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BUSINESS GROUPS, NETWORKS, AND EMBEDDEDNESS:

INNOVATION AND IMPLEMENTATION ALLIANCES IN JAPANESE ELECTRONICS, 1985-1998*

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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 123-135 Japanese electronics/electrical machinery makers, we use a dyad panel regression methodology to address a series of hypotheses drawn largely from embeddedness theory on how the firms' horizontal and vertical keiretsu business group affiliations and prior alliance networks supported and constrained partner choice in new R&D (innovation) and nonR&D (implementation) domestic economy alliances. We find that in the first half of our series (1985-91; the "preburst" period) keiretsu served as infrastructure or platform for new strategic alliances that had both innovation and implementation goals. In the second half of our series (1992-98, the "postbubble" period) the keiretsu effects on innovation alliance formation were gone, but the groups' role in nonR&D or implementation alliances, the purpose of which was often cost reduction, had expanded. Our results suggest that Japanese electronics firms over this interval of time adapted rationally to the heightened uncertainty and stringency of the Japanese domestic economic environment by searching outside their preexisting networks for innovation alliances while at the same time exploiting those networks for implementation alliances addressed to cost-reduction and other operational aims. The study speaks to embeddedness theory in showing that economic actors are not deterministically constrained by business group or other preexisting network ties but may in rational fashion exploit or abandon those ties with an eye to advancing corporate and alliance goals.

BUSINESS GROUPS, NETWORKS, AND EMBEDDEDNESS

Innovation and Implementation Alliances in the Japanese Electronics Industry, 1985-1998

The word marugakae literally means an "all encompassing embrace. " ...It describes the relationship between firms closely allied with one another. (It) can lead to substantial ..progress when there is some combination of moderate ... uncertainty and pace of change. Yet when there is ... high uncertainty, (marugakae).. can be a major source of weakness in an economy....(Then} ..give-and-take among strangers ... outperforms marugakae for separating the wheat from the chaff (Rtischev and Cole, 2003).

INTRODUCTION

An important and consistent finding of strategic alliance research is that new partnerships are embedded in an infrastructure, or, alternatively, erected on a platform, of pre-existing networks. More is at work here than a process of firms that allied in the past pairing up again in the future. The logic of alliance formation is a network, not merely a dyadic or nodal (firm-level), one. The positioning of the partners; the availability of third party ties; the macro-structural properties of the network such as clustering and connectivity—all have been shown to condition the formation of new ties (Schilling and Phelps 2007). As Gulati (1998) suggests, such patterns are counter-intuitive. One assumes that firms pursuing strategic alliances rationally assess the resources and skills a partner might supply, scan the environment for candidates whose asset and capability profiles supplement or complement their own, and then proceed to forge the tie. The reality is that organizations either enter new alliances with old partners—and the past or present

partners of old partners—and if they do venture outside their preexisting networks it is in a path-dependent, incremental way.

We address the structure and functioning of some historically important country-specific corporate networks—the keiretsu—that have long shaped strategic business partnering in Japan. Over much of the postwar period, these stable clusters of interlinked firms represented a core institutional feature of Japanese industrial organization, having many well-documented effects on the strategies, governance, and performance of individual firms; the configuration and operation of Japanese capital and industrial goods markets; Japan's distinctive patterns of international trade; and the Japanese government's regulatory practices. Yet the role of the keiretsu as supportive as well as constraining network infrastructure in the formation of Japanese firms' strategic alliances has been largely neglected. Moreover, while Japanese companies' international alliances have been widely investigated and discussed—especially in the 80's and early 90's when they were criticized as vehicles for one-sided learning (Reich and Mankin 1986)—the same has not been true of alliances within the domestic Japanese economy.

With a panel data set on strategic alliance foundings among publicly-listed firms in the Japanese electronics industry observed yearly from 1985 to 1998, our paper addresses the following questions: to what extent were new strategic alliances in the Japanese electronics industry situated within, as opposed to across or outside, keiretsu groupings? Did such embeddedness in keiretsu vary with the types of keiretsu (horizontal versus vertical) and alliance (R&D or nonR&D)? Did the functioning of keiretsu as network scaffolding for new alliances furthermore erode over time, in particular, from the pre-(1985-91) and post-(1992-98) bubble years, the latter a period of major turbulence, stress, and restructuring for Japan? Our analysis and findings address and advance a number of recent theories and research streams on the

network embeddedness of corporate alliance processes and the conditioning of those processes on patterns of change and uncertainty in market and institutional environments.

What are (were) the keiretsu?

Often characterized as business groups, the keiretsu have been quite unlike the business groups so prominent in emerging economies and to which much scholarly attention has recently been paid (see Morek, 2010, for a review). Business groups in countries other than Japan are well-bounded clusters coordinated centrally by a family-controlled headquarters or holding company situated atop a cascading pyramid of equity ties (Granovetter 2003). The keiretsu (as contrasted with the Japanese prewar zaibatsu) exhibited no such hierarchical control but have in fact been loose networks composed of fairly sparse equity and board links, personnel transfers, and preferential trade and lending flows.

Over most of the postwar period, large numbers of Japanese firms were in varying degrees enmeshed in these webs. Unsurprisingly, then, the keiretsu phenomenon has received close scrutiny from scholars, policy makers, and business practitioners (for a review see Lincoln and Gerlach 2004). A sizable interdisciplinary literature examines, at a macro level, the configuring of the keiretsu as a distinctive industrial organization form (e.g., Caves and Uekusa, 1976), and, at a micro one, their consequences for the behavior and performance of affiliated firms (e.g., Nakatani, 1984). Although few studies to date consider the keiretsu as a platform for the construction of explicit strategic alliance, a large scholarly and journalistic literature documents a substantial degree of interfirm cooperation within keiretsu groups. The vaunted flexibility and efficiency of procurement transactions in Japanese manufacturing has been mostly a keiretsu-based phenomenon (Dyer; 1996; Sako and Helper, 1998), as were the intra-group monitoring and risk-sharing once thought to infuse the Japanese economy with superior

corporate governance (Hoshi, Kashyap, and Scharfstein, 1991; Nakatani, 1984; Sheard, 1989). Evidence we later present suggests that intra-group alliances aimed, among other objectives, at cost reductions enabled member firms to weather business cycle downturns.

Keiretsu as alliance infrastructure

Organizations join hands in strategic alliances in order to manage the acquisition of resources that are difficult to generate internally or because efficiencies and synergies can be had by doing so (Pfeffer and Salancik 1978; 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. 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 1982), invisible assets (Itami and Roehl 1987), or tacit knowledge (Hansen 1999). 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. The capabilities that one firm brings to the mix and the other needs and seeks are difficult to apprehend and copy. They may also be in-decomposable—contingent for their utility on a particular combination with other assets, skills, or facilitative conditions. Copying or buying or contracting for a set of capabilities while neglecting the soil they require in order to germinate and flourish is a failing that many companies, particularly in the knowledge-based industries, routinely repeat.

Such considerations suggest that strategic alliances require a supportive social context or infrastructure in order for the partner firms to grasp one another's routines, tap their respective tacit knowledge pools, communicate effectively, and otherwise cooperate. The evidence is

considerable that one infrastructure often mobilized for these purposes is the network of strategic alliances that firms crafted in the past.

In Japan, however, much of that infrastructure was supplied by the keiretsu. In an influential article, Ronald Dore (1983) argued that the patterns of business exchange and collaboration within the keiretsu and related business networks in Japan (such as regional clusters) are infused with "goodwill," his term for a blend of trust, reciprocity, obligation, and general stance of benevolence toward exchange partners. While Dore interpreted such patterns as distinctively Japanese, his argument is close in substance to the more general one of Granovetter (1985) appearing two years later. "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."

By Dore's as well as Granovetter's reasoning, when Japanese firms internalize or "embed" their strategic alliances in highly institutionalized networks such as keiretsu, they realize certain benefits. Specifically, the bureaucratic and market governance solutions prescribed by organizational economists—formal contracting, court adjudication, merger or acquisition, and the like—are less needed and in Japan, as a matter of historical fact, have been less used. Strategic alliances undertaken by firms within a common group are easy to form and low in risk, as hazards of opportunism and defection are diminished, and little governance is required beyond the supports and constraints afforded by the group. That Japanese firms are less prone than their

American counterparts to organize strategic alliances as formal equity joint ventures is a well-documented fact (Gulati and Singh 1998).¹

We begin, then, with the following hypothesis:

H1a: Two Japanese 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.

For clarity and precision, we can write *H1a* algebraically as follows. First consider the equation:

$$Y_{it} = \beta_0 + \beta_1 \text{DiffKei}_{it} + \beta_2 \text{Kei\&NonKei}_{it} + \beta_3 \text{BothNonKei}_{it} + \sum_k \gamma_k X_{kit} + \varepsilon_{it}$$

Y_{it} = "1" if a pair, i , of two Japanese electronics firms announces a new strategic alliance in year t , otherwise 0; DiffKei = "1" if the dyad spans two different keiretsu. BothNonKei = "1" if neither firm is a keiretsu member; and Kei\&NonKei = "1" if one firm is and the other is not. The excluded and therefore reference category is that the two firms are members of the same keiretsu. The $\{\beta\}$ and $\{\gamma\}$ are regression coefficients to be estimated. In terms of this model, *H1a* states that intra-keiretsu alliances occur at the highest rate:

$$H1a: \beta_1 = \beta_2 = \beta_3 < 0$$

¹ 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."

Negative homophily: a contrasting take on intra-group alliance

H1a posits what we will call positive (or cooperative) homophily: Japanese firms' proclivity for intra-keiretsu alliance derived from the resources, economies, and other supports thereby gleaned. A second and alternative hypothesis posits negative (or defensive) homophily. This refers to intra-group partnering less for the benefits bestowed or obligations met than for the negatives incurred by going outside: in pursuit of tie-ups with rival groups or independents. Alliances that cross keiretsu lines invite knowledge spillovers and other competitive hazards so are shunned by risk averse firms. Indeed, a literature mostly in economics emphasizes the defensive function of internalizing corporate partnerships within protective governance structures in order to minimize uncontrolled information spillovers (Branstetter and Sakakibara 2002; Katz, 1986). Its focus is government-assisted consortia in providing a safe venue for knowledge-sharing and joint development. Famous examples include Japan's Ministry of International Trade and Industry's (MITI) VLSI project in the 80's and its U. S. counterpart, Sematech.

Although companies everywhere worry about information spillovers and thus seek to internalize innovation projects or embed them in preexisting networks, Japanese firms have been outliers in this regard. Whether in domestic or global arenas, they have shown a particular reticence to partnering with rivals or strangers, a pattern criticized in recent years as a factor in the country's faltering competitiveness (Chesbrough 2006; Dubarric and Hagi 2009).

H1b: Two Japanese firms are less likely to form a strategic alliance if they are in different keiretsu or if one is in a keiretsu and the other is not than if they are in the same keiretsu or if both are independents.

This phrasing suggests *that intra-keiretsu alliances enjoy no special advantages* over inter-independent alliances and so are no more prevalent. But both such alliance forms pose fewer competitive risks than do alliances that span the boundaries of one or more groups. We thus write the negative homophily hypothesis as:

$$H1b: \beta_1 < \beta_2 < \beta_3 = 0$$

Empirically, the difference between *H1a* and *H1b* turns on the placement of the independent firms. *H1a* contrasts within-group pairs with between-group pairs, group-and-independent pairs, and pairs of independents. *H1b* holds that within-group pairs and pairs of independents are the most alliance-prone configuration, followed by group-and-independent pairs, then cross-group pairs.

Still, the critics acknowledge that such practices did in the past facilitate Japan's postwar ascent to manufacturing powerhouse, and even today there exist manufacturing sectors in which Japanese firms maintain near-monopolies globally in part due to their success at keeping processes within the firm or group (*Economist* 2009).

Alliance formation as a firm-level process

Another perspective on the keiretsu role in fashioning Japanese strategic alliances shifts the unit of analysis from the dyad to the individual firm. In the existing literature, some alliance studies are pitched at the dyad level, addressing how the relations and attribute combinations of the pair condition partner choice and alliance probability (Stuart, 1998). Others discuss the individual firm and how its distinctive attributes (size, financial structure, past performance) and network position (e.g., brokerage) determine the alliances it pursues (Powell, Koput, and Smith-Doerr 1996).

Status-based patterns in which some actors are centrally and others marginally positioned in networks are an oft-noted network phenomenon (Davis 1991; Podolny 1993; Sorenson and Stuart 2008). As contrasted with the dyad-level processes of homophily or complementarity, they arise through the individual (nodal) -level process of some actors accumulating greater "social capital" (more proximate or positionally advantageous ties) than others.² Much research on strategic alliance formation patterns documents variations among firms in their alliance volumes. In the context of present concerns, our status-based prediction is that keiretsu-affiliated Japanese firms engage in more strategic alliances than their independent counterparts.

The reasons to expect keiretsu centrality in the formation of new strategic alliances turn on the resources—economic, social, cultural—controlled by the partnering firms. Prior to the collapse of the asset bubble in 1991, keiretsu firms commanded in Japanese corporate society the highest status, legitimacy, and respect. Besides the assistance of the group in times of trouble, they enjoyed the lowest cost of capital; they recruited from the best universities; they had the most support of local governments and national ministries; they had the best suppliers and distributors; and so on. Keiretsu affiliates thus comprised a pool of partner candidates attractive to any Japanese firm in search of strategic alliance. In this scenario, keiretsu-linked companies are disproportionately represented in alliances (hence independents are disproportionately excluded), but whether the alliance is within or across keiretsu boundaries matters not.

² Gould (2002) sees status hierarchies (ties distributed by actor attractiveness) and homophilic patterns (ties distributed by actor similarity) as alternative structural responses to the distribution of actor attributes. In his formal model, small inequalities in the valuation of attributes set in motion social processes that engender steep status hierarchies.

H1c: The keiretsu effect on strategic alliance is one of centrality, not homophily; i.e., within-group alliances and between-group alliances have equal and highest likelihoods of occurrence; alliances between group and independent firms are less likely; and alliances between independent firms are least likely to occur.

Put algebraically:

$$H1c: \beta_3 < \beta_2 < \beta_1 = 0$$

In this model, the alliance probability is proportionate to the amount of keiretsu affiliation in the pair. Cross-group pairs are just as alliance-prone as same-group pairs (i.e., $\beta_1 = 0$); pairings of group firms with independents are less so ($\beta_2 < \beta_1$); and pairings of independents are least so ($\beta_3 < \beta_2$).

Vertical and horizontal keiretsu

Two main keiretsu firms have been identified (Gerlach, 1992): (1) the vertical manufacturing keiretsu (hereafter vertical keiretsu); and (2) the horizontal keiretsu (*yoko keiretsu*) also known as financial keiretsu or enterprise groups (*kigyo shudan*). They differ in organization and function. Accordingly, their roles in strategic alliance formation should differ as well.

The vertical keiretsu were relatively tight-knit, hierarchically-ordered networks pivoting on a major manufacturer and fanning 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, One, and Adachi. 1988). In other settings, the vertical groups supplied the vehicle

whereby large manufacturers launched new ventures and diversified by spinning-off divisions as satellite operations in closely related industries (Ito, 1995).

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 affiliates were generally less cozy than the automobile industry norm (Asanuma 1989), they nonetheless facilitated technical cooperation, cost reduction, and flexibility, and thus 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 or parent firm, the vertical keiretsu were more "strategically" organized than the horizontal groups. Yet they, too, exhibited: durability of membership, reciprocal obligation, a commitment to risk-pooling, and shared community of fate. The manufacturers did business year after year with the same suppliers and distributors; they organized them in cooperative associations such as Matsushita's *kyoei-kai* (Sako 1996); they took (generally small) ownership stakes in them and transferred employees to them; they extended trade credits, and they secured bank loans (Ahmadjian and Oxley 2006).

However, the affiliate firms for the most part remained independently managed and owned. The horizontal keiretsu were loosely-coupled networks of large firms each hailing from a major industry sector. Of the "big-six," three descended from the prewar family-centered zaibatsu (Mitsui, Mitsubishi, and Sumitomo), whereas the other three—Fuyo, Sanwa, Dai-ichi Kangyo—emerged postwar as clusters centered on a large commercial bank (Caves and Uekusa

1976).³ At the core of each was a bank, an insurance company, a trading firm and several large manufacturers. Thus, the economic rationale for the horizontal keiretsu was less the exchange of products than the maintenance of stable and mutually supportive capital and governance ties (Aoki 1988).

Given the horizontal groups' broad sectoral diversification and low network cohesion, member firms were less interdependent functionally than in the vertical keiretsu. They thus offered fewer information and support advantages to industry-based alliances, which typically sought production scale economies or the expansion/ consolidation of supply and distribution channels.

H2a: The horizontal keiretsu effects on strategic alliance are smaller than the vertical keiretsu effects.

H2b: The horizontal keiretsu effects on strategic alliance take the negative homophily and status/centrality forms.

Alliance type and and keiretsu embeddedness

Dore's "Goodwill .." paper stressed the positive governance functions of keiretsu embeddedness for the business transactions of Japanese firms. For Granovetter (1985) and other network theorists, by contrast, whether embeddedness is good or bad for the actors involved depends on its level and circumstances (Uzzi, 1996). We argue similarly of strategic alliances in Japanese electronics: contingent on the environment (e.g., amount of change and uncertainty)

³ The bank-centered groups did, however, subsume some of the smaller prewar zaibatsu. For example, the Fuyo group absorbed the Nissan zaibatsu, and the Dai-ichi Kangyo group absorbed the Furukawa zaibatsu (see Gerlach, 1992).

and the purpose of the alliance (R&D or not); the embedding of such partnerships within keiretsu may make strategic sense and benefit the participating firms in the way Dore described. But embeddedness also may be overdone or inappropriately invoked and thus make negligible or even negative contributions to the adaptation and performance of firms (Burt 1992; Ruef 2002; Uzzi 1996; Uzzi and Spiro 2005; Zuckerman, 2003).

We will henceforth refer to nonR&D strategic alliances as "implementation" alliances to distinguish them from R&D-oriented "innovation" partnerships. The distinction is similar but not equivalent to March's (1991) "exploration" and "exploitation" dichotomy of organizational learning strategies. The limits of embeddedness are most conspicuous when the strategic undertaking targets innovation and so involves exploratory search and learning (Hansen 1999:86). An abundance of evidence shows that creativity and innovation require new and weak ties to diverse and unfamiliar alters (see, e.g., Baum, Calabrese, and Silverman 2000; Podolny, Stuart, and Hannan 1996). To be sure, the launch and execution of any corporate alliance will be facilitated to some degree by the trust, familiarity, meshing of routines, vetting by third-parties, etc., that the concept of embeddedness implies. But when innovation is the goal, process—smooth coordination—takes a back seat to outcome—creativity and inimitability. A strategically rational Japanese firm, then, should search outside its keiretsu and other preexisting networks for partnerships that target innovation.

H3a: The positive homophily effects of keiretsu are smaller when the alliance goal is innovation (R&D).

H3a is based on positive homophily reasoning: Japanese firms will venture beyond their keiretsu networks for innovation alliances, because the benefits obtained in newness, complementarity, and synergy outweigh those (trust, etc.) of intra-keiretsu partnering. For

implementation alliances, this relative weighting of intra- and extra-keiretsu advantages is reversed. Negative homophily reasoning yields a different prediction. It in essence says that actors do not so much seek similarity as avoid difference. In the present context, it stresses less the gains from embedded—intra-keiretsu—partnerships than the risk of losses in proprietary knowledge posed by alliances that cross keiretsu lines. As the creation and application of such knowledge is what R&D alliance is all about, such spillover hazards are a nontrivial concern.⁴ *H1b*, the negative homophily hypothesis, predicts that intra-group and inter-independent partnerships are of equal and greater probability than the inter-group and affiliate-and-independent alternatives. The modification of *H1b* that takes into account alliance type is the following:

H3b: The keiretsu negative homophily effects are larger when the alliance goal is innovation (R&D).

It is thus our argument that implementation alliances conform to a positive homophily logic, whereas innovation alliances follow a negative homophily logic. As earlier discussed,

⁴ An influential *Harvard Business Review* article by Kodama (1992) heralded the merits of the then-distinctively Japanese practice of placing cooperative innovation under protective organizational umbrellas: most notably the well-known MITI-led consortia, but trade associations and keiretsu groupings as well (Rtischev and Cole, 2003; Schaede, 2006). He singled out for particular praise the Sumitomo (horizontal) group alliance in semiconductors. Unacknowledged by Kodama, however, was the difficulty those consortia had in overcoming companies' resistance to cooperation across keiretsu lines. In the 1970's, MITI was forced to create two distinct research laboratories in order to get member firms and competing groups to join the VLSI project (Fransman 1990). The ministry faced similar difficulties persuading electronics firms to work together in the Fifth Generation Computer Projects in the 1980s (Guillot, Mowery, and Spencer 2000).

which model—positive or negative homophily—is judged the correct one turns on whether a difference exists in the alliance rates of intra-keiretsu and inter-independent dyads.

Finally keiretsu effects of the status centrality sort loom larger in innovation alliance. The human resource talent, the financial backing, the marketing clout, and other resources conducive to innovation success will depend on one or both alliance partners commanding the status and legitimacy that, in Japan in the 80's at least (more on the period question below), accrued heavily to keiretsu firms.⁵

H3c: The keiretsu status-centrality effects are larger when the alliance goal is innovation.

Temporal change and period effects

There is strong reason to suppose that the keiretsu embeddedness of Japan's domestic strategic alliance processes did not stay constant over time. This section lays out arguments for how the bursting of the asset bubble *circa* 1991 altered the Japanese business environment in ways that modified those processes.

Compared with the post-bubble 90's, the mid-to-late 80's were a time when the "Japan, Inc." model of ministry guidance, corporate internal labor markets, bank dependence, and keiretsu exchange and risk sharing was firmly in place. Both keiretsu forms were feared, admired, even emulated in the West (Dyer 1996). The prototypical Japanese electronics corporation of the time—large, diversified, integrated—won praise as well. Fujitsu, Matsushita, Mitsubishi Electric, NEC, Sanyo, Sony, and Toshiba boasted broad product lines ranging from commodity "white

⁵ Of course, implementation alliances formed to access new markets or distribution and supply channels might also derive benefit from a high status partner. Japanese companies' international alliances often have been of these kinds; their domestic industry-specific alliances less often.

goods" (*kaden*) such as rice cookers and air conditioners to complex semiconductors and computer systems. American business scholars such as Cusumano (1991) and Chandler (Chandler, Amatori, and Hikino 1999) saw the U. S. industry suffering from insufficient scale and scope, rendering it poor competition to the Japanese in product range, brand equity, quality, cost, and development speed.

Japan was riding high. Following the wrenching but short-lived *endaka* (high yen) slowdown brought on by the Plaza Accord of 1985, the economy rebounded to the bubble peak in 1989 when GDP growth neared 5% and the Nikkei Index hit an all time high of 38,915.

The postbubble "lost decade"

With the collapse of the Nikkei index and with it the bubble economy, the economic scene was transformed. Japan succumbed to a "lost decade" (and more) of recession, deflation, and financial distress. 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 rewritten the economy's institutional script. The changes included: tightened accounting rules; legalization of stock options, stock buybacks, and the holding company form; corporate governance reforms (smaller boards, outside directors and auditors); reduced cross-shareholding; rising foreign ownership; and a wave of financial consolidation unprecedented in the postwar era (Ahmadjian, 2003; Lincoln and Gerlach 2004: Ch. 6; Schaede 2008; Vogel 2006).

The electronics/electrical machinery industry was reconfigured as well. Notwithstanding strong global demand for consumer electronics and computer products, the sector struggled through the 90's with overcapacity, product proliferation, and price deflation. The rise of the Wintel standard, the Internet, and the packaged software industry eroded the strong competitive

position the industry had acquired in the 70s and 80s. 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. Parent firms sold off equity stakes in satellite suppliers and distributors, or, alternatively, hiked them, such that erstwhile independently managed keiretsu partners became wholly-controlled subsidiaries. All firms were under pressure to find strategies that increased their global competitiveness even at the expense of keiretsu commitments.

Conditioning on uncertainty: old ties or new?

One way to characterize the shift from preburst to postbubble regime that allows us to bring to bear some helpful theory is in terms of elevated uncertainty. Much recent research speaks to the conditioning role of uncertainty on organizations' propensities to reinforce and renew old ties versus abandoning them in favor of new ones. The evidence is considerable that under conditions of high uncertainty actors seek the familiarity, trust, and support of preexisting networks (Podolny, 1994; Sorenson and Stuart, 2008: 268).

A research literature on business groups in Asian countries other than Japan testifies that in times and places of uncertainty member firms mobilize their business group networks. Keister (2001) finds that, in regions of low levels of market development, Chinese companies aligned with business groups transact with firms with which they had prior dealings or other business ties even when lower cost alternatives were available elsewhere. More generally, following China's free market reforms launched in 1978 by Premier Deng Xiaoping—a time of systemic uncertainty and diminished trust—personalistic networks expanded as infrastructure for exchange.

In a study of Taiwanese business groups, Luo and Chung (2005) theorize similarly that the early stage of market transition for a developing economy is a time of high uncertainty, as diminished state control frees up resources and opens opportunities for competition, but the market infrastructures of a mature capitalist economy remain undeveloped. In such an environment, the particularistic business group ties (*guanxi*) of kinship, friendship, and community fill the void (Gold, Guthrie, and Wankt, 2002). In Taiwan, they write, ten years transpired between the end of heavy state regulation and the full emergence of market institutions. In the post-transition, high uncertainty period *only*, they find an association between the group's profitability and the prominence of family ties in its leadership and governance. Yet, consistent with embeddedness theory, the association proved inverted-U nonlinear: family ties in the post-transition era facilitated performance only up to a point beyond which they lowered it.

Evidence on business groups in other emerging economies is consistent with the Keister and Luo and Cheung findings that, absent advanced and stable market institutions, business groups, family ties, and other modes of internalizing transactions in social networks serve as economically functional governance structures (Khanna and Yafeh 2007).

There is evidence as well, however, that the reinforcement and activation of preexisting networks can be a misguided response to uncertainty. Beckman, Haunschild, and Phillips (2004) study the conditions under which U. S. corporations forge new board interlock and strategic alliance ties, as opposed to renewing or reinforcing extant ties of those sorts. They find companies responding to uncertainty by reinforcing old ties rather than adding new ones. Yet the consequence was adverse: firms' levels of uncertainty rose, not fell, the ostensible reason being that the learning and adaptation that might have flowed from new relationships were thereby foregone.

A similar result appears in Mizruchi and Stearns' (2001) study of U. S. commercial bank lending. Deals marked by high uncertainty motivated bankers to consult their strong tie webs of trusted friends and colleagues. But those deals were less likely to succeed, presumably again because the information so obtained was less fresh and diverse than that available elsewhere. These studies suggest that in times of stress and uncertainty, economic actors hunker down and seek refuge, as it were, in well-worn strong-tie networks. That actors should be risk averse and cautious in high-uncertainty environments is understandable, but such a "threat-rigidity" response is an invitation to failure, particularly so in the case of innovation projects, which require new knowledge pools and cooperative synergies.

Unlike the business group studies cited above, Japan in the 1980's was no emerging economy, to be sure. As the second largest in the world and whose leading export industries were more than a match for U. S. and European competitors, it was viewed by many as the global vanguard. Yet the Japanese economy of the preburst period was structured quite differently from its Western, especially Anglo-American, counterparts, and, indeed, in ways that appeared in the words of one economist typical of an "adolescent" maturation phase (Katz 1998). These included: a convoluted, distribution system; paternalistic employment practices (lifetime employment, etc.); strong ministry oversight and guidance; stunted capital markets and high bank dependence; and, by no means least, the far-flung keiretsu groups. Many of the systems associated with economic efficiency—fluid markets, formal legal contracting, and the like—were less developed relative to Western economies of comparable or smaller size.⁶

⁶ Japan was so strong, however, that by the end of the decade economists were actively revising their theories of economic efficiency in order to draw general lessons from the Japanese case (Aoki 1988; Thurow 1992).

With the bursting of the bubble, Japan's economic institutions went through wrenching change. The lost decade is thus reasonably framed as a time of market transition, institutional transformation, and heightened uncertainty. It was postwar Japan's first sustained experience since the 1950's with weak and unstable growth. Price deflation, global competition, delegitimation of once-hallowed institutions—keiretsu among them—and, particularly after 1995, significant accounting, antitrust, and corporate governance reforms were converging to reshape the economy along the lines of the Anglo-American west (Ahmadjian 2003; Vogel 2006).

Given this transformation of the Japanese business environment, it is likely that the role of the keiretsu as strategic alliance infrastructure changed as well. The nature of that change, we argue, varied with the alliance type. For strategic alliances with innovation goals, the groups ceased to function as platforms. In the post-bubble, resource-scarce, high uncertainty environment, electronics makers were under pressure to increase innovation yet were less able to do it on their own. The need to find the "right" partner in a creativity and synergy sense motivated exploratory search for new and outside alters able to offer something unique and complementary to an R&D

Yet we know that in uncertain environments firms often opt to exploit, even reinforce, their preexisting "strong tie" networks, rather than take chances on "weak ties" to "strangers." Our coding of the nonR&D alliances in our Japanese electronics industry panel shows most being geared to capacity reduction and supply chain efficiency. They can thus be characterized as relatively routine interorganizational affairs that likely prioritized seamless orchestration of the partners' resources and processes. A reasonable inference is that such orchestration and

coordination was made easier when the partnerships were situated within, rather than across or outside, individual keiretsu groups.

Our resolution of the question of whether firms fall back on old networks or assemble new ones and which strategy under what conditions is the rational and adaptive one is thus as follows. In the post-bubble climate of change and uncertainty, Japanese firms embedded their routine—i.e., implementation—alliances within their preexisting keiretsu networks. Figure 1, discussed in the data section below, shows nonR&D alliances proliferating in the 90's, in particular prior to the economy's brief recovery around 1996. But when the alliance goal was innovation, firms accepted the risks and adjusted to the uncertainty by diversifying their partnership portfolios with ties to new and disparate alters. We thus portray for the purposes of hypothesis formulation Japanese electronics firms as (intendedly or boundedly) rational corporate actors, an assumption which, of course, the evidence may not support, as indeed it did not in the Beckman/Haunschild and Mizuruchi/Stearns studies.

We further expect confinement of any keiretsu status-centrality effects on alliance formation to the preburst period. The legitimacy of the keiretsu as an organizational form and thus the status-enhancing role of keiretsu affiliation peaked with the bubble in the early 90's, dissipating fast in later years as the economy spiraled down and waves of change set in. Also delegitimizing the form was a shift in press coverage. In the 80's and early 90's, the groups' status was bolstered by the often breathless paeans in the Western business press to their power and reach, and in the vertical keiretsu case, efficiency and flexibility (see, e.g., Kelly and Port, 1992). By the mid 90's, however, that same press was castigating the keiretsu as dinosaurs whose commitment to sharing risks—shifting resources to and thereby propping up weak members—had deepened and prolonged Japan's systemic distress (Dawson 2003). And by the turn of the

century, *The Economist* (2002) was hailing the rise of a new breed of Japanese firm—among others, Kyocera, Omron, and Rohm—deemed free of the encumbrances of keiretsu and Japan's best hope for stable growth.

H4a: The homophily effects (both positive and negative) of keiretsu on innovation alliances diminished from the pre-burst to post-bubble periods.

H4b: The homophily effects (both positive and negative) of keiretsu on implementation alliances increased from the pre-burst to post-bubble periods.

H4c: The status-centrality effects of keiretsu on alliances of both types diminished from the pre-burst to post-bubble periods.

The prior alliance network: direct and indirect alliance ties

To this point our discussion has examined how Japanese electronics firms' vertical and horizontal keiretsu ties shaped their propensities to join in strategic alliances and how the keiretsu effect varied with the alliance type: innovation versus implementation. Yet these arguments, stressing the relative merits of homophily, centrality, and embeddedness 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 channeled the Japanese electronics industry alliance founding process.

At the dyad level the salient relational question is whether the pair had 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. 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 contemplating new alliance is thus to take a former partner back into its embrace. But, as argued above of keiretsu coaffiliation, such prior ties will count for less when the alliance aim is R&D. Network inertia—partners sticking together or with the same third party in venture after venture—is not a rational course of action when innovation is sought.

H5a: The effects of prior direct and indirect (third-party) alliance ties are smaller when the alliance goal is innovation.

Secondly, and generalizing from *H4a* and *H4b*:

H5b: From the pre-burst to the post-bubble period, the effects of prior direct and indirect (third-party) alliance ties decreased on innovation alliance and increased on implementation alliance.

DATA AND METHODS

Analyses of strategic alliances, as noted, have been pitched at two levels: dyad—the pair of organizations at risk of an alliance—and node—the individual organization (Stuart, 1998). We argue for the dyad as the operational unit. Firm differences (based, e.g., on size, know-how, performance) in propensities to partner can be straightforwardly captured by a well-designed dyad model. Nodal analysis, by contrast, cannot address how the particular combination of partner attributes—one firm mature, cash-rich, and set in its ways, for example, the other young and poor but hungry and nimble—uniquely conditions the odds that the pair will ally. Dyad analysis presents some technical challenges, but we believe our modeling strategy overcomes them while enabling insights into alliance formation processes not possible from firm-level analysis.

Our hypotheses were tested with a longitudinal data set on strategic alliances launched by Japanese electronics firms from 1985 to 1998. The population sampled was the Tokyo, Nagoya, and Osaka stock exchange-listed electronic industry. We included every such company that had entered into at least one alliance, whether domestic or international, over the 14-year period. This selection rule resulted in the number of sampled firms increasing over time, from a low of 123 in 1985 to a high of 135 in 1998.

Our study examines the likelihood that a pair of firms—a dyad—announced a new alliance in a given year. The alliance data were 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 gives three examples of the press reports from which the alliance data were coded.

<Table 1 about here>

From these data we constructed a panel of dyads (pairings) of firms observed in each of 14 years. For each year, the dyadic data are configured as follows: C_1, C_2 ; C_1, C_3 ; ...; C_1, C_N ; C_2, C_3 ; C_2, C_4 ; ... C_2, C_N ; ... C_{N-1}, C_N , where C_1 = firm 1, C_2 = firm 2, ..., C_N = firm N. In 1985, given 123 firms, the number of dyads is $N(N-1)/2 = [123*122]/2 = 7,503$. The 135 firms observed in 1998 converts to 9,045 dyads. For the 14 year period as a whole, the data set includes observations on 121,038 dyad-years.

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 structure) plus such dyad and network-level measures as prior direct and indirect alliance ties, subindustry classification, and alliance network density.

To evaluate our hypotheses on how the effects of keiretsu and prior alliance effects condition on the alliance goal, we divided alliance announcements into two classes. Those formed for the purpose of joint development of new products or technology were coded as innovation (R&D) alliances. Implementation (non-R&D) alliances were generally oriented to production (including capacity reduction), distribution, or supply (see Table 1).

The keiretsu data were coded from *Kigyō keiretsu soran* (Toyo Keizai, various years), an annual publication that records and describes the group affiliations of Japanese companies. Firms represented on the presidents' councils (*shacha-kai*) of the "big-six" enterprise groupings (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 (Lincoln and Gerlach 2004). It is, however, conservative, as numerous noncouncil firms were aligned with one group or another via their trade, lending, equity, directorate, and other ties.⁷ Since our unit of analysis is the dyad, we coded four dummy variables each combining the information on the horizontal keiretsu affiliations of the two firms. *DiffHKei* = 1 if the dyad spanned two presidents' councils. *BothNonHKei* = 1 if neither was a council member. *HKei&NonHKei* = 1 if one party to the dyad held a council seat but the other did not.

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

SameHKei— the excluded and therefore reference category— was coded 1 the when two firms were seated on the same council.

Similarly, four dummies capture each dyad's vertical keiretsu composition. 11 such groups are represented: Hitachi, Toshiba, NEC, Fujitsu, Sony, Matsushita, Oki Electric, Mitsubishi Electric, Kobe Heavy Industry, Sumitomo Electric, and Yasakawa Electric. *DiffVKei* = 1 if the dyad spanned two vertical keiretsu groups. *BothNonVKei* = 1 if neither firm was classified by *Kigyo keiretsu soran* as a vertical keiretsu affiliate. *VKei&NonVKei* = 1 if one firm had an affiliation but the other did not. The excluded category is *SameVKei*.

To measure a firm's position in the prior presence or alliance network, we first devised for each year an adjacency matrix (an $N \times N$ binary matrix) capturing the presence or absence of alliance ties among the sampled firms through $t-1$, the year before the current year (t). From these we derived the following network measures. Two are dyad-level: (1) *PriorDirectTie* is whether firms I and J ever had a prior alliance (=1; else=0); (2) *PriorIndirectTie* is whether firms I and J were allied with firm K in the prior year; that is, IK_{t-1} is an alliance and JK_{t-1} is an alliance. *TotTiesI* and *TotTiesJ* are defined at the firm level: each firm's prior alliance count. Finally, *TieDensity* is a population-level variate: the ratio of total alliances to all firm pairings in the prior year.

Following other strategic alliance research, we used a sub-industry classification to tap the dyad's placement in the same or different electronics industry subsectors (Ahmadjian and Oxley 2006; Gulati and Garguilo 1999). Five segments of the Japanese electronics industry were identified: electric industrial apparatus, electronic equipment, communication equipment, household electronic equipment, miscellaneous electric equipment. *DiffIndustry* = 1 if the dyad spans subindustries, 0 if not.

Finally, following Gulati and Gargiulo (1999), we included several financial composition and performance variables for each firm in each year. The financial measures were taken from the Japan Development Bank (2000) *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. The JDB source compiles information from the annual securities reports submitted to the Ministry of Finance by the listed firms.

Table 2 gives the variable mnemonics, definitions, means and standard deviations for all variables both for the total panel data set of 121,038 dyad-year records and for a reduced "choice sample" panel (discussed below) of 12,577 observations.

<Table 2 about here>

Incorporating firm attributes in a dyad model

The handling of nodal attributes in a dyad-level analysis is a long-standing problem for which a number of solutions have been proposed. Ours, following Lincoln (1984), is as follows. To represent a quantitative firm-level variable such as size or profitability, we coded for each dyad the unweighted *sum* of the two firms' values on that variable plus the *product* of those scores. The sum coefficient averages the component attributes' main effects on the dyad-level outcome, while the product coefficient captures their interaction. The interaction effect gets at whether and how *I*'s and *J*'s levels of some attribute dimension combine to influence an alliance event. It is a second derivative and thus gauges the change in the angle of the slope of *Y* on *X*, over the range of X_i (and vice versa). If positive, it is *prima facie* evidence of homophily (the alliance odds grow as X_i and X_j move together); if negative, heterophily (the alliance odds grow as X_i and X_j move apart).

The aggregation of X_i and X_j into a simple sum ($X_i + X_j$) constrains their regression slopes to equality. In a dyad analysis with a symmetric tie (e.g., alliance founding) as dependent variable, the I and J ordering 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 population of firms—the upper off-diagonal cells of the $N \times N$ matrix. The lower off-diagonal contains the same information. One can compute separate effect parameters for X_i and X_j , but the small differences materializing are discountable as sampling error. Forcing equality of the intra-dyad main effects sacrifices no substantive information and by lowering the number of terms boosts estimation efficiency.

Adjusting for dyad-analysis biases

The dependent variable is binary: a dyad/year observation is coded as 1 if the two firms in that year announced a new alliance, 0 if not. We use logit analysis as the estimation model, which in a panel analysis constitutes discrete event history analysis.⁹

Rare event bias

The logit model has been adapted by King and his colleagues to applications such as dyad regression where events (here, alliance foundings; in political science, e.g., war) are

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 salient as an IJ pairing is distinct from a JI one.

⁹ Various alternatives are available, including probit and the complementary log-log (cloglog) model. The cloglog model is the discrete counterpart to a proportional hazards model and is sometimes recommended in cases such as ours where the dependent variable is highly skewed; i.e., the hazard of an alliance is very small. In actual practice, however, cloglog, like probit, yields very similar estimates to logit, as was the case here.

extremely rare (King and Zeng 2001; Stuart and Sorenson 2008). With such data, regression parameters and probability estimates are biased. Their solution is a *choice sample* constructed in order to raise the ratio of events to nonevents. We thus drew a 10% sample of 12,577 observations with codes of 0 on the innovation alliance variable from the 121,038 dyad-years. This increased the means on our two alliance variables by a factor of 10, as Table 2 shows. A comparison of the full and choice sample means and standard deviations reveal most to be similar, the primary exceptions being such alliance-tie derived variables as *PriorDirectTie* and *TotTiesI(J)*. The one exception for which we have no explanation is the large difference between the two samples in the *Liquidity* measure.

Dyad autoregression

Apart from rare event bias, dyad regression suffers from an autocorrelated errors problem, as the same nodes recur in different dyads. OLS formulas applied to such data underestimate variances and overstate significance. We used Lincoln's (1984) adaptation of the standard network (or spatial) autoregression model. A variable, P_{ij} , is coded as the mean (probability) of the dependent variable (alliance announcement = 1 or 0) of all dyads with nodes overlapping the dyad observed. Entered in the regression, P_{ij} absorbs the autocorrelation induced by dyad overlap. The calculation is similar to including in the regression dummy variables for the rows ($i = 1, \dots, 123$) and columns ($j = 2, \dots, 123$) of the 1985 (for example) matrix whose cells define the dyads

$[N(N-1)/2 = 7503$, but it necessitates just one term—the mean of the overlapped dyads— rather than $2 \times 121 = 242$.¹⁰

RESULTS

Figure 1 plots the number of Japanese electronics industry innovation (R&D) and implementation (nonR&D) alliance announcements by year and GDP growth over the period examined. It shows a tendency for implementation alliance events to move against the business cycle. Spells of economic weakness map to upswings in the implementation alliance announcements. Most conspicuously, the *endaka* (high yen) retrenchment of 1986 corresponded to an alliance spike. Alliance foundings stayed at low ebb through the bubble era (1988-92), rising in the slump years of 1993 and 1994, declining in the 1995-96 recovery, surging again with the Asian financial crisis of 1997-98. The pattern supports our contention that implementation alliances in the Japanese electronics industry generally had consolidation and other efficiency-enhancing aims. The R&D alliance counts move within a much tighter range and display little if any countercyclical tendency.

< Figure 1 about here >

The pooled regression analysis

¹⁰ 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.

We begin with an analysis that pools the choice sample dyad observations across the entire 14 year observation period. We shall later see that it averages over and therefore conceals a number of important period effects.

We used two distinct estimation techniques. First, for each outcome variable, Equation 1 presents the coefficients from a relogit model that combines temporal fixed-effects (13 dummy variables for calendar year) with standard errors adjusted for clustering on unit (here, dyad), 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 such covariates as GDP growth that vary temporally but not cross-sectionally. Therefore, Table 3 also presents estimates from a population-averaged random effects probit (implemented in *Stata 9* with *Xtgee*) that combines first-order autoregression with error components for year and dyad.

Table 3 shows the relogit and population averaged random effects estimates to be very similar. However, as noted, the latter model permits estimation of coefficients on calendar year, prior alliance network density (lagged one year), and GDP growth. The results generally reinforce the graphical evidence in Figure 1 of countercyclicality in implementation (nonR&D) alliance activity. The GDP growth coefficient, while not significant by the usual two-tailed test, is negative. (It is significant at the 10% level by a one-tailed test). The Table also shows the incidence of implementation alliance trending down with time at a declining rate and as strongly dependent on the alliance network's density in the prior year. No such macro-level effects are evident in the innovation (R&D) alliance regression.

<Table 3 about here>

Keiretsu effects on innovation and implementation alliances

To avoid confusion, we draw attention at the outset to the rows of Tables 3 and 4 with the explanatory variable labels, *SameHKei* and *SameVKei*. The coefficients and standard errors in those rows come from a set of otherwise unreported regressions. The full regressions we do report (all other rows) include three dummy variables for each keiretsu type, *DiffHKei* and *DiffVKei*, *HKei&NonHKei* and *VKei&NonVKei*, and *BothNonHKei* and *BothNonVKei*. In these regressions, dyads assigned to the same horizontal and vertical keiretsu (*SameHKei* and *SameVKei*) are the omitted categories against which the coefficients on the included dummies are evaluated. This presentation enables a consideration of the keiretsu effects from two perspectives: (1) same-group against all alternatives; (2) the alternatives against the same-group baseline.

Table 3 reveals remarkably consistent vertical keiretsu effects on alliance formation. The only contrast is the positive same-group effects against the negative effects of the other three configurations. Thus, *H1a*, the positive homophily hypothesis, is confirmed. No evidence exists for negative homophily (*H1b*) or status-based centrality (*H1c*). Nor is there support for *H3a-c*, which condition the keiretsu effect on the alliance goal.

The horizontal keiretsu coefficients as a set are smaller than their vertical keiretsu counterparts, in line with *H2a*. They are also smaller (and nonsignificant) in the innovation case than in the implementation case, as argued by *H3a*. Furthermore, the ordering of coefficients is that of status centrality (innovation) and negative homophily (implementation) as argued by *H2b*.

Prior alliance effects in the pooled regression

H5a held that Japanese electronics firms' innovation alliances were relatively less dependent than their implementation alliances on preexisting direct and indirect alliance networks. The larger *PriorDirectTie* effect in the implementation model supports that hypothesis (The cross-model difference is significant at the 10% level by a one-tailed test). The *PriorIndirectTie* coefficients, however, are invariant by alliance type.

Financial-industrial attributes in the pooled regression

The financial and industry controls are not of much substantive concern, but one in particular is of interest. The dyad-level profit effect, *ROAI*ROAJ* is positive and significant in the innovation, not the implementation, regression. This complementarity in how the partner firms' earnings combine to condition the alliance odds—low-profit firms allying with high profit firms—calls to mind the iconic pharmaceutical industry tie-ups between cash-strapped biotech start-ups and deep-pocketed “big pharma.” It may also testify to the risk sharing prevalent in Japanese corporate networks: strong companies ally with weak ones in order to reverse their failing fortunes (Aoki, 1988; Lincoln, Gerlach, and Ahmadjian, 1996).

The negative coefficient on *DiffIndustry* says that alliances fall within, not between, electronics subsectors. Solvency has no firm-or dyad- level effect, but the two firms' sales and liquidities interact in raising rates of implementation alliance.

Period-specific results

How the keiretsu platform changed

We address now the question of period effects— whether and how the results reviewed above mask shifts with time. We proceed in a way that hews to our theorizing on the Japanese

strategic alliance process and our sense for how the Japanese economy was evolving over the interval we observe.

As noted, we periodize our data series by distinguishing years before the asset bubble's burst from after. Following *H4*, our interest centers on the keiretsu effects. Consider the innovation alliance case first. The pattern observed in Table 3 reappears in the preburst panel of Table 4. The estimates for the horizontal keiretsu dummies in that period are again ordered as (nonsignificant) status centrality. The vertical keiretsu effects, also again, conform to (highly significant) positive homophily.

<Table 4 about here>

As for the postbubble results, impressive support exists for *H4a*: the keiretsu embeddedness of the innovation alliance process is diminished. First, the horizontal keiretsu effects, still nonsignificant, are smaller by half than their preburst counterparts. More noteworthy is the postbubble disappearance of the preburst strong vertical keiretsu effects. None is significant, and the ordering has changed from positive to negative homophily: fewest alliances between vertical groups, most between independents.

The implementation alliance picture is very different. The positive homophily effects of vertical keiretsu seen in Table 3 reappear in the postbubble panel of Table 4 (column 4). The prebubble vertical keiretsu pattern is strong status centrality: independents less likely than keiretsu firms to ally.

Likewise, the horizontal keiretsu role in implementation alliance is stronger and closer to positive homophily in the postbubble period. In the preburst period, it is clear-cut negative homophily: independent firm pairs (*BothNonHKei*) differ negligibly from *SameHKei* pairs, with lower rates of alliance in the remaining categories.

In the postbubble period, then, the keiretsu roles in innovation and implementation alliances diverge. Firms in pursuit of innovation partnerships diversified their partner pools beyond their keiretsu groups. Yet their implementation alliances became more keiretsu-based.

In the preburst era, the horizontal group configuration was negative homophily: cross-group partnerships were shunned, but intra-group alliance rates equaled inter-independent rates. The preburst vertical keiretsu effect on implementation alliance was that of status centrality: affiliates were alliance-active and independents were not, but biases for intra-group and against inter-group alliance were small to nonexistent. It took the arrival of the high uncertainty post-bubble business environment for Japanese electronics companies to turn to their co-affiliates for alliances for efficient operational adaptation to the new times. Such alliances were no doubt facilitated by the similarity, familiarity, and trust endemic in intra-keiretsu relations.

The absence in the preburst "Japan, Inc." era of keiretsu positive homophily on nonR&D alliances may testify that in this stretch of Japanese economic history there was less substantive need for and consequently reliance on strategic cooperation within the business groups.

This dual-pronged alliance strategy pursued by Japanese electronics firms in the post-bubble era seems one of rational adaptation to the stressed and turbulent business environment ushered in by the bubble's demise. Firms were, on the one hand, under pressure to reduce product overlap and consolidate and simplify production, distribution, and supply, and they mobilized their keiretsu networks to those ends. They were, on the other hand, constrained both in Japan and in the global economy at large to accelerate innovation in order to differentiate their products and take market share from competitors. For alliances with innovation goals, the success of which demanded creativity and synergy, they looked for partners that were different and new.

Subperiod variations in the keiretsu effects

Our pre-burst and post-bubble periodization, substantively meaningful as we believe it is and operationally useful in its division of our series into equal halves, might be thought too aggregated such that real but unobserved variations in the keiretsu embeddedness of electronics industry alliances remain undetected within each period. To be sure, each period was marked by significant events and transitions, some wrenching. Besides the bubble and its demise (1988-91), the preburst period encompassed the *endaka* (high yen) slowdown (1986-87). Moreover, the postbubble years alternated spells of recession and stagnation with stretches of recovery, as Figure 1 shows.

To address this possibility, we reran the implementation and innovation alliance regressions on the first four year period, 1985-88, and a corresponding regression for the final three year period, 1996-98. If any of the effects reviewed above were changing within as well as between the preburst and postbubble periods, those changes should be revealed in a comparison of the earliest and latest years. Most results were in fact unchanged, but two interesting exceptions materialized that we mention here but do not formally present. First, the status centrality pattern of horizontal keiretsu effects on innovation alliances, apparent but not significant in column 1 of Table 4, is stronger and statistically significant in 1985-88. In this interval, just prior to the 1989-91 peak years of the bubble economy, the horizontal keiretsu, like the vertical keiretsu, did shape innovation alliances. Horizontal group affiliates were more active in those alliances than were horizontal group independents.

Secondly, in the last three years of our series, 1996-98, the positive homophily effect of horizontal keiretsu on implementation alliance mostly disappears: the coefficients are nonsignificant, smaller than in Column 4 of Table 4, and two are flipped in sign. Thus, the embedding of implementation alliances in horizontal keiretsu clusters proves mainly an early

postbubble phenomenon. Toward the end of that period, as other evidence shows (Lincoln and Gerlach, 2004: Ch. 3), the horizontal groups, due to mergers of the financial institutions at their cores and regulatory and corporate governance reforms, were unraveling, delegitimizing, and otherwise becoming obsolete.

Period change in the prior alliance effects

Our hypothesis (*H5b*) on the inertia of the alliance process—alternatively, embeddedness in preexisting alliance networks—straightforwardly extends *H4* on period change in the keiretsu effects. In the lean, uncertain, systemically evolving post-bubble era, the dependence of new alliances on prior direct and indirect alliance ties declined, more steeply when the alliance goal was innovation. The hypothesis gets some mild support from the implementation regression in Table 4: between the preburst and the postbubble periods, we observe declines in the effects of prior and third party ties, slight in the first instance and steep in the second. Yet the innovation alliance results say the opposite: prior and third party ties became more, not less, important drivers of alliance formation.

These period shifts in the effects of the prior alliance network mirror those of keiretsu, which, as we have seen, attenuated in the innovation case but were amplified in the implementation case. We thus entertain a story of structural change in the Japanese electrical industry alliance process that is more nuanced than the one hypothesized (*H4*, *H5b*) of postbubble disembedding, whether the network at issue is one of keiretsu or prior alliance ties. The revised story is that, as the one network receded as infrastructure for strategic alliance, the other took its place. It has been argued that some degree of preexisting network embeddedness may be everywhere a condition for new enterprise (whether alliance or firm) creation (Audia and Rider, 2005). Our finding, in particular, that prior alliance networks supplanted keiretsu as a

platform for innovation-based alliance suggests that the rigors of the post-bubble environment constrained Japanese firms to strategically rational action, an adjustment seen by critics as long overdue (Sakakibara and Porter 2001). It is safe to assume that more firm-and dyad-level strategic decision-making went into the crafting of those networks than was true of the keiretsu groupings, which evolved in haphazard and incremental fashion from a welter of historically-specific economic, political, and cultural circumstances.

The post-bubble disappearance of the cumulated prior ties interaction ($TotTiesI*TotTiesJ$) effect on implementation alliance also deserves note. In the preburst era, it seems, electronics industry alliances were pursued disproportionately by pairs of firms both of whom possessed the "social capital" of many prior strategic alliance ties. In the postbubble era, firms were less picky, more open to relationally inexperienced partners.

Period change in control variable effects

As for period variability in the control variable effects, we mention just one finding. The postbubble disappearance of Japanese electronics firms' preburst propensity to confine innovation alliances to industry subsectors—rather like the period-specific keiretsu and prior alliance effects—bespeaks a broadening and diversification of alliance activity.

CONCLUSIONS

We have produced a strong and consistent set of empirical results documenting how Japan's famous keiretsu inter-corporate networks constrained, supported, and channeled the new strategic alliances that Japanese firms in a key industry sector— electronics and electrical machinery—pursued across a fourteen year period of Japanese history punctuated by major economic change. Following the precedents of a considerable research literature on strategic

alliance patterns in the U. S. and other countries, we further studied how prior strategic alliance networks also influenced the alliance formation process. Finally, we examined how the size, financial structure, and subindustry composition of Japanese electronics firms combined to condition the rate at which those firms paired up in new alliances.

Our substantive and theoretical concerns were several. First, we were interested in the degree to which partnerships aimed at innovation (R&D) differed from alliances aimed at implementation (nonR&D), which in the Japanese electronics industry context often addressed capacity reduction and efficiency enhancement. In line with the general contours of embeddedness theory as formulated by Granovetter, Uzzi, and others, we reasoned that strategically rational Japanese electronics firms would to a smaller degree "embed" their innovation-oriented (R&D) alliances either in keiretsu or in prior alliance networks than they would alliances with nonR&D (implementation) goals. The results of our pooled (1985-1998) regression analysis were largely if imperfectly supportive of that theory. The results on horizontal keiretsu and prior direct alliance ties fit it well. The results on vertical keiretsu and prior indirect alliance ties did not.

We argued that the keiretsu affiliations of electronics firms conditioned alliance formation processes in three distinct ways. The obvious one and that most in tune with embeddedness reasoning is that, for the positive reasons of trust, familiarity, similarity, etc., affiliated firms established new strategic alliances with co-affiliates of the same groups. A complementary argument stressed less such benefits of embedded or intra-keiretsu partnering than the information spillover and other competitive hazards posed by partnerships with firms aligned with rival groups and, to a lesser extent, unaffiliated (independent) firms. The third argument assumes a firm-or node-level rather than dyad-level causal mechanism. Some attributes

have status significance in networks such that actors in possession of them are pulled to the center of the network space, whereas those without them are consigned to the periphery. In the present context, keiretsu—the horizontal groups in particular— commanded impressive status and power in the Japanese society of corporations, and, as a consequence, were centrally situated in its networks over most of the postwar period.

Thus, in the high uncertainty period (1992-98) that followed the bubble's collapse, the alliance process in the Japanese electronics industry appears to have been governed by greater strategic rationality on the part of the participating firms than in the preceding preburst period. As in the studies by Beckman et al. and Mizuchi & Steams, Japanese firms did mobilize/reinforce their extant (keiretsu) networks with higher rates of intra-group alliance. But these were nonR&D, implementation alliances, which mostly sought consolidation and coordination economies. Over the same interval, electronics firms actually *reduced* the embeddedness in keiretsu of their partner choices for innovation alliances. This apparent two-pronged strategy— on the one hand mobilizing old networks of familiar and similar partners for operational purposes, while on the other hand embracing new and diverse partners for ventures in innovation—seems a rational adaptation to a business environment marked by discontinuous change and high uncertainty. That environment stood in sharp contrast to the relatively stable "Japan, Inc." regime of the preceding era in which, our data show, both innovation and implementation alliance events were embedded within the vertical keiretsu, and, in the earliest years of that period, the horizontal keiretsu as well. The use of horizontal keiretsu as a platform for implementation alliance, however, proved to be of limited duration. By the last few years of our series, the evidence for this had disappeared, a result in keeping with the large volume of

journalistic and academic reporting on the late 90's "withering away" of the horizontal keiretsu form.

Yet this portrait of how the part played by keiretsu as preexisting networks was altered in opposing directions from the preburst to the postbubble periods is complicated by the complementarity we find in the shifting roles of another preexisting network, that of prior strategic alliance ties. As the keiretsu effect on the innovation alliance process retreated across the preburst/postbubble divide, that of prior direct and indirect alliance correspondingly advanced. Conversely, as the keiretsu embeddedness of implementation alliances deepened from the first to second period, we observe a corresponding decline in the infrastructural role of the prior alliance network.

Other results on period change, less central to our theoretical concerns, are nonetheless interesting for their consistency with our general arguments and findings on the network effects. The disappearance in the postbubble period of the preburst negative *DiffIndustry* effect on innovation alliances, like the vanishing keiretsu effects, says that in the later period firms were selecting alliance partners from a more diverse pool.

Much has been written on the transformation of the Japanese economy subsequent to the collapse of the bubble, the wrenching transitions of the ensuing "lost decade," and the emergence of a new but unsteady equilibrium in the mid-2000's. The general portrait is of an economy in which corporate governance and strategy, as well as employment practice and industrial relations, are much less enmeshed in the distinctive institutions of the postwar prebubble period: ministry guidance, bank dependence, keiretsu groupings, internal labor markets, and the like. Our results on the shifting embeddedness of corporate strategic alliance processes within the Japanese electronics industry highlights as clearly as any evidence, we believe, the transformation of

institutional logic that took place. Preexisting networks became less a set of binding constraints, boundaries, and identities and more, as Swidler (1986) argued of culture, a "tool kit," or, in the language of strategic management theory, a bundle of "dynamic capabilities" mobilized and applied judiciously and selectively in keeping with corporate competitive goals (Teece, Pisano, and Shuen, 1997). In the postbubble era, Japanese electronics firms, we have seen, looked beyond their keiretsu groupings for partners to innovation alliances, which, all accounts agree, demand for success diversity and freshness in a partner pool. Yet those alliances remained anchored in a preexisting network, albeit one constituted, not of keiretsu, but of previously consummated strategic alliance ties. On the other hand, when the alliance targeted, not innovation, but implementation/execution tasks requiring consolidation and coordination skills, electronics firms even more than before picked their partners from their keiretsu webs of relations, the embeddedness properties (in terms of trust, shared routines, etc.) of which can be assumed superior to the counterpart networks of prior strategic alliance ties.

The literature on the embeddedness of enterprise, alliance, and exchange in social and interorganizational networks gives the impression that the "network effect," as Uzzi (1996) called it, is a deterministic one such that the actors involved have little choice or discretion to reposition themselves within a network or even switch networks so as to better adapt, survive, and compete (Zuckerman, 2003). Our evidence on the Japanese electronics industry in the 1990's suggests otherwise: under the pressure of stringent and uncertain economic conditions, Japanese firms in that industry executed such repositioning rather rationally and well.

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Table 1. Illustrative strategic alliance announcements

Alliance Type	Examples
Innovation (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.[...]”</p> <p><i>(Nihon Kogyo Shinbun – Dec. 8, 1995)</i></p>
Implementation (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 on 8,192 pairings $((N^2-N)/2)$ of Japanese electronics firms observed in each of 14 years (1985-1998)

Variable	Total Sample (N=121, 038)		Choice Sample (N=12,577)	
	Mean	SD	Mean	SD
<i>Innovation alliance</i> (=1): Firms I & J formed an R&D alliance in year <i>t</i>	.001	.031	.009	.096
<i>Implementation alliance</i> (=1): Firms I & J formed a nonR&D alliance in <i>t</i>	.003	.058	.033	.177
<i>Same HKei</i> (=1): Firms I & J are in the same horizontal keiretsu	.040	.197	.042	.202
<i>DiffHKei</i> (=1): Firms I & J are in different horizontal keiretsu	.183	.387	.194	.395
<i>HKei&NonHKei</i> (=1): I is in a horizontal keiretsu and J is not	.502	.500	.496	.500
<i>BothNonHKei</i> (=1): Neither I nor J are in a horizontal keiretsu	.274	.446	.268	.443
<i>SameVKei</i> (=1): Firms I & J are in the same vertical keiretsu	.0233	.1509	.029	.168
<i>DiffVKei</i> (=1): Firms I & J are in different vertical keiretsu	.196	.397	.168	.374
<i>VKei&NonVKei</i> (=1): Firm I is in a vertical keiretsu and Firm J is not	.502	.500	.533	.499
<i>BothNonVKei</i> (=1): Neither firm I nor firm J is in a vertical keiretsu	.279	.448	.270	.443
<i>DiffIndustry</i> (=1): Firm I and J are in different subindustries	.774	.418	.764	.425
<i>PriorDirectTie</i> (=1): I & J had a prior (direct) strategic alliance tie (=1)	.018	.133	.044	.205
<i>PriorIndirectTie</i> (=1): I & J had a prior indirect alliance tie through a 3 rd -party (=1)	.072	.259	.074	.262
<i>TotTiesI(J)</i> : Firm I 's (J's) total prior alliances	15.779	31.775	10.988	27.615
<i>TieDensity</i> : Total alliances/total dyads in the year	.038	.010	.038	.010
<i>SalesI(J)</i> : Firm I's (J's) total sales in prior year (in millions of yen)	.296	.687	.358	.780
<i>ROAI(J)</i> : Firm I (J)'s ROA (net income before taxes)/assets in prior year	.074	.072	.037	.047
<i>LiquidityI(J)</i> : Firm I (J)'s (assets – inventory)/ current liabilities in prior year	3.707	2.086	1.741	1.281
<i>SolvencyI(J)</i> : Firm I (J)'s: (long-term debt/current assets) in prior year	.058	.092	.057	.088
<i>%GDPGrowth</i> : % change in gross domestic product over previous year	.026	.023	.026	.023

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

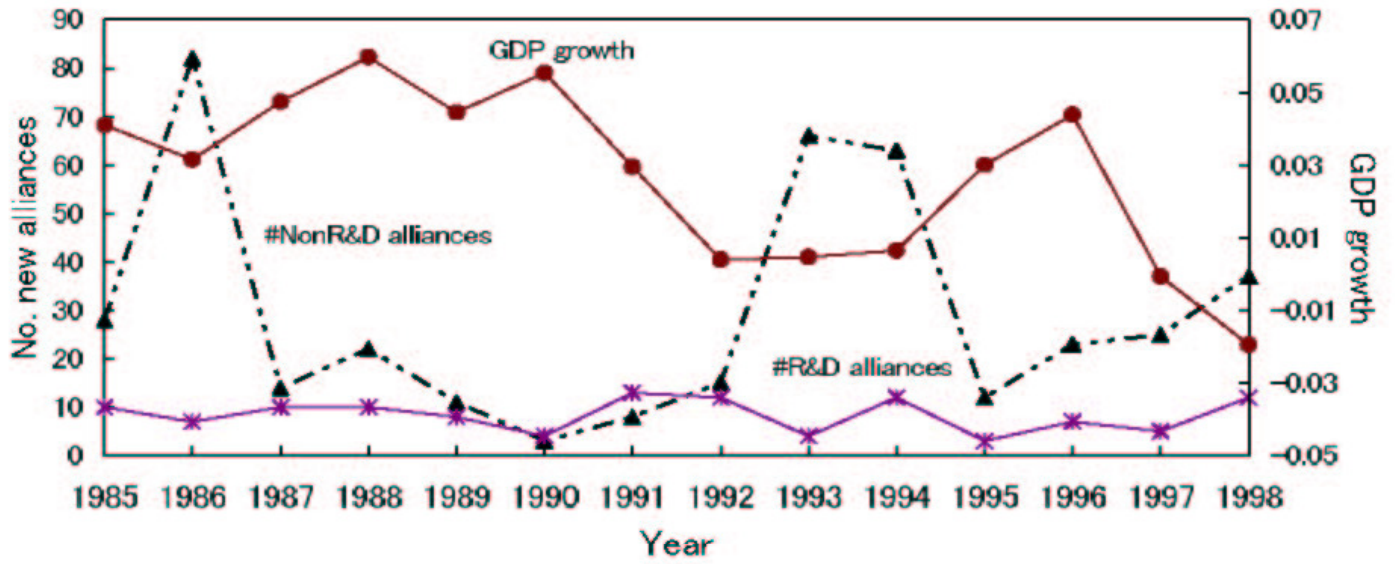


Table 3. Logit regressions of R&D and nonR&D alliance foundings, 1985-1998 (N=12,577)^a

Explanatory Variables	Fixed effects model		Random effects model	
	Innovation	Implementation	Innovation	Implementation
Horizontal keiretsu variables				
<i>SameHKei^b</i>	0.537 (0.467)	0.929** (0.297)	0.538 (0.461)	0.933** (0.295)
DiffHKei	-0.366 (0.535)	-1.165** (0.322)	-0.393 (0.527)	-1.155** (0.319)
HKei&NonHKei	-0.439 (0.536)	-0.911** (0.323)	-0.438 (0.529)	-0.924** (0.323)
BothNonHKei	-0.736 (0.515)	-0.663* (0.331)	-0.701 (0.511)	-0.676* (0.328)
Vertical keiretsu variables				
<i>Same VKei^b</i>	1.410** (0.405)	1.296** (0.304)	1.423** (0.414)	1.274** (0.299)
DiffVKei	-1.535** (0.451)	-1.282** (0.339)	-1.557** (0.453)	-1.227** (0.338)
VKei&NonVKei	-1.474** (0.429)	-1.111** (0.317)	-1.470** (0.433)	-1.095** (0.315)
BothNonVKei	-1.536* (0.735)	-1.503** (0.388)	-1.518* (0.749)	-1.487** (0.386)
Prior alliance network variables				
PriorDirectTie	1.846** (0.379)	2.690** (0.254)	1.799** (0.379)	2.951** (0.255)
PriorIndirectTie	0.940** (0.361)	0.924** (0.253)	0.895* (0.364)	1.050** (0.247)
(TotTiesI+TotTiesJ)/100	1.137+ (0.602)	0.725 (0.493)	1.021+ (0.547)	0.733 (0.485)
(TotTiesI*TotTiesJ)/100	0.000 (0.008)	-0.002 (0.006)	0.002 (0.008)	-0.004 (0.008)
Control variables				
DiffIndustry	-0.590* (0.246)	-0.928** (0.199)	-0.602* (0.244)	-0.960** (0.198)
SalesI + SalesJ	0.043 (0.171)	-0.197 (0.138)	0.089 (0.165)	-0.146 (0.133)
SalesI * SalesJ	-0.067 (0.075)	0.092 (0.082)	-0.074 (0.072)	0.122 (0.079)
ROAI + ROAJ	4.191+ (2.189)	4.878 (3.786)	4.471* (2.183)	4.824 (3.611)
ROAI * ROAJ	- (26.855)	-86.024 (82.563)	-110.329** (22.378)	-49.837 (81.641)
SolvI + SolvJ	-0.410 (1.464)	-2.475+ (1.291)	-0.466 (1.495)	-2.846* (1.286)
SolvI * SolvJ	-12.106 (39.233)	12.677 (19.218)	-17.112 (39.588)	8.702 (20.543)
LiqI + LiqJ	-0.351** (0.130)	-0.295** (0.091)	-0.342** (0.129)	-0.347** (0.099)
LiqI * LiqJ	0.185** (0.060)	0.127** (0.033)	0.182** (0.062)	0.134** (0.034)
Dyad Autoregression	142.658** (24.493)	110.869** (9.840)	137.691** (19.810)	84.621** (5.886)
Year			-0.921 (1.668)	-2.682+ (1.405)
Year ²			0.004 (0.009)	0.012+ (0.007)
TieDensity			36.283 (86.040)	175.942* (73.112)
%GDPGrowth			-3.619 (10.191)	-10.390 (7.150)

Table 3 (continued).				
Constant	-5.373** (0.778)	-5.938** (0.634)	44.666 (78.513)	131.442* (66.719)
Observations	12577	12577	12577	12577
<p>^a Not shown in the relogit regressions are fixed effects (13 dummies) for calendar years.</p> <p>^b Coefficients in this row are taken from an identical regression save that <i>SameHK</i> and <i>SameVK</i> are substituted for other horizontal and vertical keiretsu dummies.</p> <p>+ Significant at 10%; * “ at 5%; ** “ at 1%. Standard errors adjusted for clustering on dyad.</p>				

Table 4. Relogit regressions of innovation and implementation alliance foundings by period, Japanese electronics firms^a				
	(1)	(2)	(3)	(4)
Explanatory Variables	Preburst: 1985-91	Postbubble: 1992-98	Preburst: 1985-91	Postbubble: 1992-98
	Innovation	Innovation	Implementation	Implementation
<i>Horizontal keiretsu variables</i>				
<i>SameHKei^b</i>	0.605 (0.470)	0.244 (0.925)	0.868+ (0.499)	0.893* (0.363)
DiffHKei	-0.339 (0.574)	-0.123 (1.020)	-1.259* (0.550)	-1.063** (0.403)
HKei&NonHKei	-0.508 (0.560)	-0.222 (0.990)	-1.071* (0.522)	-0.693+ (0.404)
BothNonHKei	-0.746 (0.532)	-0.290 (0.965)	-0.182 (0.491)	-0.847* (0.429)
<i>Vertical keiretsu variables</i>				
<i>SameVKei^b</i>	2.190** (0.445)	0.880 (0.717)	1.430** (0.547)	1.504** (0.360)
DiffVKei	-2.180** (0.537)	-1.103 (0.739)	-1.167+ (0.607)	-1.769** (0.415)
VKei&NonVKei	-2.236** (0.491)	-0.829 (0.734)	-1.093* (0.545)	-1.421** (0.385)
BothNonVKei	-2.577** (0.851)	-0.541 (1.159)	-1.843** (0.711)	-1.571** (0.456)
<i>Prior alliance network variables</i>				
PriorDirectTie	1.151* (0.475)	2.157** (0.646)	2.814** (0.478)	2.618** (0.318)
PriorIndirectTie	-0.543 (1.106)	1.686** (0.542)	1.766** (0.431)	0.790** (0.299)
(TotTiesI+TotTiesJ)/100	0.390 (1.219)	0.962 (0.796)	-0.587 (1.054)	0.743 (0.582)
(TotTiesI*TotTiesJ)/100	0.037 (0.024)	0.004 (0.009)	0.049* (0.024)	-0.001 (0.007)
<i>Control variables</i>				
DiffIndustry	-0.915** (0.352)	-0.221 (0.371)	-0.790** (0.294)	-1.013** (0.269)
SalesI+SalesJ	0.351 (0.254)	-0.015 (0.256)	-0.283 (0.221)	-0.138 (0.182)
SalesI*SalesJ	-0.142 (0.140)	-0.102 (0.101)	0.058 (0.137)	0.062 (0.095)
ROAI+ROAJ	1.760 (3.004)	2.809 (3.068)	11.037* (5.449)	-0.237 (2.528)
ROAI*ROAJ	-89.845** (32.496)	-146.77** (36.894)	-195.59** (72.075)	65.285 (57.492)
SolvI+SolvJ	1.781 (2.284)	-2.727 (1.719)	-6.263* (2.773)	-1.503 (1.316)
SolvI*SolvJ	7.734 (55.133)	27.730 (36.595)	76.257** (29.413)	2.836 (22.420)
LiqI+LiqJ	-0.161 (0.146)	0.319 (0.442)	-0.352+ (0.207)	-0.284** (0.096)
LiqI*LiqJ	0.169** (0.053)	-0.425 (0.419)	0.175+ (0.100)	0.122** (0.034)
Dyad Autoregression	121.504** (40.401)	124.805** (31.740)	148.910** (18.661)	92.769** (12.117)

Table 4 (continued).

Constant	-4.749** (0.877)	-6.749** (1.290)	-6.435** (1.118)	-5.477** -0.62
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^aRegressions include fixed effects for calendar year differences within periods.

^bCoefficients in this row are taken from a set of regression identical to the present one save that *SameHK* and *SameVK* are substituted for all other horizontal and vertical keiretsu dummies.

+Significant at 10%; * “ at 5%; ** “at 1%. Standard errors adjusted for clustering on dyad.