency has no firm- or dyad-level effect, but the two firms’ sales (in Equation 2) and liquidities interact positively in determining the odds of nonR&D alliance. Their profitabilities interact negatively and almost identically in the R&D and nonR&D regressions. Due to an inflated standard error, the profit coefficient in the nonR&D case is nonsignificant, but a cross-equation χ^2 test finds no difference with the R&D results.¹³ The negative profit interaction with respect to innovative alliances brings to mind the much-studied tie-ups between cash-strapped biotechs and deep-pocketed pharmaceuticals. That it is, if not larger, more stable in the R&D model may bespeak a parallel propensity in Japanese electronics for strong and weak firms to ally.¹⁴ Also likely, however, is that strategic alliances serve a risk-sharing

¹³ Note that the negative profitability and liquidity interactions are consistent with the *keiretsu* risk-sharing scenario.

¹⁴ Gerlach and Lincoln (2000) discuss the centrifugal process whereby innovative start-ups in Japanese electronics are launched as spin-offs from a large firm but are kept within the latter’s orbit of influence through *keiretsu*-type ties (equity stakes, personnel transfers) *and* strategic alliances). Note, however, that we do not here find a significant dyad-level (interaction) effect of firm size as measured by sales.

function such that strong companies—perhaps at the behest of creditors, *keiretsu* partners, and government regulators—enter alliances with weak ones in hopes of reversing the latter’s failing fortunes.

Period-specific results

The changing keiretsu role

We have thus found a number of strong statistical associations between Japanese electronics firms’ vertical and horizontal *keiretsu* attachments and their pursuit of R&D and nonR&D strategic alliances. These are net of various firm- and dyad-level attributes pertaining to those firms’ past strategic alliance networks and their industrial and financial makeup. We now study the stability of these patterns over time. There is reason to suppose that the *keiretsu* effect on alliance formation was not constant across a turbulent stretch of Japanese economic history. Nor, presumably, were the effects of firms’ relations and positions in prior alliance networks. Our 14-year observation interval spans several spells of major crisis and change: the bubble era (1988-90) of superheated asset appreciation and global expansion; the post-bubble crash, recession, and retrenchment (1991-94); and finally the 1995-98 period, marked, initially, by strong economic growth but which foundered again on the shoals of the 1997-98 Asian financial crisis. The latter nineties, moreover, were a time of significant regulatory and corporate governance change.

We hypothesized (H5a) a fall in the *keiretsu* effect on alliance activity—innovative ones in particular-- over the entire 1985-98 series, the bulk of the change coming between the prebubble (1985-90) and postbubble (1991-98) periods. Prior research on *keiretsu* clusterings finds them declining in cohesion and economic consequence (e.g., in risk-sharing activity).¹⁵ Through the same interval Japan’s global economic integration was rising, and Japanese firms in electronics, autos, and other competitive industries were shedding time-worn practices and strategies and embracing new ways and new partners.

In like fashion, we hypothesized (H5b) less inertia or persistence in the partner selection process— especially after the bubble economy’s collapse and more with respect to R&D than nonR&D

¹⁵The greatest declines were from the prebubble era to the late 90’s, albeit with some groups fading faster than others and some periods temporarily reversing the longer term trend.

alliance foundings. However, an opposite prediction might be credibly made. If *keiretsu* networks were providing less of the trust, experience-testing, and third-party monitoring that strategic alliances require, perhaps alternative networks were emerging to take their place. It is a plausible conjecture that, as *keiretsu* commitments fell away, electronics firms' ties and positions within the network of extant and prior alliances took on greater importance in partner search and choice.

To address these questions of change, we periodized our time series, running the R&D and nonR&D regressions within each of four sub-intervals: the prebubble (1985-87); the bubble (1988-1990); the postbubble recession (1991-1994); the late 90's restructuring (1995-98). The prebubble era represented the peak in the evolution of the "old" Japanese network economy: tight-knit *keiretsu*, bank monitoring; ministry guidance; opaque corporate governance; and the like.

<Table 4 about here>

What is most notable about the prebubble results is the strong horizontal *keiretsu* effects on R&D alliance foundings. Their form is (asymmetric) positive homophily—all three horizontal *keiretsu* terms take significant and negative coefficients of equal magnitude. But a centrality hierarchy consistent with H2b is evident as well: *BothNonHK* alliances are least common; followed by *HK&nonHK*; *DiffHK*; then same horizontal *keiretsu* (*SameHK*, the baseline).

According to Table 4, the prebubble (85-87) was the *one* period in which the R&D alliance process was detectably influenced by horizontal *keiretsu* ties. The contrast with the next period—the bubble era—is striking. While only the coefficient on *BothNonHK* is significant, the horizontal *keiretsu* effects have shifted to *positive*. Moreover, by a $\chi^2_{(3)}$ of 8.05, they differ at the .05 significance level from their prebubble counterparts. In the two later periods they revert to negative again. Other *keiretsu* research shows the bubble to have been a nadir in the historical trajectories of the horizontal groups, followed in the recessionary aftermath by a (short-lived) rebound in cohesion and action (Lincoln and Gerlach, 2004: Ch. 3).

On the other hand, the horizontal *keiretsu* effects on nonR&D alliance foundings exhibit positive homophily up to the final (restructuring) period, 95-98. None are significant in the prebubble, a pattern sharply at odds with our contention that the strategic alliances of the time were severely *keiretsu*-constrained. Still, a difference-of-slopes test between the nonR&D and R&D equations fails [$\chi^2_{(3)} = 3.68$, $p = .299$], so we do not speculate on what may be an anomalous result. A test for the cross-equation equality of *all* the network effects (*keiretsu* and prior alliance) yields a $\chi^2_{(10)}$ of 39.44, significant beyond the .0001 confidence level.

But the 1995-98 restructuring era is when the horizontal *keiretsu* constraint radically shifts, exhibiting a strong “negative centrality” pattern not heretofore evident in our analysis. As nonR&D alliance partner prospects, *keiretsu* firms in the latter 90’s, it seems, were transformed into pariahs of a sort: an alliance was most likely when neither party to the dyad had a horizontal group affiliation; next so when just one did; and least so when both did, whether in the same or different groups. A test contrasting the horizontal *keiretsu* effects on nonR&D alliances between the 91-94 and 95-98 periods is significant beyond the .0001 level by a $\chi^2_{(3)} = 29.14$. Combined with the lack of a horizontal *keiretsu* effect on R&D alliances, the latter 90’s has the look of a “regime shift” (Pempel, 2000): the wholesale disappearance of horizontal *keiretsu* homophily *and* centrality as constraining forces in the strategic partnering of Japanese firms. While a dramatic break with the past, this result accords with other evidence on the unraveling and deactivation of the horizontal *keiretsu* from the mid-90’s on.

The vertical *keiretsu* effects are much more stable over time. They fade to nonsignificance in the last two periods, but they retain negative signs and, in the *DiffVK* case, strength. The column 6 versus 8 difference is not significant by a $\chi^2_{(2)} = 2.83$ ($p > 0.243$). The column 8 versus 4 comparison, however, is [$\chi^2_{(3)} = 29.14$, $p > .065$].

Moreover, the vertical *keiretsu* constraint on nonR&D alliance foundings, after weakening in the bubble, returns with a vengeance in 1995-98. A test contrasting the 91-94 and 95-98 regressions is significant ($p < .0001$) by a $\chi^2_{(3)} = 29.14$.

Change in the prior alliance effects

How does Table 4 speak to our hypothesis (H5b) that, not only did the *keiretsu* hold on alliance activity loosen through this period of time, but so did that of the prior alliance network; to wit, in an increasingly turbulent business environment old ties mattered less than previously in the determination of new ones?

Favoring H5b is the notably larger pre-bubble compared to post-bubble contributions to alliance activity of the centrality variables (*CentSum*, *CentProd*, *TotPriorSum*, and *TotPriorProd*). Opposing it is the intensification of the third-party effects in the two postbubble periods (91-94 and 95-98) along with the discernible 1995-98 uptick in the prior alliance effect. This data pattern comports with our view that the networks embedding alliance activity—both *keiretsu* and prior alliance-- had become less integrated, more fragmented, toward the end of our series. The focal dyad's prior alliances and third party ties took on the trust-building and monitoring roles that had been the *keiretsu*'s and so constrained the alliance formation process more. Centrality or peripherality in the prior alliance network, however, constrained it less. With that network less an integrated whole than in the past, position in it conveyed a weakened “social capital” signal as to each firm's access to and from all others.

Change in the industrial/financial effects

Some period fluctuations in the roles of the financial/industrial variables are evident, but most are insufficiently important to warrant separate comment. One that does is the disappearance of the negative functional complementarity effect, particularly on R&D alliances, in later years. That the partners to innovative ventures represented a more diverse set of industries toward the end of our series than the beginning squares with our general take on the evolution of Japan's economy over this span of time.

DISCUSSION

We have produced a set of generally clear and consistent empirical findings on the changing role of Japan's legacy corporate networks in the strategic alliance formation process in that country's

electronics industry. Our inquiry combines an examination of how prior alliance networks condition alliance foundings—a mainstay of contemporary strategic alliance research—with an analysis of how *keiretsu* networks—both vertical and horizontal—similarly channel the search for and selection of alliance partners.

How *keiretsu* networks constrained the rates at which Japanese electronics firms formed strategic alliances has been shown to vary with the *keiretsu* type (vertical versus horizontal), the alliance goal (R&D or not), and period (1985-87 prebubble, 1988-90 bubble, 1991-94 postbubble slump, and 1995-98 restructuring era). As anticipated by H1a, the dominant form assumed by both *keiretsu* effects is positive homophily: strategic alliances were much more likely *within keiretsu* clusters than between: (1) two firms from different *keiretsu*; (2) a *keiretsu* firm and independent. Pairings of independent firms (the ‘symmetric positive homophily’ hypothesis of H1a’) were also for the most part unlikely to yield alliances, but we did observe this pattern in the similar nonR&D alliance rates of horizontal independents and same horizontal group firms.

A key argument of our paper is that the “strong tie” networks that the *keiretsu* represent were more constraining of *implementation* alliances (nonR&D) than *innovation* alliances (R&D). Our analysis of the pooled 1985-98 panel data set finds that to be an accurate characterization of the horizontal *keiretsu* constraint but not its vertical *keiretsu* counterpart, which proved essentially identical on nonR&D and R&D alliance foundings. Yet the aggregate pattern masks important period differences. The hypothesized homophily/centrality effects of horizontal *keiretsu* in the R&D cases materialized *only* in the first period—1985-87. They do shape nonR&D alliances in this fashion through the postbubble (91-94) years, but that, too, is replaced in the last (95-98) period by a striking pattern wherein horizontal *keiretsu* firms—once central actors in (nonR&D) alliance networks—are relegated to the periphery; i.e., participating in alliance foundings at rates below their independent counterparts.

By contrast, the vertical *keiretsu* have similarly strong and significant homophilic effects on R&D and nonR&D alliances in the first two (prebubble and bubble) periods, but in the second two (postbubble and restructuring) those effects vanish from the R&D partnering process. They persist, however, in the

nonR&D process. Indeed, the vertical *keiretsu* constraint is as pronounced and significant in the 1995-98 restructuring period as in the 1985-87 prebubble period and considerably more so than in the intervening 1988-94 years. The reason, we strongly surmise, is the vertical groups' deployment of the strategic alliance form as a mechanism of cost-saving consolidation and other restructuring.

Thus, our core hypothesis on the *keiretsu*—that they constrained R&D alliances less than nonR&D alliances—finds overall support with one major proviso: that this was not always such but rather describes the “new” network regime into which Japan transitioned in the wake of the bubble economy's demise. In the old regime—most of all the 1985-87 prebubble when the *keiretsu* were at their most cohesive across the periods we examine (see Lincoln and Gerlach, 2004: Ch. 3)-- both implementation and innovation alliances were heavily intra-group.

The onset of this transformation of the *keiretsu* hold on R&D alliances was earlier for the horizontal groups than the vertical groups, a pattern consistent with our claim that the former's “weaker-tie” structuring made them less constraining of innovative alliances than the latter's “stronger-tie” configuration. Another credible interpretation, however, is that the bubble era (when Japanese companies were abandoning those erstwhile kingpins of the horizontal *keiretsu*—the large commercial banks—for the lure of equity financing in an inflated stock market) was a much more stringent environment for the horizontal than the vertical groups, which at the time were being heralded in and outside Japan for their role in Japanese manufacturing's worldwide superiority.

Our evidence on the *keiretsu* constraint is made especially credible, we believe, by its independence of the prior alliance effects that have drawn so much attention in the network tradition of strategic alliance research. Beyond our vertical and horizontal *keiretsu* classifications, the models presented here include such dyad-level variables as prior direct and third-party alliance ties; the firm- (main effect) and dyad- (interaction) level centrality terms; and (in Table 3's Equation 2) the density of the alliance network as a whole. Some of these vary over time in ways that complement the fluctuations in the *keiretsu* effects. While the *keiretsu* constraint on R&D alliance founding attenuated in the postbubble era, the third-party effect intensified, suggesting that the monitoring and brokerage roles that

had been the *keiretsu*'s were shifting to the prior alliance network. On the other hand, the advantage in positioning for new alliances of centrality in the "old" alliance network diminished in importance (particularly in the R&D case) from pre- to post-bubble, indicating that a firm's generalized "social capital" was contributing less to strategic partner selection, while the dyad-level properties of direct and indirect alliance history were contributing more. These patterns comport well with our general argument that the strategic alliance network in Japanese electronics, once heavily constrained by the macro-level contours of *keiretsu* alignment and status, was giving way in a modernizing and marketizing economy to a set of much more micro-level and strategic processes of partner choice and alliance creation.

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Figure 1. Plots of new R&D and nonR&D strategic alliances in the Japanese electronics industry, 1985–1998

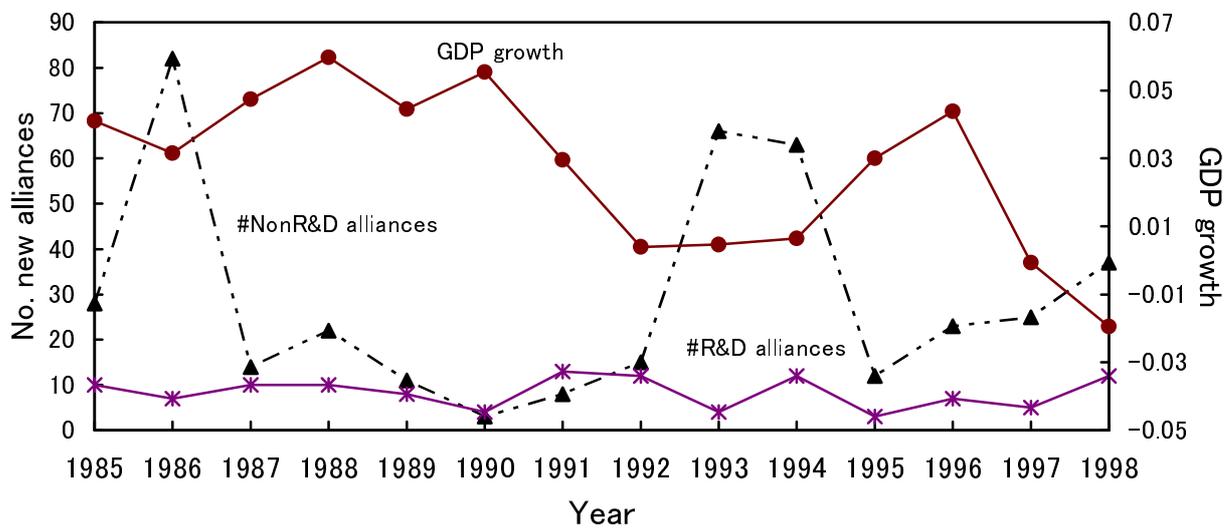


Table 1. Illustrative strategic alliance announcements

Alliance Type	Examples
R&D	<p>“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.[...]” <i>(Nihon Kogyo Shinbun – Dec. 8, 1995)</i></p>
Non R&D	<p>“Sharp announced on April 15 that its new cellular phone to be commercialize will be manufactured by Nihon Musen Co. [...]” <i>(Nihon Kogyo Shinbun – April 16, 1995)</i></p> <p>“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 [...]” <i>(Nihon Kogyo Shinbun – December 1, 1994)</i></p>

Table 2. Descriptive statistics		
Variable	Mean	St Dev
<i>R&D alliance (=1)</i>	.0001	.0311
<i>NonR&D alliance (=1)</i>	.0034	.058
<i>SameVK: Firms I & J are in the same vertical keiretsu</i>	.0233	.1509
<i>DiffVK: I & J are in different vertical keiretsu</i>	.196	.397
<i>VK&NonVK: I is in a vertical keiretsu and J is not</i>	.502	.500
<i>BothVKInd: Neither I nor J are in a vertical keiretsu</i>	.279	.448
<i>SameHK: I & J are in the same horizontal keiretsu</i>	.040	.197
<i>DiffHK: I & J are in different horizontal keiretsu</i>	.183	.387
<i>HK&HKInd: I is in a horizontal keiretsu and J is not</i>	.502	.500
<i>BothNonHK: Neither I nor J are in a horizontal keiretsu</i>	.274	.446
<i>FuncComp: Functional complementarity (I & J in different subindustries)</i>	.774	.418
<i>PriorTie: I & J had a prior (direct) strategic alliance tie (=1)</i>	.018	.133
<i>3rdPartyTie: I & J had a prior indirect alliance tie through a 3rd-party (=1)</i>	.072	.259
<i>CentSum: Sum of I & J's centralities in the prior alliance network network</i>	5.189	7.154
<i>CentProd: Product of I & J's centralities in prior alliance network</i>	6.902	31.977
<i>TotPriorSum: Sum of I&J's total prior alliances</i>	15.779	31.775
<i>TotPriorProd: Product of I&J's total prior alliances</i>	66.416	627.405
<i>TieDensity: Total alliances/total dyads in the year</i>	.038	.010
<i>SalesSum: Sum of I & J's total sales in prior year</i>	.541	.959
<i>SalesProd: Product of I & J's total sales in prior year</i>	.071	.511
<i>ROASum: Sum of I & J's (net income before taxes)/assets in prior year</i>	.074	.072
<i>ROAProd: Product of I & J's (net income before taxes)/assets in prior year</i>	.002	.004
<i>LiquiditySum: Sum of I & J's (assets – inventory)/ current liabilities in prior year</i>	3.707	2.086
<i>LiquidityProd: Product of I & J's (assets–inventory)/ current liabilities in prior yr</i>	3.446	4.472
<i>SolvencySum: Sum of I & J's (long-term debt/current assets) in prior year</i>	.111	.135
<i>SolvencyProd : Product of I & J's (long-term debt/current assets in prior year</i>	.003	.012

Table 3. Probit regressions of new R&D and nonR&D strategic alliances in Japanese electronics, 1985-98				
Explanatory variables	(1)		(2)	
	NonR&D	R&D	NonR&D	R&D
<i>Horizontal keiretsu classification</i>				
DiffHK	-0.242* (0.115)	-0.033 (0.203)	-.221* (.112)	-.028 (.314)
HK&NonHK	-0.261* (0.116)	-0.151 (0.196)	-.268* (.115)	-.147 (.205)
BothNonHK	-0.133 (0.117)	-0.140 (0.181)	-.116 (.117)	-.121 (.189)
<i>Vertical keiretsu classification</i>				
DiffVK	-0.758** (0.115)	-0.698** (0.177)	-.710*** (.115)	-.709*** (.184)
VK&NonVK	-0.724** (0.112)	-0.679** (0.160)	-.693*** (.114)	-.690*** (.167)
BothNonVK	-0.816** (0.132)	-0.663** (0.243)	-.825*** (.132)	-.677** (.262)
<i>Prior alliance network</i>				
PriorTie	1.207** (0.101)	0.838** (0.146)	1.193*** (.104)	.796*** (.147)
3rdPartyTie	0.336** (0.098)	0.226+ (0.122)	.376*** (.019)	.221 (.125)+
CentSum	-0.037** (0.012)	0.011 (0.015)	-.036** (.012)	.002 (.015)
CentInt X 100	.334** (0.0829)	0.439 (0.977)	.378*** (.082)	.45 (.98)
TotPriorSum	0.004+ (0.002)	0.001 (0.002)	.005* (.002)	.001 (.003)
TotPriorProd X 100	-0.018 (0.029)	0.036 (0.035)	.038 (.028)	.035 (.037)
<i>Financial and industry structure</i>				
SalesSum	-0.053 (0.051)	0.009 (0.067)	-.042 (.049)	-.004 (.065)
SalesInt	0.036 (0.027)	0.007 (0.032)	.053* (.026)	.003 (.032)
FuncComp	-0.382** (0.062)	-0.202* (0.087)	-.403*** (.063)	-.207* (.088)
ROASum	0.887 (1.128)	0.661 (0.678)	1.513 (1.226)	.658 (.693)
ROAProd	-27.925 (21.131)	-23.053* (8.963)	-14.959 (28.845)	-24.142*** (7.859)
SolvencySum	-0.624 (0.393)	-0.081 (0.405)	-.810* (.374)	-.075 (.399)
SolvencyProd	1.206 (5.360)	-2.151 (6.105)	-.215 (5.225)	-2.766 (6.188)
LiquiditySum	-0.081** (0.026)	-0.045 (0.036)	-.116*** (.033)	-.046 (.034)
LiquidityProd	0.034** (0.006)	0.010 (0.018)	.036*** (.006)	.010 (.016)
<i>Time-dependent covariates</i>				
Year (85-98)	-----	-----	-.215*** (.063)	-.021 (.084)
TieDensity	-----	-----	75.381** (25.331)	-13.270 (30.548)
GDPGrowth	-----	-----	-6.746** (2.617)	-3.035 (3.843)
Autoregression	58.167** (4.371)	61.095** (7.197)	40.532*** (2.764)	56.613*** (6.716)
Constant	-1.955** (0.196)	-2.564** (0.214)	14.848** 4.887	-.311 (6.617)
Pseudo R ²	0.6196	0.4229		

Robust standard errors in parentheses. +p<10, *p<.05, **p<.01, ***p<.001.
Regression includes year fixed-effects (13 dummy variables for years 1986-98).
Note: Eq 1 is a maximum-likelihood probit model with robust standard errors adjusted for clustering on dyad. Eq. 2 is a population-averaged random effects panel model with with time and unit (dyad) components and first-order autoregression.

Table 4. Probit regressions of R&D and nonR&D alliance findings by period ^a								
Explanatory variables	85-87		88-90		91-94		95-98	
	nonR&D	R&D	nonR&D	R&D	nonR&D	R&D	nonR&D	R&D
<i>Horizontal keiretsu classification</i>								
DiffHK	-0.163 (0.280)	-0.316* (0.150)	-0.501 (0.347)	0.411 (0.424)	-0.391** (0.150)	-0.069 (0.379)	0.186 (0.242)	0.050 (0.547)
HK&NonHK	-0.158 (0.278)	-0.440* (0.179)	-0.794* (0.311)	0.336 (0.373)	-0.623** (0.161)	-0.155 (0.358)	0.548* (0.244)	-0.144 (0.548)
BothNonHK	0.132 (0.280)	-0.694* (0.334)	-0.232 (0.311)	0.478+ (0.269)	-0.702** (0.169)	-0.176 (0.350)	0.684** (0.258)	-0.205 (0.531)
<i>Vertical keiretsu classification</i>								
DiffVK	-0.976** (0.295)	-0.583** (0.198)	-0.677* (0.339)	-1.259** (0.305)	-0.640** (0.163)	-0.514 (0.374)	-1.385** (0.176)	-0.556 (0.424)
VK&NonVK	-0.905** (0.292)	-0.691** (0.172)	-0.716+ (0.370)	-1.274** (0.320)	-0.616** (0.158)	-0.511 (0.338)	-1.050** (0.157)	-0.173 (0.363)
BothNonVK	-1.013** (0.342)	-0.593* (0.264)	See note b	See note b	-0.493** (0.189)	-0.472 (0.443)	-1.220** (0.226)	0.004 (0.555)
<i>Prior alliance network</i>								
PriorTie	1.059** (0.255)	0.773** (0.279)	1.882** (0.508)	0.797* (0.321)	0.641** (0.187)	0.705** (0.255)	1.409** (0.199)	1.064** (0.381)
3rdPartyTie	0.305 (0.218)	-0.167 (0.320)	0.613 (0.560)	See note b	0.353** (0.134)	0.405* (0.189)	0.137 (0.176)	0.446+ (0.262)
CentSum	-0.135** (0.040)	0.065+ (0.034)	-0.048 (0.061)	-0.105* (0.046)	-0.006 (0.021)	0.023 (0.032)	-0.024 (0.022)	-0.001 (0.025)
CentProd	0.013** (0.003)	-0.005+ (0.003)	0.000 (0.004)	0.009** (0.003)	0.004* (0.002)	-0.001 (0.002)	0.001 (0.001)	-0.000 (0.001)
TotPriorSum	0.034** (0.013)	-0.018 (0.011)	-0.005 (0.008)	0.022** (0.006)	-0.007 (0.006)	0.004 (0.004)	0.007* (0.003)	0.005 (0.006)
TotPriorProd X 100	-0.081** (0.027)	0.061* (0.026)	0.039* (0.018)	-0.014 (0.021)	0.021* (0.008)	-0.000 (0.007)	0.003 (0.004)	0.012* (0.006)
<i>Financial and industrial structure</i>								
SalesSum	-0.152+ (0.086)	0.103 (0.120)	0.154 (0.293)	0.151 (0.197)	0.098 (0.102)	-0.148 (0.136)	-0.108 (0.086)	0.067 (0.135)
SalesProd	0.232* (0.093)	0.021 (0.080)	-0.110 (0.134)	-0.270 (0.210)	-0.093+ (0.052)	0.121* (0.057)	0.029 (0.036)	-0.146* (0.062)
FuncComp	-0.255+ (0.136)	-0.286+ (0.167)	-0.519** (0.189)	-0.363+ (0.188)	-0.525** (0.109)	-0.028 (0.197)	-0.260* (0.128)	-0.172 (0.164)
Roasum	0.831 (2.663)	-0.100 (0.973)	2.789 (3.542)	0.020 (2.166)	-0.686 (0.827)	0.169 (1.574)	1.715 (1.572)	1.472 (1.458)
RoasumProd	-55.514 (36.336)	-18.340+ (10.040)	-20.404 (45.132)	22.321 (23.242)	43.253+ (25.566)	-85.540* (37.720)	-14.473 (29.426)	-44.445* (17.925)
SolvSum	-0.084 (0.800)	-0.187 (1.058)	-0.944 (1.296)	0.884 (1.142)	-1.167+ (0.658)	-0.155 (0.684)	0.228 (0.337)	-0.176 (0.569)
SolvProd	-0.571 (9.138)	-22.233 (36.826)	-350.192+ (186.791)	0.030 (5.283)	-0.708 (11.385)	2.050 (4.337)	1.600 (1.755)	-6.081 (11.468)
LiquidSum	-0.017 (0.108)	-0.041 (0.080)	0.005 (0.140)	0.020 (0.087)	-0.069* (0.032)	-0.005 (0.080)	-0.053 (0.067)	0.070 (0.113)
LiquidProd	0.001 (0.069)	0.012 (0.032)	-0.134 (0.108)	0.006 (0.046)	0.031** (0.006)	-0.047 (0.078)	0.014 (0.022)	-0.075 (0.099)
Autoregression	71.261** (9.703)	47.792* (20.375)	100.334** (18.924)	73.908** (19.974)	45.790** (6.666)	72.617** (11.644)	45.355** (6.984)	-36.785 (25.027)
Constant	-1.968** (0.328)	-2.334** (0.327)	-2.332** (0.402)	-2.957** (0.516)	-2.254** (0.303)	-3.533** (0.523)	-2.965** (0.397)	-4.142** (0.564)
Pseudo R ²	0.695	0.398	0.582	0.485	0.644	0.511	0.598	0.447
Robust standard errors in parentheses. +p<10, *p<.05, **p<.01, ***p<.001.								
^a Regression includes year fixed-effects (13 dummy variables for years 1986-1998)								
^b Coefficient cannot be estimated because the explanatory variable is a constant								