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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 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 (1985–1991; the "preburst" period), keiretsu served as infrastructure for new strategic alliances that had both innovation (R&D) and implementation (nonR&D) goals. In the second half of our series (1992–1998, the "postbubble" period), the keiretsu effects on R&D alliance formation were gone, but the groups' role in nonR&D alliances had magnified. Moreover, as the keiretsu effect on new alliances fell or rose, those of prior direct and indirect alliance ties moved in the opposite direction. We conclude with some discussion of whether these period shifts in the embeddedness of the electronics industry alliance formation process were or were not effective adaptations to the turbulence and uncertainty of the postbubble Japanese economy.

**JEL classification:** F2, 03, M1, Z1

> *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*).*

## 1. Introduction

An important and consistent finding of strategic alliance research is that new partnerships are embedded in an infrastructure of preexisting networks. More is at work here than a process of once-allied firms simply joining hands in subsequent

undertakings. Alliance formation has a network, not merely a dyadic or nodal (firm-level), logic. The positioning of the partners, the presence of third-party ties, and such macro-structural properties of the network as clustering and connectivity—all condition the formation of and persistence of ties (Schilling and Phelps, 2007). Such pervasive patterns, as Gulati (1998) suggests, run counter to intuition. Firms pursuing strategic alliances might be expected to begin with an appraisal of the resources and capabilities needed in a partner prospect, and then follow that appraisal with a far-flung search for suitable candidates. The reality is that new alliances are often forged with old partners—or perhaps the partners of those partners. Thus, the process of alliance-building begins with an extant tie or network and only then proceeds to an assessment of what capabilities are available within that restricted pool and how to go about meshing them.

In this paper, we focus on the alliance-forming process in the domestic economy of one country—Japan—and the role in that process of a very distinctive kind of preexisting network: the business groups known as *keiretsu*. Over much of the postwar period, these stable clusters of closely interlinked firms comprised a foundational institution of Japanese industrial organization, with many well-documented effects on the strategies, governance, financing, and behavior of the firms; the configuration and operation of Japanese capital and industrial goods markets; the country's distinctive patterns of international trade; and its government's industrial policies and regulatory practices. Yet the role of the keiretsu as both supportive and constraining infrastructure in the formation and operation of Japanese firms' strategic alliance networks has been largely neglected. Moreover, whereas Japanese companies' international alliances have been widely studied and discussed—especially in the 80s and early 90s, when they were faulted as vehicles for predatory learning (Reich and Mankin, 1986)—little such attention has been paid to the alliances pursued by Japanese firms themselves 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, we address the following questions: To what extent were new strategic alliances in the Japanese electronics industry nested within, as opposed to across and outside, keiretsu groupings? Did such keiretsu embeddedness vary with the keiretsu (horizontal versus vertical) and alliance (R&D or nonR&D) type? Did the functioning of keiretsu as supportive infrastructure for new alliances change over time, particularly between the pre- (1985–1991) and post- (1992–1998) bubble years, the latter a period of major turbulence, stress, and restructuring for Japan? Our study engages and builds on several recent theories and research streams on the network embeddedness of Japanese domestic alliance processes and the conditioning of those processes on cycles of change and uncertainty in market and institutional environments.

### 1.1 What are (were) the keiretsu?

Often termed business or enterprise groups, the keiretsu are quite unlike the business groups prominent in emerging economies to which much scholarly attention has recently been paid (see Morck, 2010, for a review). Business groups outside Japan tend to be well-bounded clusters coordinated centrally by a family-controlled headquarters or holding company situated at the apex of a pyramid of equity ties (Granovetter, 2003). The keiretsu (in contrast to the prewar zaibatsu) exhibit little such hierarchical control but are in fact loose networks of relatively sparse ownership and governance links, personnel movements, and reciprocal trade and lending flows.

Over most of the postwar period, large numbers of Japanese firms were in varying degrees entangled in these webs. It is thus unsurprising that the keiretsu phenomenon has been the object of close scrutiny both within and outside Japan (for a review see Lincoln and Gerlach, 2004). A large interdisciplinary literature examines, at the macro level, the configuring of the keiretsu as a distinctive industrial organization form (Caves and Uekusa, 1976), and, at a micro one, the groups' effects on the behavior and performance of member firms (Nakatani, 1984). Although, as noted, few such studies consider how keiretsu figure in formal strategic alliance per se, many document the varieties of interfirm cooperation found within the groups. The celebrated flexibility and efficiency of supply chain transactions in Japanese manufacturing are grounded in keiretsu ties (Dyer, 1996), as were the within-group monitoring and risk-pooling once widely thought to infuse the Japanese economy with superior corporate governance (Nakatani, 1984; Asanuma, 1989; Hoshi *et al.*, 1991; Thurow, 1992). Evidence we later present suggests that group-based alliances aimed, among other targets, at cost reductions enabled member firms to weather business cycle downturns.

#### 1.1.1 Keiretsu as alliance infrastructure

Firms join hands in strategic alliances in order to secure resources and knowledge that are difficult to generate internally or because efficiencies and synergies can thereby be achieved (Pfeffer and Salancik, 1978). The strategic alliance

form also enables a degree of tacit knowledge-sharing and process-meshing that harder contract forms do not permit (Williamson, 1999). Indeed, much recent organization theory claims that what endows a firm with "core" competency or capability and sustainable competitive advantage 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 is also true of alliances. When the assets pooled are intangible, specific, and interdependent, their cultivation and utilization require of the partners' mutual trust and goodwill, easy familiarity, cultural compatibility, and supportive third parties. Copying or buying or contracting for a set of capabilities in a vacuum—failing, in other words, to prepare in these ways the soil within which exchanges and collaborations might flourish—is a recipe for alliance failure.

Such considerations suggest that strategic alliances require a preexisting network infrastructure with which to support the partners' efforts to grasp and fit one another's routines, tap and transfer one another's knowledge pools, and otherwise advance communication, cooperation, and coordination. Much evidence shows that one infrastructure frequently used for these purposes is the network of alliances built and leveraged by the partners in the past.

In Japan, much of that alliance-building infrastructure was provided by the keiretsu and was thus ready-made and primed for use. Ronald Dore (1983) has made the argument that business collaboration within the keiretsu and related networks (such as regionally based industry clusters) is infused with "goodwill," his term for a blend of trust, reciprocity, obligation, and benevolence toward exchange partners. While Dore viewed such patterns as distinctively Japanese, his argument is rather close in substance to the more general one of Granovetter (1985) 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 this reasoning, when Japanese firms internalize or embed their strategic alliances in interfirm networks such as keiretsu, they realize important benefits. The "hard" governance solutions prescribed by economists and lawyers—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 keiretsu grouping are easy to form and low in risk, as the usual hazards of opportunism and defection are attenuated, and little formal governance is required beyond the supports and constraints provided 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]

These arguments lead us to the following hypothesis:

*H1a: Two Japanese firms are more likely to form a strategic alliance if they are affiliated with the same keiretsu than if they are in different keiretsu or if one or both are independents (no keiretsu affiliation).*

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

$$Y_{it} = \beta_0 + \beta_1 DiffKei_{it} + \beta_2 Kei\&NonKei_{it} + \beta_3 BothNonKei_{it} + \Sigma_k \gamma_k X_{kit} + e_{it}$$

$Y_{it}$ = "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 affiliate; and *Kei&NonKei* = "1" if one is an affiliate and the other is not. The excluded and therefore reference category is that the two firms are coaffiliates (in the same group). The $\{\beta\}$ and $\{\gamma\}$ are regression coefficients to be estimated. In terms of this model, *H1a* states that coaffiliate alliances occur at the highest rate:

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

## 1.2 Negative homophily: another take on intra-group alliance

*HIa* posits what we call "positive" (or cooperative) homophily: coaffiliate firms form a strategic alliance in order to exploit the resources, economies, mutual monitoring, and risk-pooling that their groups provide. A second and alternative hypothesis posits what we will call "negative" or defensive homophily. Keiretsu firms limit partner search to coaffiliates because they wish to avoid tie-ups with rival groups or independents. Partnerships of the latter sort pose

1 Perhaps surprisingly, 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."

competitive risks due in particular to knowledge spillovers. Economists have emphasized the defensive logic driving the placement of corporate partnerships under a protective governance umbrella in order to minimize such spillovers (Katz, 1986; Branstetter and Sakakibara, 2002). The solution they propose is government-sponsored consortia as safe venues for knowledge-sharing and joint development. Famous examples are Japan's Ministry of International Trade and Industry's (MITI) VLSI project in the 80s and its US counterpart, Sematech.

While knowledge-intensive firms generally seek to avoid information spillovers and are therefore motivated to internalize innovation projects within the boundaries of their preexisting networks, Japanese firms have been extreme in this regard. Whether in domestic or global arenas, they have shown a marked reluctance to partner with rivals or even strangers, a pattern criticized in recent years for contributing to Japan's faltering competitiveness (Brown and Linden, 2010); Chesbrough, 2006; Dubarric and Hagiu, 2009).[2]

*H1b: Two Japanese firms are less likely to form a strategic alliance if they are affiliated with different keiretsu or if one is in a keiretsu and the other is not than if they are coaffiliated with 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:

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

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 configurations, followed by group-and-independent pairs, then cross-group pairs.

A final possibility that we do not formally hypothesize and for which only slight evidence emerges from our analysis is that there is a firm-level keiretsu "status" effect. Because group-affiliated firms command prestige and power in the Japanese corporate stratification system—as indeed they did at least until the asset bubble's burst—they tend to occupy central positions in the network of intercorporate ties. In this reasoning, the probability of alliance in a dyad is proportionate to the representation of keiretsu in it. Thus, within-group and between-group pairs will have the most alliances, followed by group-and-independent pairs, and finally independent-independent pairs.

### 1.3 Vertical and horizontal keiretsu

Two main keiretsu forms exist (Gerlach, 1992; Lincoln and Shimotani, 2010): (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, we should expect their roles in strategic alliance processes to differ as well.

The vertical keiretsu are relatively tight-knit, hierarchically ordered networks that pivot on a major manufacturer and fan out to encompass an array of satellite firms 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 *et al.*, 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 endowed Japanese manufacturers with the requisite scale and support to compete in global export markets (Womack *et al.*, 1990). While ties between electronics makers and their keiretsu entourage were less cozy than the automobile industry norm (Asanuma, 1989), they nonetheless were harnessed in the service of 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).

2 A study of Japanese and US firms by Cohen *et al.* (2002) finds that knowledge spillovers to competitors are greater in Japan than in the United States. They stress differences between the countries in patent law and writing, but this may also testify to Japanese firms' well-documented efforts to learn from others, whether partners or competitors.

In the way they divide labor in the development, manufacture, or distribution of a product line and in their centering a lead or parent firm, the vertical keiretsu appear more "strategically" organized than the horizontal groups. Yet they, too, were marked by durability of membership, reciprocal obligation, 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 (Asanuma, 1989, 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" horizontal groups, three descended from the prewar family-owned zaibatsu (Mitsui, Mitsubishi, and Sumitomo), whereas the other three—Fuyo, Sanwa, and 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 behind 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.

*H2: The horizontal keiretsu effect on strategic alliance formation is weaker than the vertical keiretsu effect and is more likely to take the negative homophily form.*

### 1.4 Alliance type and keiretsu embeddedness

Dore's "Goodwill" paper stressed the positive governance functions of embeddedness in keiretsu for the operations and transactions of the affiliate firms. For Granovetter (1985) and other network theorists, by contrast, whether embeddedness hurts or helps the actors involved is contingent on various factors. One is its level: embeddedness can be overdone. Uzzi's (1996) study of Manhattan garment manufacturers found a strongly curvilinear (U-shaped) association between the embeddedness of a firm's supplier–buyer ties and its hazard of failure. Another much-studied contingency is uncertainty in the environment. As reviewed in the next section, a long-standing stream of theory and research holds that adaptation to uncertainty requires "exploratory" search and learning that go beyond the boundaries of actors' preexisting networks. At odds with this view is work that finds uncertainty raising actors' risk-aversion, motivating them to rely for partners on their preexisting ties.

A final contingency is the performance outcomes are to be maximized. Embedded networks—strong, dense, reciprocated, and bounded—may be effective when the task at hand requires efficient implementation of technologies that are well-understood and the emphasis is on tight coordination. As in Hansen's (1999) study of interdivisional knowledge transfers among corporate product development teams, embedded (or "strong" in his terminology) ties are then expected to outperform "weak" or unembedded ties. Such networks, however, are less effective when innovation and learning are the imperatives (Burt, 1992; Hansen, 1999; March, 1991; Reagans and Zuckerman, 2001). Actors that are deeply enmeshed in complex strong-tie networks are as a consequence constrained in their flexibility of action and in the diversity of information and other resources they can access.

The limits of embeddedness are most pronounced when the strategic undertaking targets innovation and so demands 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 (Podolny *et al.*, 1996; Baum et al., 2000). The launch and development of any alliance are facilitated to some degree by the trust, familiarity, reciprocity, meshing of routines, vetting by third parties, etc., that the concept of embeddedness implies. But when innovation is the aim, process—smoothly executed operation—takes a back seat to outcome—novelty and inimitability. A Japanese firm should then be expected to search beyond the boundaries of its extant networks for partnerships strategically focused on innovation.

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 (Gerlach, 1992).

*H3: The positive homophily effect of keiretsu is decreased and the negative homophily effect is increased when the alliance aim is innovation (R&D).*

Thus, Japanese firms will go outside their keiretsu networks for innovation alliances, because the benefits obtained in newness, complementarity, and synergy outweigh those (trust, etc.) of intra-group partnering. For implementation alliances, this relative weighting of intra- and extra-keiretsu advantage is reversed. The negative homophily idea yields a different prediction. It says that actors do not so much seek similarity as avoid difference. It stresses less the gains from embedded—intra-keiretsu—partnerships than the cost of losses in proprietary knowledge posed by alliances that cross keiretsu lines. As the creation and application of such knowledge is what R&D collaborations are all about, such spillovers 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.

Our argument, then, is that nonR&D alliance conforms to a positive homophily logic, whereas R&D innovation alliance follows one of a negative homophily. As earlier discussed, which model—positive or negative homophily—is judged correct turns on whether a difference can be found in the alliance frequency of intra-keiretsu and inter-independent dyads.

### 1.5 Period change: from preburst to postbubble

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 collapse of the asset bubble *circa* 1991 altered the Japanese business environment so as to alter those processes in significant ways.

Compared with the postbubble 90s, the mid-to-late 80s was an era when the "Japan, Inc." model of ministry guidance, firm internal labor markets, bank dependence, and keiretsu-based exchange and risk-sharing was firmly entrenched. Both horizontal and vertical keiretsu forms were admired, feared, attacked, but also emulated in the West (Kelly and Port, 1992; Dyer 1996). The prototypical Japanese electronics corporation of the time—large, diversified, integrated—drew widespread praise as well. Fujitsu, Matsushita, Mitsubishi Electric, NEC, Sanyo, Sony, 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. Business scholars such as Cusumano (1991) and Chandler (Chandler *et al.*, 1999) criticized the US electronics industry for its insufficient scale and scope, which made it uncompetitive with the Japanese in product range, brand equity, quality, cost, and development speed.

Japan at the time was riding high. Rebounding from the wrenching but short-lived *endaka* (high yen) slowdown brought on by the Plaza Accord exchange rate adjustment of 1985, the economy soared to the 1989 bubble peak of 5% gross domestic product (GDP) growth and a Nikkei Index all-time high of 38,915.

#### 1.5.1 The postbubble "lost decade"

With the crash of the Nikkei and with it the asset bubble, the Japanese economic scene was transformed. The country succumbed to a "lost decade" (and more) of recession, deflation, and chronic financial distress. GDP growth averaged 1.5% in 1992–1997 as compared with 4.5% in 1985–1991. Government and industry responded with re-regulation and restructuring, which by the millennium's end had 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; Vogel, 2006; Schaede, 2008).

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, 2008). 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 1970s, 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 *et al.*, 2000).

The electronics industry was substantially reconfigured as well. Despite strong global demand for consumer electronics and computer products, the sector struggled through the 90s with overcapacity, product proliferation, and price deflation. The advent 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 (Cole and Nakata, 2014). Firms downsized, divested low-margin business, and formed pacts with one another to reduce capacity and streamline operations (Ahmadjian and Lincoln, 2001). Vertical keiretsu suppliers, no longer assured the business of a parent manufacturer, sought new customers abroad and in a wider range of industries. Core firms sold off equity stakes in satellite suppliers and distributors, or, alternatively, hiked them, converting independently managed keiretsu affiliates into wholly controlled subsidiaries. All firms were under pressure to find strategies to increase their global competitiveness even at the expense of keiretsu commitments and alignments.

### 1.6 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 as opposed to abandoning them in favor of new and different ones. The evidence is strong that in the face of high uncertainty, economic actors will 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 and other preexisting networks. Keister (2001) finds that, in Chinese regions of low levels of market development, firms in business groups favored transaction partners with whom they had prior dealings and social ties even when lower-cost alternatives could be found 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 that support economic maturity remain undeveloped. In such an environment, they suggest, particularistic business group ties (*guanxi*) of kinship, friendship, and community fill the void (Gold *et al.*, 2002). In Taiwan, 10 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 in its leadership and governance. Yet consistent with embeddedness theory, the association was inverted-U-shaped: family ties in the post-transition era elevated 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 mature and stable market institutions, business groups, family ties, and other modes of internalizing exchange in preexisting networks provide economically functional governance (Khanna and Yafeh, 2007).

The reinforcement and activation of preexisting ties may, however, be a misguided response to uncertainty. Beckman *et al.* (2004) study the conditions under which US 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 of doing so was adverse: firms' levels of uncertainty rose, not fell, perhaps because the learning and adaptation that new ties might have fostered were thereby foregone.

A similar result appears in Mizruchi and Stearns' (2001) study of US 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 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 when the goal is innovation, which demands new knowledge pools and synergies grounded in complementarity (Beckman *et al.*, 2004).

Unlike the business group studies cited above, Japan in the 1980s was by no means an emerging economy. As the second largest in the world and whose leading export industries were more than a match for US and European

competitors, it was viewed widely as the global vanguard. Yet the Japanese economy of the preburst period was structured very 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 convoluted distribution channels, paternalistic employment systems, ministry-led industrial policy, stunted capital markets and bank debt dependence, and, of course, the pervasive keiretsu groupings. Many of the systems associated with economic efficiency—fluid markets, legal contracting, and the like—were less advanced relative to Western economies of comparable or smaller size.[5]

With the termination 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 1950s with weak and unstable growth. Price deflation, global competition, delegitimation of once-hallowed institutions—keiretsu prominently among them—and, especially after 1995, significant accounting, antitrust, and corporate governance reforms—all converged to reshape the Japanese economy along the contours 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 supportive 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 postbubble, 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 alliance.

Yet we know that in uncertain environments, firms often opt to exploit, even reinforce, their entrenched embedded networks, averting the risky and sometimes costly work of forging ties to "strangers." Our coding of the nonR&D alliances in our Japanese electronics industry panel revealed most to be 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 routines. A reasonable inference is that such orchestration and coordination was made easier when the partnerships were situated within, rather than across or outside, the keiretsu groups.

Our resolution of the question of whether firms fall back on old networks or assemble new ones and which strategy for what purposes and under what conditions is the adaptive one is thus as follows. In the postbubble climate of change and uncertainty, we suggest, Japanese firms increased the keiretsu embeddedness of their nonR&D alliances. Figure 1, discussed below, shows nonR&D alliances proliferating in the 90s, in especially so to the brief recovery in 1995–1996. But they adjusted to the heightened uncertainty by reducing coaffiliate partnerships and thus diversifying their R&D alliance portfolios by adding ties to new and disparate alters.

*H4: From the preburst to postbubble periods, the keiretsu effect on innovation alliances decreased, whereas that on implementation alliances increased.*

### 1.7 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 conditioned their propensities to join in strategic alliances and how this "keiretsu effect" varied with the alliance type: innovation versus implementation. Yet these arguments, accentuating the merits of homophily, centrality, and embeddedness in the formation and performance of strategic alliances, have generality beyond the keiretsu question. 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 been strategic partners in the past. Two firms that teamed up once in the development or manufacture or distribution of a product can be assumed to have a shared stock of experience and know-how that can be tapped again. They presumably also have routines in place for collaboration that need not be built from scratch. Issues of mesh and fit have been addressed, as have those of trust-

5 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).

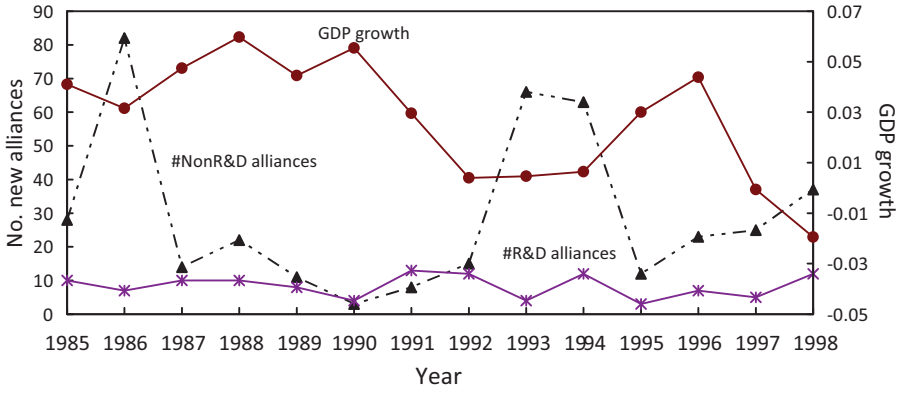


**Figure 1.** Plots of new R&D and nonR&D strategic alliances in the Japanese electronics industry, 1995–1998.

building and knowledge-pooling. The path of least resistance for a firm contemplating a new alliance is thus to take a former partner back into its embrace. But, as argued above of keiretsu ties, such prior partnership is expected to 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 an adaptive course of action when innovation is the strategic goal.

*H5a: The effect of prior direct and indirect alliance on new alliances is reduced when the alliance goal is R&D.*

As for the period change, we simply transfer the reasoning behind *H4* on the keiretsu effect to the prior alliance effect: under heightened uncertainty, firms "disembed" their innovation alliances but increase the embeddedness of their implementation alliances.

*H5b: From the preburst to postbubble period, the prior alliance effect on innovation alliances decreased, whereas that on implementation alliances increased.*

## 2. 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 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. Node-level analysis, by contrast, cannot address how the particular combination of partner attributes—one firm mature, cash-rich, and set in its ways, for example, and the other young and resource-constrained 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 include 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—publicly 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.

From these data we constructed a panel of dyads (pairings) of firms observed in each of the 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, and $C_N$ = Firm N. In 1985, given 123 firms, the number of dyads is $N(N-1)/2 = [123 \times$

**Table 1.** Illustrative strategic alliance announcements

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

122]/2 = 7,503. The 135 firms observed in 1998 convert to 9,045 dyads. For the 14-year period as a whole, the data set includes observations on 121,038 dyad-years.

## 2.1 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 (Table 1).

The keiretsu data were coded from *Kigyo 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 (*shacho-kai*) of the "big-six" enterprise groupings (Mitsui, Mitsubishi, Sumitomo, Sanwa, Fuyo, Dai-Ichi Kangyo) were coded as horizontal keiretsu affiliates. *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 have been aligned with one group or another via their trade, lending, equity, directorate, and other ties.[6] As 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. *SameHKei*—the excluded and therefore reference category—was coded 1 when the two firms were seated on the same council.

Similarly, four dummies capture each dyad's vertical keiretsu composition. Eleven such groups are represented: Hitachi, Toshiba, NEC, Fujitsu, Sony, Matsushita, Oki Electric, Mitsubishi Electric, Kobe Heavy Industry, Sumitomo Electric, and Yaskawa 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 calculated the following network measures. Two are dyad-level: (1) *PriorDirectTie* is whether firms *I* and *J* ever had a prior alliance (=1; else = 0); and (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. These are measures of "degree

6 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 1970s (Pascale and Rohlen, 1983).

**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 |
| *Innovation alliance* (=1): Firms I & J formed an R&D alliance in year *t* | 0.001 | 0.031 | 0.009 | 0.096 |
| *Implementation alliance* (=1): Firms I & J formed a nonR&D alliance in *t* | 0.003 | 0.058 | 0.033 | 0.177 |
| *Same HKei* (=1): Firms I & J are in the same horizontal keiretsu | 0.040 | 0.197 | 0.042 | 0.202 |
| *DiffHKei* (=1): Firms I & J are in different horizontal keiretsu | 0.183 | 0.387 | 0.194 | 0.395 |
| *HKei&NonHKei* (=1): I is in a horizontal keiretsu and J is not | 0.502 | 0.500 | 0.496 | 0.500 |
| *BothNonHKei* (=1): Neither I nor J is in a horizontal keiretsu | 0.274 | 0.446 | 0.268 | 0.443 |
| *SameVKei* (=1): Firms I & J are in the same vertical keiretsu | 0.0233 | 0.1509 | 0.029 | 0.168 |
| *DiffVKei* (=1): Firms I & J are in different vertical *keiretsu* | 0.196 | 0.397 | 0.168 | 0.374 |
| *VKei&NonVKei* (=1): Firm I is in a vertical keiretsu and Firm J is not | 0.502 | 0.500 | 0.533 | 0.499 |
| *BothNonVKei* (=1): Neither firm I nor firm J is in a vertical keiretsu | 0.279 | 0.448 | 0.270 | 0.443 |
| *DiffIndustry* (=1): Firm I and J are in different subindustries | 0.774 | 0.418 | 0.764 | 0.425 |
| *PriorDirectTie* (=1): I & J had a prior (direct) strategic alliance tie (=1) | 0.018 | 0.133 | 0.044 | 0.205 |
| *PriorIndirectTie* (=1): I & J had a prior indirect alliance tie through a third-party (=1) | 0.072 | 0.259 | 0.074 | 0.262 |
| *TotTies*I(J): Firm I's (J's) total prior alliances | 15.779 | 31.775 | 10.988 | 27.615 |
| *TieDensity*: Total alliances/total dyads in the year | 0.038 | 0.010 | 0.038 | 0.010 |
| *Sales*I(J): Firm I's (J's) total sales in prior year (in millions of yen) | 0.296 | 0.687 | 0.358 | 0.780 |
| *ROA*I(J): Firm I (J)'s ROA (net income before taxes)/assets in prior year | 0.074 | 0.072 | 0.037 | 0.047 |
| *Liquidity*I(J): Firm I (J)'s (assets – inventory)/current liabilities in prior year | 3.707 | 2.086 | 1.741 | 1.281 |
| *Solvency*I(J): Firm I (J)'s: (long-term debt/current assets) in prior year | 0.058 | 0.092 | 0.057 | 0.088 |
| *%GDPGrowth*: % change in gross domestic product over previous year | 0.026 | 0.023 | 0.026 | 0.023 |

centrality," and, as earlier noted, are interpretable as "status" measures. 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 (Gulati and Garguilo, 1999; Ahmadjian and Oxley, 2006). Five segments of the Japanese electronics industry were identified: electric industrial apparatus, electronic equipment, communication equipment, household electronic equipment, and 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.

### 2.1.1 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). For a more fine-grained use of such interactions in testing the homophily hypothesis, see Podolny (1994).

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 a *JI* alliance are one and the same.[7] 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 resulting small differences can be discounted as sampling error. Forcing equality of the within-dyad main effects sacrifices no substantive information and boosts estimation efficiency by reducing the number of terms.

### 2.2 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.[8]

#### 2.2.1 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 extremely rare (King and Zeng, 2001; Sorenson and Stuart, 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 reveals 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.

#### 2.2.2 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 ($i = 1,\ldots,123$) and columns ($j = 2,\ldots,123$) of the 1985 (for example) matrix whose cells define the dyads [$N(N\text{-}1)/2 = 7{,}503$], but it necessitates just one term—the mean of the overlapped dyads— rather than $2 \times 121 = 242$.[9]

## 3. 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

7 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.

8 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.

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

**Table 3.** Logit regressions of innovation (R&D) and implementation (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* | | | | |
| *SameHKei*[b] | *0.537* | *0.929*** | *0.538* | *0.933*** |
| | *(0.467)* | *(0.297)* | *(0.461)* | *(0.295)* |
| DiffHKei | −0.366 | −1.165** | −0.393 | −1.155** |
| | (0.535) | (0.322) | (0.527) | (0.319) |
| HKei&NonHKei | −0.439 | −0.911** | −0.438 | −0.924** |
| | (0.536) | (0.323) | (0.529) | (0.323) |
| BothNonHKei | −0.736 | −0.663* | −0.701 | −0.676* |
| | (0.515) | (0.331) | (0.511) | (0.328) |
| *Vertical* keiretsu *variables* | | | | |
| *Same VKei*[b] | *1.410*** | *1.296*** | *1.423*** | *1.274*** |
| | *(0.405)* | *(0.304)* | *(0.414)* | *(0.299)* |
| DiffVKei | −1.535** | −1.282** | −1.557** | −1.227** |
| | (0.451) | (0.339) | (0.453) | (0.338) |
| VKei&NonVKei | −1.474** | −1.111** | −1.470** | −1.095** |
| | (0.429) | (0.317) | (0.433) | (0.315) |
| BothNonVKei | −1.536* | −1.503** | −1.518* | −1.487** |
| | (0.735) | (0.388) | (0.749) | (0.386) |
| *Prior alliance network variables* | | | | |
| PriorDirectTie | 1.846** | 2.690** | 1.799** | 2.951** |
| | (0.379) | (0.254) | (0.379) | (0.255) |
| PriorIndirectTie | 0.940** | 0.924** | 0.895* | 1.050** |
| | (0.361) | (0.253) | (0.364) | (0.247) |
| (TotTies$I$ + TotTies$J$)/100 | 1.137+ | 0.725 | 1.021+ | 0.733 |
| | (0.602) | (0.493) | (0.547) | (0.485) |
| (TotTies$I$ × TotTies$J$)/100 | 0.000 | −0.002 | 0.002 | −0.004 |
| | (0.008) | (0.006) | (0.008) | (0.008) |
| *Control variables* | | | | |
| DiffIndustry | −0.590* | −0.928** | −0.602* | −0.960** |
| | (0.246) | (0.199) | (0.244) | (0.198) |
| Sales$I$ + Sales$J$ | 0.043 | −0.197 | 0.089 | −0.146 |
| | (0.171) | (0.138) | (0.165) | (0.133) |
| Sales$I$ × Sales$J$ | −0.067 | 0.092 | −0.074 | 0.122 |
| | (0.075) | (0.082) | (0.072) | (0.079) |
| ROA$I$ + ROA$J$ | 4.191+ | 4.878 | 4.471* | 4.824 |
| | (2.189) | (3.786) | (2.183) | (3.611) |
| ROA$I$ × ROA$J$ | −105.200** | −86.024 | −110.329** | −49.837 |
| | (26.855) | (82.563) | (22.378) | (81.641) |
| Solv$I$ + Solv$J$ | −0.410 | −2.475+ | −0.466 | −2.846* |
| | (1.464) | (1.291) | (1.495) | (1.286) |
| Solv$I$ × Solv$J$ | −12.106 | 12.677 | −17.112 | 8.702 |
| | (39.233) | (19.218) | (39.588) | (20.543) |
| Liq$I$ + Liq$J$ | −0.351** | −0.295** | −0.342** | −0.347** |
| | (0.130) | (0.091) | (0.129) | (0.099) |
| Liq$I$ × Liq$J$ | 0.185** | 0.127** | 0.182** | 0.134** |
| | (0.060) | (0.033) | (0.062) | (0.034) |
| Dyad autoregression | 142.658** | 110.869** | 137.691** | 84.621** |
| | (24.493) | (9.840) | (19.810) | (5.886) |
| Year | | | −0.921 | −2.682+ |
| | | | (1.668) | (1.405) |

(continued)

**Table 3.** Continued

| Explanatory Variables | Fixed-effects model | | Random-effects model | |
|---|---|---|---|---|
| | Innovation | Implementation | Innovation | Implementation |
| Year$^2$ | | | 0.004 | 0.012+ |
| | | | (0.009) | (0.007) |
| TieDensity | | | 36.283 | 175.942* |
| | | | (86.040) | (73.112) |
| %GDPGrowth | | | −3.619 | −10.390 |
| | | | (10.191) | (7.150) |
| Constant | −5.373** | −5.938** | 44.666 | 131.442* |
| | (0.778) | (0.634) | (78.513) | (66.719) |
| Observations | 12577 | 12577 | 12577 | 12577 |

[a]Not shown in the relogit regressions are fixed effects (13 dummies) for calendar years.
[b]Coefficients in this row are taken from an identical regression, save that *SameHK* and *SameVK* are substituted for other horizontal and vertical keiretsu dummies.
+Significant at 10%; * Significant at 5%; ** Significant at 1%. Standard errors adjusted for clustering on dyad.

alliance events to move against the business cycle. Spells of economic weakness map to upswings in the nonR&D 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 (1988–1992), rising in the slump years of 1993 and 1994, declining in the 1995–1996 recovery, and surging again with the Asian financial crisis of 1997–1998. 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.

## 3.1 The pooled regression analysis

We begin with an analysis that pools the choice sample data across the entire 14-year observation period. This pooled analysis averages over and therefore obscures some important period effects, but it is a useful first attack on some of our concerns.

We use 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 ($N \times N$–1)/2, where $N$ is the number of firms), not the number of dyads times the number of years: 14 × ($N \times N$–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 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 alliance trending down at a declining rate and as highly contingent on the alliance network's density in the prior year. No such macro-level effects are evident in the R&D alliance regression.

### 3.1.1 Keiretsu effects on R&D and nonR&D 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 were taken from a set of otherwise unreported regressions. The full regressions we 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 models, dyads assigned to the same horizontal and vertical keiretsu (*SameHKei* and

**Table 4.** Relogit regressions of innovation (R&D) and implementation (nonR&D) alliance foundings by period, Japanese electronics firms[a]

| Explanatory variables | (1) Preburst: 1985–1991 Innovation | (2) Postbubble: 1992–1998 Innovation | (3) Preburst: 1985–1991 Implementation | (4) Postbubble: 1992–1998 Implementation |
|---|---|---|---|---|
| *Horizontal keiretsu variables* | | | | |
| *SameHKei*[b] | *0.605* | *0.244* | *0.868+* | *0.893** |
| | *(0.470)* | *(0.925)* | *(0.499)* | *(0.363)* |
| DiffHKei | −0.339 | −0.123 | −1.259* | −1.063** |
| | (0.574) | (1.020) | (0.550) | (0.403) |
| HKei&NonHKei | −0.508 | −0.222 | −1.071* | −0.693+ |
| | (0.560) | (0.990) | (0.522) | (0.404) |
| BothNonHKei | −0.746 | −0.290 | −0.182 | −0.847* |
| | (0.532) | (0.965) | (0.491) | (0.429) |
| *Vertical keiretsu variables* | | | | |
| *SameVKei*[b] | *2.190*** | *0.880* | *1.430*** | *1.504*** |
| | *(0.445)* | *(0.717)* | *(0.547)* | *(0.360)* |
| DiffVKei | −2.180** | −1.103 | −1.167+ | −1.769** |
| | (0.537) | (0.739) | (0.607) | (0.415) |
| VKei&NonVKei | −2.236** | −0.829 | −1.093* | −1.421** |
| | (0.491) | (0.734) | (0.545) | (0.385) |
| BothNonVKei | −2.577** | −0.541 | −1.843** | −1.571** |
| | (0.851) | (1.159) | (0.711) | (0.456) |
| *Prior alliance network variables* | | | | |
| PriorDirectTie | 1.151* | 2.157** | 2.814** | 2.618** |
| | (0.475) | (0.646) | (0.478) | (0.318) |
| PriorIndirectTie | −0.543 | 1.686** | 1.766** | 0.790** |
| | (1.106) | (0.542) | (0.431) | (0.299) |
| (TotTies*I* + TotTies*J*)/100 | 0.390 | 0.962 | −0.587 | 0.743 |
| | (1.219) | (0.796) | (1.054) | (0.582) |
| (TotTies*I* × TotTies*J*)/100 | 0.037 | 0.004 | 0.049* | −0.001 |
| | (0.024) | (0.009) | (0.024) | (0.007) |
| *Control variables* | | | | |
| DiffIndustry | −0.915** | −0.221 | −0.790** | −1.013** |
| | (0.352) | (0.371) | (0.294) | (0.269) |
| Sales*I* + Sales*J* | 0.351 | −0.015 | −0.283 | −0.138 |
| | (0.254) | (0.256) | (0.221) | (0.182) |
| Sales*I* × Sales*J* | −0.142 | −0.102 | 0.058 | 0.062 |
| | (0.140) | (0.101) | (0.137) | (0.095) |
| ROA*I* + ROA*J* | 1.760 | 2.809 | 11.037* | −0.237 |
| | (3.004) | (3.068) | (5.449) | (2.528) |
| ROA*I* × ROA*J* | −89.845** | −146.77** | −195.59** | 65.285 |
| | (32.496) | (36.894) | (72.075) | (57.492) |
| Solv*I* + Solv*J* | 1.781 | −2.727 | −6.263* | −1.503 |
| | (2.284) | (1.719) | (2.773) | (1.316) |
| Solv*I* × Solv*J* | 7.734 | 27.730 | 76.257** | 2.836 |
| | (55.133) | (36.595) | (29.413) | (22.420) |
| Liq*I* + Liq*J* | −0.161 | 0.319 | −0.352+ | −0.284** |
| | (0.146) | (0.442) | (0.207) | (0.096) |
| Liq*I* × Liq*J* | 0.169** | −0.425 | 0.175+ | 0.122** |
| | (0.053) | (0.419) | (0.100) | (0.034) |
| Dyad autoregression | 121.504** | 124.805** | 148.910** | 92.769** |
| | (40.401) | (31.740) | (18.661) | (12.117) |
| Constant | −4.749** | −6.749** | −6.435** | −5.477** |
| | (0.877) | (1.290) | (1.118) | −0.62 |

[a]Regressions include fixed effects for calendar year differences within periods.

[b]Coefficients 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%; * Significant at 5%; ** Significant at 1%. Standard errors adjusted for clustering on dyad.

*SameVKei*) are the omitted categories against which the coefficients on the included dummies are evaluated. This presentation mode enables consideration of the keiretsu effects from two perspectives: (1) same-group against all alternatives; and (2) the alternatives against the same-group baseline.

Table 3 reveals remarkably consistent vertical keiretsu effects. The only contrast is the positive same-group effects against the negative effects of the other three configurations. Thus, *H1a*, the positive homophily prediction, is confirmed, but there is no evidence for negative homophily (*H1b*). Nor does the keiretsu effect vary with the alliance goal: R&D versus nonR&D (*H3*).

The coefficients on the horizontal keiretsu dummies are smaller across the board than their vertical keiretsu counterparts, consistent with *H2*. Moreover, they are only significant in the nonR&D (implementation) regression, and their ordering there approximates the negative homophily form.

#### 3.1.2 Prior alliance effects in the pooled regression

We turn attention now to the role of preexisting networks other than keiretsu. *H5a* holds that Japanese electronics firms' R&D alliances are relatively less dependent than their nonR&D alliances on prior 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.

#### 3.1.3 Financial-industrial attributes in the pooled regression

The financial and industry controls are of little substantive concern, but two are of interest. The dyad-level profit effect, $ROAI \times ROAJ$, is negative 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 tie-ups between cash-strapped biotech start-ups and deep-pocketed "big pharmas." It may also testify to the risk-sharing prevalent in Japanese corporate networks: strong companies ally with weak ones in order to reverse the latter's failing fortunes (Aoki, 1988; Hoshi *et al.*, 1991; Lincoln *et al.*, 1996).

The negative coefficient on *DiffIndustry* says that alliances occur 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.

### 3.2 Period-specific results

#### 3.2.1 How the keiretsu infrastructure 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 (Column 1). The estimates for the horizontal keiretsu dummies in that period are again nonsignificant. The vertical keiretsu effects, also again, are highly significant and are ordered in the positive homophily pattern.

As for the postbubble results, impressive support exists for *H4*: 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 strong vertical keiretsu effects in the preburst era. None is significant, and the coefficient magnitudes are sharply reduced.

The implementation alliance picture is very different. For both keiretsu types, the positive homophily pattern is much stronger in the postbubble period (Col. 4) than in the preburst period (Col. 3). In the preburst period (Col. 3), the horizontal group effects take a clear negative homophily form, whereas the vertical keiretsu coefficients suggest a blend of weak positive homophily and status influences: less frequent alliances of independents than alliances that include a keiretsu firm.

From the preburst to the postbubble period, then, the keiretsu roles in innovation and implementation alliances diverged. Firms in pursuit of innovation partnerships diversified their partner pools such that keiretsu affiliations no

longer mattered. Their implementation alliances, by contrast, became more deeply embedded in keiretsu and in a sharper positive homophily way. This evidence is consistent with the reasoning behind *H4*: that in the resource-constrained, turbulent, and uncertain environment of the postbubble era, keiretsu groups were encouraging and supporting their members' programs of consolidation and collaboration

#### 3.2.2 Subperiod shifts in the keiretsu effects

Our preburst and postbubble periodization, substantively meaningful as we believe it is and operationally expedient 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 (1988–1991), the preburst period encompassed the *endaka* (high yen) slowdown (1986–1987). 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, 1985–1988, and a corresponding regression for the final three-year period, 1996–1998. If any of the effects reviewed above were changing both within and 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 we mention two interesting exceptions, the evidence for which we do not formally present. First, the horizontal keiretsu effects on innovation alliances, nonsignificant in Column 1 of Table 4, proved significant and stronger in 1985–1988. In this four-year interval, just before the 1989–1991 peak bubble years, the horizontal groups, like their vertical counterparts, had a sizable hand in innovation alliances. A status effect was also in evidence: horizontal keiretsu affiliates as a set were more active in alliances than were unaffiliated firms.

Second, in the last three years of our series, 1996–1998, the positive horizontal keiretsu homophily effects on implementation alliance had disappeared: the coefficients were smaller than in Column 4 of Table 4, nonsignificant, and two had the "wrong" signs. It appears, then, that the embedding of implementation alliances in horizontal keiretsu infrastructure was an early postbubble phenomenon. Toward that period's end, the horizontal groups, likely due in part to financial consolidations, cross-shareholding sell-offs, and governance and regulatory reforms, were unraveling, delegitimating, and otherwise becoming obsolete (Lincoln and Gerlach, 2004: Ch. 3).

#### 3.2.3 Period change in prior alliance embeddedness

Our hypothesis (*H5b*) on the inertia or path dependence of the alliance process—alternatively framed as embeddedness in prior alliance networks or "temporal" embeddedness (Przepiorka and Diekmann, 2013)—is the same as *H4* on period shifts in the keiretsu effects: decreased embeddedness of innovation alliance foundings and increased embeddedness of implementation foundings. The pattern in Table 4, however, is just the opposite: the prior direct and indirect alliance effects in the R&D case increase markedly from the preburst to the postbubble period, whereas they decreased (less markedly) in the nonR&D case.

It thus appears that, as the keiretsu were receding as alliance-building infrastructure for innovative collaborations in Japanese electronics, the prior alliance network was taking its place.

### 3.3 Other period shifts

Other period shifts worth noting in passing suggest a general destructuring of Japanese electronics industry networks in the postbubble era. An example is the between-period drop in the $TotTiesI \times TotTiesJ$ coefficient. In the preburst era, alliances (especially nonR&D) formed at higher rates in pairs of firms, both of which were central in the prior alliance network. That effect was altogether gone in the postbubble period. Prior network status mattered less; firms in the new environment had become more receptive to relationally inexperienced partners.

Another change testifying to broadening and diversification of alliance activity is the postbubble disappearance of the preburst tendency to confine R&D alliances to industry subsectors.

## 4. Conclusions

We have produced a strong and consistent set of empirical results documenting how 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 14-year stretch of Japanese history punctuated by major economic change. Following a considerable research stream on strategic alliance patterns in the United States and other Western countries, we also studied how firms' preexisting alliance networks shaped their new alliance choices. Finally, we examined how the size, financial structure, and subindustry composition of Japanese electronics firms conditioned the rate at which those firms paired up in new alliances.

Our substantive and theoretical concerns were several. First, in keeping with embeddedness theory, we reasoned that Japanese electronics firms' strategic alliances, as was largely true of their supply chain transactions, were more likely to occur within horizontal and vertical keiretsu groups than across or outside them.

We argued that firms' keiretsu affiliations conditioned their alliance formation processes in two distinct ways. The most obvious and most in tune with embeddedness reasoning is what we call "positive homophily": groups supply their members with resources, capabilities, and services—trust, familiarity, reciprocity, monitoring, and so on—that facilitate and expedite partner search and alliance construction. A complementary hypothesis invokes homophily as well but of a negative or defensive sort. It holds that alliances within groups, like alliances of independents, offer the partnering firms no particular collaborative advantages. However, such alliances are less exposed to information spillovers and other competitive hazards than tie-ups that cross keiretsu boundaries.

We were further interested in whether the processes' conditioning alliances for innovation (R&D) diverged from those for implementation (nonR&D). Following a large literature on innovation that stresses its dependence on diversity, complementarity, and flexibility of organization, we hypothesized that innovation alliances would prove less embedded in preexisting networks. Implementation alliances, argued to rely for success on dense communication and close cooperation, would prove more so.

The results of our pooled (1985–1998) regression analysis supported that hypothesis but only with respect to the horizontal keiretsu and implementation alliances. The pattern of effects was negative homophily. The role of horizontal group embeddedness in alliance formation thus appears to have been the mostly defensive one of sheltering member firms from the risks of outside collaborations. This interpretation squares with our earlier-stated view of the horizontal keiretsu as less coherently and strategically organized than their vertical counterparts (Asanuma, 1989; Gerlach, 1992).

By contrast, the vertical keiretsu exhibited strong and essentially identical positive homophily effects on innovation and implementation alliances alike. This evidence thus suggests that coaffiliate alliances in the vertical keiretsu, unlike those within the horizontal groups, had the benefit of group-specific resources and supports not available to cross-group alliances or alliances involving unaffiliated firms.

This relatively straightforward story is made more complex, however, by the period differences we find between the years up to and including the asset bubble (1985–1991) and those following its collapse (1992–1998). The demise of the bubble induced a major economic regime shift: from the highly structured and relatively stable postwar "Japan, Inc." era to the turbulent and high-uncertainty "lost decade" era that followed. Our general hypothesis on this shift was that Japanese firms adapted to it with a two-pronged strategy: raising the embeddedness in keiretsu of their nonR&D alliances, whereas lowering it in their R&D alliances.

From one perspective, the two-pronged alliance strategy appears well-tailored to the complex and turbulent business environment brought on by the bubble's demise. Firms, on the one hand, were under pressure to reduce product overlap and consolidate and simplify production, distribution, and supply, and they leveraged their keiretsu networks for those ends. They were, on the other hand, constrained both in Japan and in the global economy at large to accelerate and deepen innovation in order to differentiate their products and increase market share.

This two-pronged strategy—fallback for partners on preexisting networks when the alliance goal is implementation but search outside those networks for new and different partners when innovation is the aim—comports with a rough consensus in recent scholarship on how actors should design and navigate their networks conditional upon what they want to achieve. That consensus holds that innovation thrives when networks are diverse, far-flung, permeable, and flexible, as opposed to dense, closed, multiplex, and homogeneous. On the other hand, networks of the latter sort are generally deemed conducive to smooth and fast intra-network communication flow, thick transfers of tacit knowledge, and tightly knit collaborative action.

From another perspective, however, the adaptiveness of the two-pronged strategy to Japan's uncertain postbubble business environment is open to doubt. One might well question the longer-term utility of embedding even implementation alliances in an infrastructure of keiretsu ties. Similar reinforcement and re-leveraging of preexisting networks by US firms was shown by Beckman *et al.* (2004) to fail as a response to uncertainty. Perhaps, following those

authors' reasoning, Japanese electronics firms' moves to reinforce their keiretsu networks with a new layer of coaffiliate pacts were less a rational adaptation to uncertainty than a "threat-rigidity" response: a reflexive circling of the wagons in ill-considered reaction to external shock. To the many critics of Japan's on-again off-again program of postbubble restructuring and recovery, what the economy needed most and sooner rather than later in the postbubble era was a dismantling of the keiretsu and their consignment to the dustbin of business history (Katz, 1998; Bremner and Thornton, 1999; Economist, 2002; Dawson, 2003).[10]

Doubt might be inspired as well by our finding that, while electronics industry R&D alliances following the bubble were disembedding from the keiretsu, they were becoming more embedded in networks of prior alliance ties. The positive interpretation of these diverging trends is that such leveraging of prior alliance networks in the search for new alliance partners is a pervasive pattern in the United States and other advanced Western economies, so Japan's postbubble drift in this direction is a reformist and forward-looking sign. Critics of Japan have for many years called for the country to remodel its market institutions along the contours of the (mostly Anglo-American) West (Vogel, 2006). The shifts we have documented in Japan's strategic alliance processes testify that following the bubble, some convergence on this dimension of business structuring was indeed underway.

An optimistic take on that convergence is the following. Unlike the keiretsu, which constrained large numbers of firms to align with and abide by the routines, rules, and collective pressures of a relatively small and fixed number of static interfirm communities, prior alliance networks vary from firm to firm and are thus less aggregated, centralized, and, consequently, constraining of new alliance search. Yet there may be merit as well in the following pessimistic interpretation. When firms reflexively invoke path-dependent and risk-averse routines of collaboration in lieu of riskier but, in the long term, more fundamentally adaptive expansive and exploratory search, they are acting in myopic ways. Most scholars, as we suggested at the outset, view the large inertial element in strategic alliance dynamics with a skeptical eye. Falling back on old partners in repeated rounds of alliance formation, as we suggested at the outset, has little of the flavor of "strategic" search. It has more the look of a retreat from uncertainty, far less a commitment to grapple with it head-on.

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10 Even today when the keiretsu are less identifiably bounded groups than collections of weakly interlinked firms with loosely shared identities and histories, Japan continues to vacillate between old and new ways. The handling of the Olympus Corporation accounting scandal suggested strongly that keiretsu-style maneuverings are still woven into the fabric of Japanese business. As *The Economist (2012)* commented:

> *"...(T)he forces of old Japan—Olympus's main bank and biggest shareholder, SMBC, and a group of cross-shareholding firms—close(d) ranks to protect the company from ... meddlesome outsiders."*

Yet the recent takeovers of failing Japanese electronics maker Sharp by Taiwan's Hon Hai (Harner, 2016) and scandal-tarred Mitsubishi Motors by Renault – Nissan (billed as a "strategic alliance," but one that gave Nissan a 34% controlling stake) came as a surprise to observers who expected that both interventions would follow the Olympus example of keiretsu-type insiders engineering a self-serving solution that shouldered outside interests aside (Shiraki and Tajitsu, 2016).

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