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" Rethinking Relationship-Specific Investments: Subcontracting in the Japanese Automobile Industry "

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Rethinking Relationship-Specific Investments: Subcontracting in the Japanese Automobile Industry

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Abstract: According to modern contract theory, how firms structure their trading patterns and governance structures will depend both on the size of any relationship-specific investments they make, and on the feasibility of detailed contracts. Suppose contracts are hard to draft and enforce, but firm A must invest heavily in a capital asset whose value depends on A's continued trades with firm B. If A makes this investment on its own, B may try to restructure opportunistically the terms of the contract ex post. To mitigate the risk of such hold ups, predict contract theorists, A and B may negotiate a variety of governance mechanisms they would not otherwise choose. In the extreme, they may even decide to merge.

The puzzle to this theory is less in its logic. It is more in its empirics. Over the past two decades, scholars have looked hard for evidence of governance arrangements driven by large relationship-specific investments. Although they find some evidence of such arrangements in idiosyncratic industries like public utilities, aerospace, and defense, they find less evidence in more "ordinary" industries. Within this context, the Japanese automobile industry has played an important symbolic role: an "ordinary" industry thought to be structured by extra-contractual governance arrangements driven by substantial relationship-specific investments.

In this article, we re-evaluate that ordinary industry. Despite examining a variety of data on ties among suppliers and assemblers, we find less evidence of large relationship-specific investments than most accounts imply, and less evidence of extra-contractual governance arrangements driven by such investments. Perhaps, we suggest, the time has come to reconsider whether relationship-specific investment theory explains quite as much as we have thought.

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Longer ago than either of us cares to remember, one of us attended junior high in Tokyo. On Saturdays, he worked at a printed circuit factory. Or maybe "factory" makes it all sound too grand. A small building in back of a gas station, it had 3 or 4 punch presses. The "president" supervised matters (though he actually spent more time hanging out at the gas station), together with a sidekick who did assorted odd jobs besides. Several middle-aged women with no apparent technical education or skill ran the presses.

The junior high kid spent his time trimming the sheets to which others would eventually attach the transisters. The women then punched the holes and margins onto the boards, and the president's sidekick loaded the finished boards onto a truck. Periodically, he returned them to the firm that had ordered the work, and brought more sheets to punch along with any press dies the firm needed. The punch presses were standard generic affairs, and the buyer seems to have kept title to the dies.

Thirty years later, the other one of us knows the president of a factory near Nagoya. For many years, the firm has done machining work for a first-tier Toyota subcontractor. Unfortunately for the firm, Toyota has increasingly substituted integrated plastic units for the steel parts the firm machines. Worried that the Toyota-bound work might disappear, the president has begun to move the firm toward machining materials for computer hard disks on the side.

A machining firm can make a wide variety of products, the president seemed to explain. His firm could make products for the automobile industry or otherwise, Toyota-bound or otherwise. If the demand for shock-absorber parts fell, well then it would simply make computer disks instead.

What neither of us saw in either firm was any evidence of investments that were specific to the firm's trading partners. Yet whether such relationship-specific investments (RSIs) structure the arrangements firms make matters. Indeed, for at least two independent reasons, whether they structure the Japanese automobile industry matters crucially.

Within law & economics, the prevalence of RSIs matter because of the way the issue goes to the heart of market contracting. At root, RSI theory challenges our routine assumption that straightforward market contracting produces something close to socially optimal arrangements. Yet although the theory is clear, the empirics are less so. Scholars have looked hard for evidence of governance arrangements driven by large relationship-specific investments. To date, they reach but mixed results. They find substantial evidence of the relation between RSIs and governance within idiosyncratic industries like public utilities, aerospace, and defense. Although they find some evidence of the relation within "ordinary" industries, they find considerably less. In that empirical context, the Japanese automobile industry has stood as a prominent exception -- an important source of RSI-driven extra-contractual governance arrangements in an "ordinary" industry.

Within Japanese studies, RSIs provide a convenient theoretical rationale for taking the conventional tales of "socially embedded" contracts and relational stability at face value. To

date, all-too-many scholars have been all-too-happy to "explain" these tales by citing strong cultural norms of integrity or oligation. The theoretically more astute justifiably find the "explanations" hollow. For them, RSIs have offered an analytically coherent incentive-compatible rationale for exactly the same tales.

In the article below, we argue that the usual accounts of the industry are myth. Notwithstanding those accounts, the industry does not contain widespread, substantial physical-asset or human-capital RSIs. To the extent that we are right, theorists might do well to rethink the empirical role RSI theory has played over the past two decades. We do not argue that firms never make RSIs or that contracts will always solve incentive problems. Far be it from us to make such a claim, especially since this is an article only about one industry in one country. Neither do we claim that RSI theory is wrong as theory. Neither of us is a theorist, this is not a theoretical paper, and the intuition behind RSI theory has always made eminently good sense to us anyway. Instead, we make a much more modest point: that modern production may require lower levels of idiosyncratic investment than we have usually supposed; that market contracting may work better than usually asserted; and that, as a result, RSI theory may explain less of the contracting and governance patterns we observe than we have sometimes thought.

In the article that follows, we argue that RSIs in the Japanese automobile industry are usually quite small and usually play a minor role. Toward that end, we begin by summarizing the implications RSI theory poses for contract theory (Section I.A.), and surveying the empirical evidence (I.B., C.). We then turn to the Japanese automobile industry. First, we anecdotally canvass the practices at Honda (II.B.), and provide a background to the industry as a whole (II.C.) Second, we examine the evidence of RSIs among second- and third-tier suppliers (III.A.)). Finally, we examine the evidence amoung first-tier suppliers (III.B.).

I. Specific-Investment Theory

A. The Idea:

Relationship-specific investments (RSI) matter -- and matter deeply, argued Benjamin Klein, Robert Crawford, and Armen Alchian and Oliver Williamson.[1] Dozens of scholars have since repeated the logic they pioneered, and today it graces such mainstream sources as Dennis Carlton and Jeffrey Perloff's industrial organization text, or Paul Milgrom and John Roberts' management text.[2] According to this intuition, the scope and size of RSIs can directly affect the governance arrangements firms choose. Whether business partners negotiate long-term contracts, spot contracts, equity investments, franchise arrangements, or even mergers -- whether they negotiate any of these can depend vitally on the RSIs at stake.

Crucially, investments specific to a relationship generate appropriable quasi-rents. In a world of incomplete contracting, as Scott masten, James Meehan, Jr., and Edward Snyder put it, that appropriability may increase the "resources expended attempting to negotiate a favorable

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[1] Benjamin Klein, Robert G. Crawford & Armen A. Alchian, Vertical Integration, Appropriable Rents, and the Competitive Contracting Process, 21 J. Law & Econ. 297 (1978); Oliver E. Williamson, Transaction-Cost Economics: The Governance of Contractual Relations, 22 J. Law & Econ. 233 (1979); Oliver E. Williamson, The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting (New York: The Free Press, 1985).

[2] Dennis W. Carlton & Jeffrey M. Perloff, Modern Industrial Organization chs. 2, 13 (New York: HarperCollins, 2d ed., 1994); Paul Milgrom & John Roberts, Economics, Organization and Management ch. 9 (Englewood Cliffs: Prentice-Hall, 1992). The theory plays an even more pronounced role in David Besanko, David Dranove & Mark Shanley, The Economics of Strategy Part I (New York: John Wiley & Sons, 1996).

distribution of the gains from trade."[3] In the words of Klein-Crawford-Alchian themselves, "[a]fter a specific investment is made and such quasi-rents are created, the possibility of opportunistic behavior is very real."[4] To avoid such rent-seeking and rent-avoidance costs, firms may sometimes introduce governance arrangements that are otherwise unnecessary (and probably problematic, given the way most of them weaken market incentives). RSIs can potentially transform a competitive market exchange into a bilateral monopoly, in other words. When appropriate contractual arrangements are infeasible, that transformation may call forth arrangements that otherwise would be superfluous at best.[5] Or as Klein-Crawford-Alchian wrote:[6]

> The crucial assumption underlying the analysis of this paper is that, as assets become more specific and more appropriable quasi rents are created (and therefore the possible gains from opportunistic behavior increases), the costs of contracting will generally increase more than the costs of vertical integration. Hence, ceteris paribus, we are more likely to observe vertical integration.

B. The Evidence:

1. GM-Fisher Body. Consider a short summary of the account Klein-Crawford-Alchian used to popularize this analysis: the 1926 merger between General Motors and Fisher Body. Before 1919, claimed Klein-Crawford-Alchian, car companies used wooden or wood-and-metal coaches. Making these early coaches involved standard tools and standard knowledge. Making a good one took skill, but it was a skill a coach maker could use as easily to fit a coach onto a frame by assembler A as on one by assembler B. Conversely, assembler A could as easily use a coach from coachmaker X as from coachmaker Y.

In this pre-1919 world, continued Klein-Crawford-Alchian, assemblers and coach makers traded on what was virtually a spot market. In doing so, they took little risk. If a coach maker stopped selling, the assembler could buy its coaches elsewhere. If an assembler stopped buying, the coach maker could sell its coaches elsewhere. As neither had invested much in either assets or skills that were specific to the relationship, neither had much to lose from switching contract partners.

By the next decade, Klein-Crawford-Alchian wrote, car makers started to make standardized coaches out of steel, and fashioning these steel coaches required dies. In turn, these dies cost large sums, and could be used only for specific models. Now, the assembler and coach maker faced the prospect of investing in an asset that paid off only within the relationship. As such, the asset generated appropriable quasi-rents: if the coach maker bought the die, the assembler could threaten to end the relationship in order to shift the terms of the deal in its favor.

Rather than risk this opportunism, reasoned Klein-Crawford-Alchian, assemblers and coach makers integrated vertically. In 1919, Fisher Body and General Motors entered into a long-term contract. Alas, given the problems inherent in long-term contracts in the real world,

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[3] Scott E. Masten, James W. Meehan, Jr., & Edward A. Snyder, The Costs of Organization, 7 J. Law, Econ. & Org. 1, 6 (1991)

[4] Klein, Crawford & Alchian, supra note, at 298.

[5] See Williamson (1979), supra note, at 241-42.

[6] Klein, Crawford & Alchian, supra note, at 298.

opportunism-related problems persisted. By 1926, GM simply acquired Fisher Body outright. Given the large RSIs involved, the two firms found it paid to eliminate the risk through vertical integration.

2. RSI taxonomy. -- To Klein-Crawford-Alchian, the risk of opportunism in the GM-Fisher Body relationship lay in the investment in large stamp dies: "The manufacture of dies for stamping parts in accordance with the above specifications gives a value to these dies specialized to [the assembler], which implies an appropriable quasi rent in those dies. Therefore, the die owner would not want to be separate from [the assembler]."[7] Yet such physical assets are not the only RSIs theorists identify. Oliver Williamson, for example, cites several types of RSIs, of which we consider three here:[8]

> site specificity -- e.g. successive stations that are located in a cheek-by-jowl relation to each other so as to economize on inventory or transportation expenses;
>
> physical asset specificity -- e.g. specialized dies that are required to produce a component; [and]
>
> human asset specificity that arises in a learing-by-doing fashion ...

The evidence of occasional site specificity may well be the strongest. If a utility company builds a generating plant near a coal mine, for example, the utility and mine lock themselves into a relation close to a bilateral monopoly. Sometimes, this affects the governance structures they choose.[9]

The evidence of human-capital specificity is more tenuous, though here too somescholars claim to find evidence on point. Marketing scholars, for example, argue that employees sometimes invest in brand-specific knowledge in ways that affect the governance choices firms make.[10] Others claim that employees invest in relation-specific manufacturing know-how to similar effect.[11]

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[7] Klein, Crawford & Alchian, supra note, at 308.

[8] See Williamson (1985), supra note, at 95 (ital. & para. added); see also Williamson (1979), supra note. Williamson (1985), supra note, also discusses a fourth category of "dedicated assets."

[9] Keith J. Crocker & Scott Masten, Mitigating Contractual Hazards: Unilateral Options and Contract Length, 19 Rand J. Econ. 327 (1988); Stephen J. DeCanio & H.E. Frech III, Vertical Contracts: A Natural Experiment in Gas Pipeline Regulation, 149 J. Institutional & Theoretical Econ., 149: 370 (1993); C. Paul Hallwood, On Choosing Organizational Arrangements: The Example of Offshore Oil Gathering, 38 Scottish J. Pol. Econ. 227 (1991); Jean-Francois Hennart, Upstream Vertical Integration in the Aluminum and Tin Industries, 9 J. Econ. Behav. & Org. 281 (1988); Paul L. Joskow, Vertical Integration and Long-term Contracts: The Case of Coal-burning Electric Generating Plants, 1 J. Law, Econ., & Org. 33 (1985); Paul L. Joskow, Contract Duration and Relationship-Specific Investments: Empirical Evidence from Coal Markets, 77 Am. Econ. Rev. 168 (1987); Paul L. Joskow, Price Adjustment in Long-term Contracts: The Case of Coal, 31 J. Law & Econ. 47 (1988); Scott E. Masten & Keith J. Crocker, Efficient Adaptation in Long-Term Contracts: Take-or-Pay Provisions for Natural Gas, 75 Am. Econ. Rev. 1083 (1985); J. Harold Mulherin, Complexity in Long-term Contracts: An Analysis of Natural Gas Contractual Provisions, 2 J. Law, Econ., & Org. 105 (1986); Russell Pittman, Specific Investments, Contracts, and Opportunism: The Evolution of Railroad Sidetrack Agreements, 34 J. Law & Econ. 565 (1991); Pablo T. Spiller, On Vertical Mergers, 1 J. Law, Econ., & Org. 285 (1985).

[10] Erin Anderson, Transaction Costs as Determinants of Opportunism in Integrated and Indepenent Sales Forces, 9 J. Econ. Behav. & Org. 247 (1988); Erin Anderson & Anne T. Coughlan, International Market Entry and Expansion via Independent or Integrated Channels of Distribution, 51 J. Marketing 71 (1987); Erin Anderson & David C. Schmittlein, Integration of the Sales Force: An Empirical Examination, 15 Rand J. Econ. 385 (1984); John George & Barton A. Weitz, Forward Integration into Distribution: An Empirical Test of Transaction Cost Analysis,

By contrast, observers tend to find less evidence (though more than zero, to be sure) of the sort of physical-asset specificity Klein-Crawford-Alchian used to explain the GM-Fisher Body merger. Granted, Keith Crocker and Kenneth Reynolds did conclude that physical-asset specificity affects the structure of defense procurement decisions. Scott Masten made the same point about government aerospace purchases.[12] Yet if ever there were idiosyncratic procedures, the defense and aerospace industries would be the place to find them. In more quotidian industries, observers seem to find evidence of physical-asset specificity harder to locate.[13]

Consistent with the difficulty in finding widespread evidence of the ties between physical-asset specificity and governance, the GM-Fisher Body story raises its own problems as well. If relation-specific dies were the problem, GM could have mitigated it contractually by owning the dies itself -- a tactic modern car companies routinely use.[14] So long as it owned and could repossess the dies, it faced little more risk through contract than it did through vertical integration.

More basically, by 1919 GM already held a majority interest in Fisher Body anyway.[15] Absent any unusual arrangement, as a controlling shareholder GM could have appointed the

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4 J. Law, Econ. & Org. 337 (1988); Jan B. Heide & John George, The Role of Dependence Balancing in Safeguarding Transaction-Specific Assets in Conventional Channels, 52 J. Marketing 20 (1988); Gary L. Lilien, Advisor 2: Modeling the Marketing Mix Decision for Industrial Products, 25 Management Science 191 (1979).

[11] Henry Ogden Armour & David J. Teece, Vertical Integration and Technological Innovation, 62 Rev. Econ. & Stat. 470 (1980); Marvin B. Lieberman, Determinants of Vertical Integration: An Empirical Test, 39 J. Indus. Econ. 451 (1991); Scott E. Masten, James W. Meehan, Jr., & Edward A. Snyder, Vertical Integration in the U.S. Auto Industry: A Note on the Influence of Transaction Specific Assets, 12 J. Econ. Behav. & Org. 265 (1989); Kirk Monteverde & David J. Teece, Supplier Switching Costs and Vertical Integration in the Automobile Industry, 13 Bell J. Econ. 206 (1982a); Gary P. Pisano, Using Equity Participation to Support Exchange: Evidence from the Biotechnology Industry, 5 J. Law, Econ. & Org. 109 (1989).

[12] Keith J. Crocker, & Kenneth J. Reynolds, The Efficiency of Incomplete Contracts: An Analysis of Air Force Engime Procurement, 24 Rand J. Econ. 126 (1993); Scott E. Masten, The Organization of Production: Evidence from the Aerospace Industry, 27 J. Law & Econ. 403 (1984).

[13] However, Kirk Monteverde & David J. Teece, Appropriable Rents and Quasi-Vertical Integration, 25 J. Law & Econ. 321 (1982b) find that it does lead the buyer to retain title to the dedicated physical asset used in the production process. Other studies claiming to locate evidence of physical-asset specificity include David T. Levy, The Transactions Cost Approach to Vertical Integration: An Empirical Examination, 67 Rev. Econ. & Statistics 438 (1985) (claiming that advertising intensity proxies for RSIs); Ian C. MacMillan, Donald C. Hambrick & Johannes M. Pennings, Uncertainty Reduction and the Threat of Supplier Retaliation: Two Views of the Backward Integration Decision, 7 Org. Stud. 263 (1986) (using multi-industry "Profit Impact of Market Strategies" database); Thomas M. Palay, Comparative Institutional Economics: The Governance of Rail Freight Contracting, 13 J. Legal Stud. 265 (1984) (idiosyncratic freight cars).

[14] On the GM-owning-the-die tactic, see, e.g., Masten, Meehan & Snyder (1991), supra note; Monteverde & Teece (1982b), supra note; Williamson (1985), supra note, at 95. Klein himself acknowledges this point in Benjamin Klein, Vertical Integration as Organizational Ownership: The Fisher Body-General Motors Relationship Revisited, 4 J. Law, Econ. & Org. 199, 205 (1988). For modern practice, see Walker & Weber (1984), supra note, at 395.

[15] Coase, supra note, at 71; Klein, Crawford & Alchian, supra note, at 308 n.25.

entire board, and through the board could have mandated all policy.[16] Whether the coaches were steel or wood and whether GM owned the dies or Fisher, neither GM nor Fisher Body would have faced the risk of any opportunism justifying an otherwise not cost-justified merger between of the two firms.

Indeed, GM seems to have done perfectly well with independent suppliers for other specialized products. A.O. Smith, for example, was already making automobile frames for GM and others in the early 1930s. Half-a-century later, it was still the largest automobile frame manufacturer, was still independent, and still had GM as a principal customer. "Major model changes involve substantial expenses by A.O. Smith for new tooling, the arrangement of production lines and learning time for production employees," reports Ronald Coase -- but contractual and reputational constraints keep opportunism to manageable levels.[17]

C. Japan:

Despite the apparent shortage of evidence showing widespread extra-contractual governance mechanisms driven by large physicial-asset specificities, RSIs have played an increasingly prominent part in academic discussions of Japan. The story begins with the late Banri Asanuma. Asanuma devoted much of the 1980s to studying the industry, and throughout the decade reported his results in both Japanese and English. He also maintained a long-standing interest in Williamson's work, translating Markets and Hierarchies into Japanese.[18]

According to Asanuma, the relation between Japanese automobile assemblers and suppliers is long-standing, and long-standing for reasons that closely reflect the Williamson-Klein-Crawford-Alchian logic. First, the parties trade in "customized parts." Second, the parties can produce these customized parts efficiently only by investing in "relation-specific skills." Third, through those skills they produce a "relational quasi rent" and -- to return to the original point -- that rent creates an incentive to maintain the relationship long-term. How the parties prevent the rent-seeking and rent-avoidance activities that troubled Williamson and Klein-Crawford-Alchian, Asanuma seems not to have addressed.[19]

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[16] In conversation, Scott Masten suggests that the Fisher brothers controlled this stock through a voting trust. Although that would indeed removed GM's voting control, in most states the disability would have been temporary. State statutes generally limit the terms of voting trusts to 10 years or less. See Robert Charles Clark, Corporate Law 777 (Boston: Little, Brown, 1986); Harry G. Henn & John R. Alexander, Laws of Corporations and Other Business Enterprises 531-32 (St. Paul: West, 1983).

[17] Coase, supra note, at 71-72. Perhaps reflecting some of these issues, ten years after the original article, Klein switched much of his explanation for the 1926 merger to human-capital investments. See Klein, supra note, at 208.

[18] Banri Asanuma, Nihon ni okeru meekaa to sapuraiyaa to no kankei [The Manufacturer-Supplier Relationship in Japan], in Sapuraiyaa shisutemu [Supplier System] 1, 37 n.* (Takahiro Fujimoto, Toshihiro Nishiguchi & Hideshi Ito, eds., Tokyo: Yuhikaku, 1998). The translation appeared as Shijo to kigyo soshiki [Markets and Firm Organization] (Tokyo: Nippon hyoron sha, 1980).

[19] Banri Asanuma, Manufacturer-Supplier Relationships in Japan and the Concept of Relation-Specific Skill, 3 J. Japanese & Int'l Eco. 1 (1989).

Relying in part on Asanuma's field work, Masahiko Aoki similarly argues that Japanese manufacturers and subcontractors rely on RSIs.[20] Subcontractors invest heavily, explains Aoki, in skills that are specific to their relationship with a given manufacturer. To make money on such investments, a subcontractor must be able to expect long-term returns. By the Williamsonian-Klein-Crawford-Alchian logic, the insecurity inherent in the appropriability of the quasi-rents should drive the subcontractor to merge with the manufacturer. In Japan, they do not. This presents a puzzle to Aoki, who solves it by arguing that Williamson and Klein-Crawford-Alchian overstate the problem of opportunism: generally, a firm will keep its promises out of concern for its own reputation.

Jeffrey H. Dyer finds the extensive use of RSIs crucial to the very success of the automobile industry in Japan -- a practice that leads to "lower costs, higher quality, and greater profits":

> [A] key to the success of Japanese network relationships is the practice of dedicating supplier assets to the customer. That is, Japanese auto-parts suppliers send engineers to work at the customer's site, locate plants near the customer, or invest in customized physical assets.

All told, concludes Dyer, "dedicated assets provide Japanese manufacturers with substantial competitiive advantages."[21]

Concurrently, this analysis crossed into legal scholarship. In an intriguing recent study of Japanese cross-shareholdings, leading corporate law scholars Ronald Gilson and Mark Roe tie the shareholdings to RSIs.[22] Where Aoki primarily stressed the relationship-specific human capital investments, Gilson-Roe suggest that Japanese production (including the automobile industry) involves high degrees of all three Williamsonian RSIs: human-capital specificity, site specificity, and even physical-asset specificity.

Like other scholars in this tradition, Gilson-Roe note that RSIs generate appropriable quasi-rents. Where Aoki argued that reputational effects largely prevent opportunism, however, Gilson-Roe turn to the cross-shareholdings. Because (they argue) Japanese business groups (i.e., the keiretsu) often own controlling interests in manufacturing firms, groups can collectively control their members. Should any one member behave opportunistically, a group can collectively intervene. The RSIs in the industry are large, in short, and generate distinctive extra-contractual governance arrangements.

II. The Industry

A. Introduction:

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[20] Masahiko Aoki, Information, Incentives, and Bargaining in the Japanese Economy 216-17 (New York: Cambridge University Press, 1988); see also Masahiko Aoki, Toward an Economic Model of the Japanese Firm, 28 J. Econ. Lit. 1 (1990).

[21] Dedicated Assets: Japan's Manufacturing Edge, Harv. Bus. Rev. (Nov.-Dec. 1994), at 174, 174.

[22] Understanding the Japanese Keiretsu: Overlaps Between Corporate Governance and Industrial Organization, 102 Yale L.J. 871, 884 (1993); a similar argument is made in David Flath, The Keiretsu Puzzle, 10 J. Japanese & Int'l Eco. 101 (1996). An assertion similar to that made by Gilson & Roe is also made in J. Mark Ramseyer Cross-shareholding in the Japanese Keiretsu, in Convergence in Corporate Law: The Emerging Questions (Jeffrey Gordon & Mark Roe, eds., Chicago: University of Chicago Press, forthcoming 2000). Not to put too fine a point on it, the claim here is that the argument about the automobile industry in Ramseyer, supra, is wrong.

Such is the theory. The question is how much of the governance patterns in the Japanese automobile industry it explains. We confess to being skeptical. What we know of the industry suggests that RSIs are modest, and what we know of Japanese contracting practice suggsts that the parties could solve most of their problems by contract.[23] RSI theory, however, posits that parties will negotiate extra-contractual governance mechanisms primarily when they find large RSIs juxtaposed with significant barriers to contract.

To begin to examine these issues, in the study that follows we pose two necessarily inter-related empirical questions: (a) whether assemblers and suppliers do make large RSIs, and (b) whether any RSIs they make lead to extra-contractual governance arrangements. We are the first to admit that we lack direct measures of RSIs. We do, however, have a variety of indirect measures (however imperfect). In the article below, we combine them with an investigation of when and how the parties negotiate what sort of extra-contractual governance mechanisms.

B. Subcontracting at Honda:[24]

1. Introduction. -- To give a feel for the industry, we begin this analysis of Japanese subcontracting by describing five firms in the Honda network. We realize that the statistically inclined will be impatient with the discursive account. Because much of the misunderstanding about the industry results from the way most scholars understandably lack an intuitive sense of the "shop floor," however, we begin with some anecdotes.

The points we make are not distinctive to Honda. Instead, they apply to contracting relationships in other manufacturing networks as well.[25] Because of the assurances of confidentiality the original researchers gave their interviewees, we do not identify the firms involved.

Founded a half century ago, Honda conquered the motorcycle world in the 1960s.[26] It remains near the apex of that industry, and now stands as Japan's third largest automobile producer besides. Where Toyota sold 3.2 million cars in 1998 and Nissan 1.6 million, Honda sold 1.2 million. Where Toyota had 1998 sales of 7.8 trillion yen and Nissan 3.5 trillion, Honda

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[23] Whether enforced through the courts or through reputational mechanisms. On reputational sanctions in the industry, see Yoshiro Miwa, Firms and Industrial Organization in Japan 75-76 (Houndmills: Macmillan, 1996).

[24] In general, in this Section II.B. we rely on Nihon rodo kenkyu kiko, Sangyo bungyo kozo to rodo shijo no kaiso sei [The Structure of the Division of Labor in Production, and the the Class Structure of the Labor Market] (Tokyo: Nihon rodo kenkyu kiko, 1992) and conversations with the original investigators. We update the data through Fuyumi Miyoshi, Jidosha gyokai hayawakari mappu [Easy-to-Read Map of the Automobile Industry] (Tokyo: Ko shobo, 1999); Nihon keizai shimbun sha, Nikkei kaisha joho [Nikkei Company Information] (Tokyo: Nihon keizai shimbun sha, relevant years); Shukan Toyo keizai, Kigyo keiretsu soran [Overview of Firm Keiretsu] (Tokyo: Toyo keizai shimpo sha, relevant years) where appropriate. For information on the supplier system generally, see Miwa, supra note, at Sec. 4.2. On the lack of important government aid to the industry, see John Creighton Campbell, The Automobile Industry and Public Policy, in Robert E. Cole & Taizo Yakushiji, The American and Japanese Auto Industries in Transition 79 (Ann Arbor: Center for Japanese Studies, The University of Michigan, 1984).

[25] As the discussions of the Nissan network in Rodo, supra note, reflect, and as Miwa's own interviews confirmed. Contrary to many claims, the contracting practices by the firms in the industry (including Toyota) are standard, and used routinely by firms in a variety of other industries too. See Miwa, supra note, at 64-68. To test the common Toyota-is-different hypothesis, we add a Toyota dummy in the regressions below.

[26] See generally Miwa, supra note, at 64.

had sales of 3.1 trillion. Where Toyota had a workforce of 70,000 and Nissan 40,000, Honda had a workforce of 29,000.

Honda buys components from perhaps 280 firms. It maintains long-term ties with about 80 of these, and has equity stakes in a third of the 80. It pays its suppliers amounts equal to about 80 percent of its sales. In many cases, these subcontractors are substantial firms in their own right: Keihin (carburators, fuel injection systems; sales of 144 billion yen, and 4,000 employees), for example, or Nippon seiki (guages; 87 billion sales, and 1,700 employees), and Yutaka giken (exhaust systems; 72 billion sales, and 1,100 employees).

Honda buys shock absorbers from 3 firms, but relies most heavily on A^1. With sales of 103 billion yen and 2,800 employees, A^1 is one of Honda's largest subcontractors. In turn, A^1 buys from over 200 suppliers. Many of A^1's suppliers (the steel producers, for instance, or rubber) are large and do not rely heavily on A^1 sales. Others (like the stamping and machining firms that make peripheral products) are much smaller.

Generally, A^1 buys peripherals from 8 stamping and 13 machining companies. Of the former, 3 firms sell less than 20 percent of their output to A^1, 2 sell 40-60 percent, and 3 sell over 60 percent. Of 11 machining firms (we lack data on 2), 3 sell under 10 percent of their output to A^1, 2 sell 10-30 percent, 3 sell 50-60 percent, and 3 sell over 70 percent.

Among these second-tier subcontractors, B^1 runs stamping operations and B^2 machining operations. In turn, B^1 buys from 62 suppliers, and B^2 from 15. Among these third-tier subcontractors, C^1 does spot-welding jobs and C^2 stamping work, both for B^1. Begin with these third-tier firms, and turn then to the second- and finally the first-.

2. Third-tier subcontractors. --

C^1. Established in 1968 as a welding operation, C^1 initially consisted of the president, his wife, and 2 part-time employees. Together, they produced television parts. They started selling to B^1 in 1985, and by 1989 had annual sales of 78 million yen, 11 workers, and 17 welding machines. The firm now sells half its output to B^1. The rest of its output involves electrical equipment, water heaters, and automobile accessories like audio and lighter parts.

On the 27^{th} or 28^{th} of each month, B^1 gives C^1 the next month's order plan. Twice a day, it sends a truck with the materials for C^1 to weld and picks up any finished work.

For all practical purposes, only the president at C^1 has any engineering expertise. Of the 11 workers, 3 are family members and 8 are non-family employees with less than 10 years' experience. When faced with a new product from B^1, the president personally determines the technical specifications of the manufacturing process: what voltage to set for the weld, for instance, how much time to use, and what pressure to apply. After he does, the employees follow his instructions.

C^2. Firm C^2 began in 1973 with 5 workers. For several years, it did stamping work for air conditioners and vending machines. As demand fell the president asked B^1 for work. When B^1 agreed, C^2 bought the new equipment necessary. Within a year, it had 15 employees and sent 70 percent of its work to B^1.

Of the 15 people at C^2, 3 are family members, 5 are full-time employees, and 7 are part-time. The work is sufficiently simple that virtually any employee can do it with little experience. B^1 pays C^2 on a piece-rate basis, and charges it for the supplies and stamping dies it needs.

C^2 sends some of its work (10-20 percent of its sales) to 4 other firms. These fourth-tier subcontractors too are mostly family operations. Typically, they have 1 or 2 non-family employees.

3. Second-tier subcontractors. --

B^1. The creation of an ex-Nakajima Aircraft employee, B^1 began in 1947. Initially, it produced agricultural machines, but in 1954 took up stamping work. It adopted its current corporate status in 1962, and began selling door-handle parts two years later.

In 1971, B^1 began doing stamp work for A^1. By 1984, it had 85 employees (including 7 part-time) and sales of 2.13 billion yen. It pays its suppliers amounts equal to 40 percent of its sales. It sells two-fifths of its output to A^1 and two-fifths to another firm that incorporates the work into brake assemblies bound for Honda. The remaining fifth it sells elsewhere. It owns its own stamp presses.

When A^1 and B^1 negotiate a new job, they set the expected quantity and price, and calculate a depreciation charge for the stamp dies. On the 20th of each month, A^1 announces its projected demand for the next 90 days. Within each month, when necessary it can change orders on 5 days' notice.

B^2. As of 1987, second-tier subcontractor B^2 had 55 employees and 667 million yen in sales. Established in 1964, it had started as a machining firm for a textile machine producer. Because the president knew the president of first-tier subcontractor X, it shifted to automobile parts the next year.

In 1970, with 15-16 employees, B^2 began trading with A^1. At the time, X had no objection to its doing so. When B^2's orders from A^1 began to rival its sales to X, X still did not object. By 1987, B^2 sold half its output to A^1.

B^2 specializes in precision machining. Of its 55 employees, 37 are "regular" employees (27 male and 10 female; 27 full-time and 10 part-time). Of the 27 full-time regular employees, 20 have less than 10 years' experience.

The part-time employees are primarily housewives from nearby farms. They do the same labor-intensive manufacturing work as their full-time counterparts. Although the company would prefer that they worked full-time, they remain part-time to preserve the option of staying home during the peak agricultural work season.

In 1987, B^2 hired a retired A^1 director as a technical advisor. He advised the firm twice a week on equipment investment, negotiations with A^1, and assorted other managerial issues. B^2 holds title to its own equipment. It buys from its own subcontractors products worth a quarter of its total sales.

4. First-tier subcontractor A^1. -- Founded in 1938, A^1 began by manufacturing aircraft parts. In 1953, it switched to motorcycle shock absorbers for the young Honda firm. When Honda moved into automobiles, A^1 followed. In 1970, it experienced financial problems, and Honda responded by buying an equity stake (now 35.8 percent). It has since listed its stock on the Tokyo Stock Exchange. Its president and about half its directors are from Honda.

A^1 currently makes shock absorbers and a variety of other air- and oil-pressure-related goods. By product, of its 1998 sales 61 percent go to cars or trucks, 33 percent to motorcycles, and 8 percent to boats. By buyer, 72 percent of its sales go to Honda, 8 percent to Suzuki, and smaller amounts to such firms as Kawasaki, Yamaha, Fuji Heavy Industries (maker of Subarus),

Mazda, and Mitsubishi Auto. Purchases from its own suppliers count for about 63 percent of its sales.

A[1] regularly designs products with Honda and sends its people to Honda as guest engineers. In developing these new products, A[1] and Honda generally ignore the lower-tier subcontractors (who, as the discussion above suggests, lack much engineering expertise anyway).

Honda models are subject to a 4-year product cycle, with minor annual changes. Many of A[1]'s products are subject to the annual changes.

C. Industry-wide Data:[27]

1. Firm size. -- Turn now from this discursive account to aggregate statistics on the industry, and consider first some information on firm size (Section 1) and supplier associations (Section 2). Although (as the account above implies) many second- and third-tier suppliers are small, some first-tier suppliers are larger even than a few of the assemblers.[28] As noted earlier, Toyota has 70,000 employees and annual sales of 7.8 trillion yen. Mazda, however, has only 24,000 employees and 1.5 trillion yen in sales, Suzuki has 14,000 employees and 1.2 trillion yen sales, and Daihatsu has 11,000 employees and 783 billion yen sales.

By comparison, Denso (maker of air-conditioning and other automobile-industry electrical units) has 40,000 employees and sales of 1.3 trillion yen. Asahi Glass has 8,000 employees and 855 billion yen in sales, Aishin seiki (running gear) has 12,000 employees and 521 billion yen sales, and Kyocera (high-tech ceramics) has 13,000 employees and 492 billion yen in sales. Indeed, several first-tier suppliers are multi-national conglomerates that swamp the smaller automobile assemblers: Hitachi with 69,000 employees and annual sales of 4.1 trillion yen, Toshiba with 66,000 employees and 3.7 trillion yen in sales, or Matsushita Electric with 46,000 employees and 4.9 trillion yen in sales.

Nor should one think suppliers simply make ashtrays and brakes for Toyota and Honda to bolt onto their cars. Sometimes the "assembler" out-sources even the assembly itself. A "Toyota" car, for example, might well have been assembled by Toyoda Automatic Loom, Toyota Auto Body, or Kanto Automobile Works. All told, Toyota consigns the entire assembly of nearly half its cars. At times in its history, Toyota even consigned the development of some of its cars to other firms.[29]

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[27] In this Section II.C. and elsewhere, we obtain general information on firm sales, employees, and the like from Nihon keizai, supra note; Toyo keizai, supra note; Nihon keizai shimbun sha, Kaisha soran [Annual Corporation Reports] (Tokyo: Nihon keizai shimbun sha, relevant volumes and years); Nihon jidosha buhin kogyo kai & Oto toreedo jaaneru, eds., Nihon no jidosha buhin kogyo (1998 nen ban) [Japanese Automotive Parts Industry, 1998] (Tokyo: Oto toreedo jaaneru, 1998) (hereinafter cited as JAPIA); Toyo keizai shimposha, Shikiho: Mijojo gaisha ban [Seasonal Reports: Unlisted Companies] (Tokyo: Toyo keizai shimposha, relevant years).

[28] These are not mutually exclusive categories. The same supplier may be a first-tier supplier with respect to one assembler, but a second- or third-tier supplier with respect to another. Teikei kikaki sells both to Aisan kogyo (a supplier) and to Yamaha (an assembler); Aisan sells directly to Toyota (an assembler), but also to Denso (a supplier).

[29] Haruhito Shiomi, The Formation of Assembler Networks in the Automobile Industry: The Case of Toyota Motor Company (1955-1980), in Haruhito Shiomi & Kazuo Wada, eds., Fordism Transformed: The Development of Production Methods in the Automobile Industry 28, 30-31 (Oxford: Oxford University Press, 1995); Kanto jidosha kogyo, Kanto jidosha kogyo 40 nen shi [40-Year History of Kanto jidosha kogyo] 118, 153 (Yokosuka: Kanto jidosha kogyo, 1986).

We have less data on the second-, third-, or fourth-tier suppliers. The Japan Automotive Parts Industry Association (JAPIA) does not maintain a list of these suppliers, and even if it did their small size would make information on them hard to collect. The annual government Census of Manufactures, however, does collect data on manufacturing establishments (each plant within a firm is a separate unit), and this census confirms the small size of most automobile supplier plants. In Table 1, we give plant size in the transportation equipment sector. Of the 7,533 establishments, 4,236 (56 percent) have 10-29 employees. Only 128 establishments (1.7 percent) have more than 1,000.[30]

[Insert Table 1 about here.]

2. Supplier associations. -- Most assemblers maintain associations of first-tier suppliers that meet from time to time, primarily to exchange information.[31] Toyota, for example, has 189 suppliers in its network, Nissan has 234, and Mitsubishi 377.

Observers frequently cite these associations as evidence of automobile industry "keiretsu," and assume that the groups are exclusive. In fact, they are anything but. Consider a simple correlation matrix of association membership. Yamaha, Suzuki, and Honda also make motorcycles, and thus draw on a different set of suppliers. Among the other assemblers, however, all correlation coefficients except one are above 0.20, and among Subaru, Daihatsu and Mazda all coefficients are above 0.50. Even the membership correlation coefficient for arch rivals Toyota and Nissan is 0.22. Put another way, of the 189 Toyota and 234 Nissan association members, 68 suppliers are in both associations.[32]

Or consider the following. 1,098 firms are in one or more of the Toyota, Nissan, Mitsubishi, Subaru, Mazda, Daihatsu, Hino, Isuzu, Yamaha, Suzuki, and Honda networks.[33] Among these firms, the mean association membership is 1.91. 738 firms are in only 1

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[30] Tsusho sangyo sho, ed., Heisei 9 nen, Kogyo tokei hyo: sangyo hen [Census of Manufactures: Report by Industry, 1997] (Tokyo: Tsusho sangyo sho, 1999). Not all data is available broken down at the 3-digit sectors. However, of the 13,518 establishments in the 2-digit transportation equipment sector, 9,964 are from the 3-digit automotive sector; of the 907,000 employees in the 2-digit sector, 770,476 are in the 3-digit automotive sector. The correlation coefficients between the 2-digit transportation and 3-digit automotive sectors are: (a) for distribution of employees, by establishment size -- 99.96 percent; and (b) for distribution of establishments, by establishment size -- 99.97 percent.

[31] On supplier associations, see generally Miwa, supra note, at 70-72.

In several cases, the assembler maintains more than one association. Toyota, for example, has three associations divided on the basis of geography. Honda does not maintain a formal association; here, we use its list of suppliers instead.

For our data base, we rely on the 1998 JAPIA list of 1649 firms, supra note. The list primarily includes JAPIA members, but includes some prominent non-member parts manufacturers, and excludes some members who do not make parts (e.g., scrap dealers) or wholesales who deal primarily in other goods. Id., at 251.

[32] Toyota has a 20 percent equity interest in Hino and a 34 percent interest in Daihatsu. As one might expect given this equity network, the correlation coefficients among the supplier associations for these three firms are higher -- ranging from 0.30 to 0.44

[33] The Honda network is not a formal organization like the others. However, we follow the categorization of JAPIA, supra note, which lists some firms as regular suppliers to Honda.

association; 135 are in 2 associations; 135 are in 3 to 5 associations; 62 are in 6 to 8 associations, and 28 are in 9 or more.

Nor are these associations peculiar to the assemblers. Many suppliers maintain their own associations of suppliers who in turn contract with it. For example, Denso (air conditioners; 40,000 employees and 1,375 billion yen in sales) has an association of 67 suppliers; Koito (lighting equipment; 4,600 employees and 148 billion yen in sales) has an associaton of 68 suppliers; Akebono Brake (2,900 employees and 108 billion yen in sales) has an association of 79 suppliers; and Kayaba (oil pressure equipment; 4,200 employees and 177 billion yen in sales) has an association of 270 suppliers.[34] More generally, of the 373 firms on which the JAPIA provides data, 188 (50 percent) maintained their own supplier associations. Among the firms with 500 or fewer employees, the figure was 39 percent (62 firms), among those with 501-1,000 employees, 53 percent (46); among those with 1,001-5,000 employees 67 percent (72); and among those with 5,001 or more employees, 40 percent (8).

III. Relation-Specific Investments

A. Smaller Firms:

The discussion of the Honda network suggests two preliminary points about the level of RSIs at the smaller suppliers. First, they invest very little in relationship-specific human capital. We know they invest little in relationship-specific human capital because they invest little in human capital at all. In many of these firms, only 1 or 2 people know any engineering. The other employees are so new that if they did have any expertise it would be general rather than specific to the firm or its partners.

Second, small as they are, the firms can and do sell to buyers in several distinct industries. Not only do they not sell to a single firm, they do not even sell to a single industry. Depending on their niche, they stamp, they machine, they assemble, they weld. If the price is right, they will stamp, machine, assemble, and weld Honda-bound products. But they can apparently do the same for aircraft, air conditioners, boats, textile equipment, television sets, and vending machines.

Loosely to be sure, industry-wide data confirm these impressions. First, employee tenure at the small firms is notoriously short. Consider data from the government's annual census of wages (Figure 1).[35] Among the smallest firms (those in the 2-digit transportation equipment sector with 10-99 employees), nearly 40 percent of the workers have been at the firm for less than 4 years. Another 20-odd percent have worked there 5-10 years. Even among the firms with 100-999 employees, half have less than 10 years' tenure.

Second, the small firms lack substantial physical-asset investments of any sort, much less relationship-specific physical assets (Table 1). At the smallest plants, per employee capital

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[34] Nihon denso, Nihon denso 25 nen shi [A 25-Year History of Nihon Denso] 243-44 (Kariya: Nihon denso, 1974); Koito seisakusho, Koito seisakusho 70 nen shi [A 70-Year History of Koito Seisakusho] 42 (Tokyo: Koito seisakusho, 1985); Akebono bureeki, Hanseiki no ayumi [A Half Century of Progress] 347 (Tokyo: Akebono bureeki, 1979); Kayaba kogyo, Kayaba kogyo 50 nen shi [A 50-Year History of Kayaba Kogyo] 284-86 (Tokyo: Kayaba kogyo, 1986).

[35] Rodosho, Chingin sensasu, Heisei 9 nen chingin kozo kihon tokei chosa [Basic Survey on Wage Structure 1997] (Tokyo: Rodo sho, 1998). In compiling this figure, we use data provided to us by the ministry that break down industry into smaller categories than that used for the final published survey.

investment is a mere 4 million yen -- at 120 yen/dollar, about $33,000. Even among plants with 200 or more employees, the figure approaches only 7.8 million yen, or about $65,000.

Finally, as explained in more detail immediately below, among automobile suppliers of all sizes, most technology is general rather than specific. Those investments that are specific, in turn, are specific not to a relationship but to a model. As such, they necessarily have at most 4 years' duration.

[Insert Figure 1 about here.]

B. Larger Firms:

1. The logic. -- Given this lack of substantial investments among second- and third-tier suppliers, if any suppliers in the Japanese automobile industry do have large RSIs, they must be among the larger first-tier suppliers. At least there, according to Table 1 and Figure 1, the levels of capital invstment are relatively high and employee tenure long. At least there, physical assets could be substantial and relationship-specific, employees could have significant relationship-specific expertise, and those investments could affect the governance arrangements the firms adopt. And at least there, the assemblers do sometimes make equity investments: as we show in Table 4, the probability that an assembler invests in a supplier does increase with supplier size.

Yet even here, basic logic should give one pause. First, these firms make products common to all cars everywhere. All cars have windshields, shock absorbers, headlights, seats, piston rings, and cigarette lighters. They may come in different sizes and different shapes, but if a supplier can make a given product for one assembler, it could probably make it for a comparably priced car at another.

Put another way, any asset-specificity in production seems model-specific rather than relationship-specific. Suppose a supplier needs to invest in idiosyncratic equipment or training to make Camry-bound tail lights. If those investments would not transfer to Accord-bound tail lights, they probably would not transfer to Corolla-bound ones either.[36]

Second, any model-specific investments are short-lived. At most assemblers, a model lasts only 4 years. As a result, even if a subcontractor does own a specialized asset, it usually will not generate quasi-rents long-term. Instead, it will generate them for 4 years at most. Yet the subcontractors already sign contracts with the assembler that last for the term of the model. If any firm earns model-specific quasi-rents on its investments, it can readily protect them by contract and by the prospect of market competition at the end of the model cycle.

Third, by simple geography and component size, even any site specificities should be minor. Japan is small, and so are most components. The entire country covers roughly the size of California, and Toyota city is a scant 200 miles from Tokyo. Other than car bodies and completed engines, moreover, most automobile parts are easy to ship. Given the elaborate networks of railroads and super highways, suppliers everywhere should be able cost-effectively to deliver components to assemblers anywhere.[37]

Fourth, if the biggest companies potentially have the largest RSIs, they are also the ones least likely to let that specificity affect fundamental aspects of governance like equity ownership.

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[36] As implied in Asanuma's own discussion. See Asanuma (1989), supra note, at 4.

[37] The high cost to consumers of shipping materials around Japan through the commercial transportation industry is irrelevant. Automobile assemblers are large enough that if such shippers (whether because of regulatory restrictions or because of cartelization) charge more than the average cost of transportation (a function only of tolls, fuel, driver wages, and truck maintenance and repair), the assembler can provide the transportation services in-house.

They are simply too big, and too diversified. Among the suppliers, take the 248 stock-exchange listed firms. These firms maintain memberships in a mean 3.2 supplier associations. Or take the firms for which we have data on sales to automobile assemblers (again, about 250). On average, these firms sell about half their output to their lead customers in the automobile industry. Even if such firms did make large RSIs, they would rarely want to structure their basic governance mechanisms to deal with firms buying only half their output.

2. Cross-shareholdings. -- a. Introduction. Turn from these broad impressions to firm-level data on the first-tier suppliers. To explore the role RSIs play in this environment, we first identify those contractual ties where logic predicts large RSIs -- if they exist anywhere -- would most likely exist. We then ask whether the parties to those ties negotiate the extra-contractual governance mechanisms (like equity investments) that RSI theory dictates.

Note the limits inherent in this exercise. Necessarily, we examine a composite hypothesis: (i) that RSIs are large enough to create significant problems of opportunism, (ii) that contractual solutions to such problems are infeasible, and (ii) that the RSIs and contracting problems lead to the predicted governance mechanisms. Suppose, despite having good proxies for RSIs, that we fail to observe the predicted governance mechanisms. In itself, that result would not tell us whether the hypothesis failed because RSIs were small, because contracts worked, or because RSI theory did not apply. Note too that we ask readers to table the the social scientific custom of focusing on regressions presented in the second-half of the paper as the key test in an article. To us, at least, the the most relevant material on RSIs is the least technical -- that which we obtain by observation and industry-wide data. We present the regressions below only as supplementary evidence.

In the automobile industry, we reason that large RSIs will most likely exist in transactions where suppliers have close, exclusive (or nearly exclusive) ties to a given assembler. Posit that to produce a given part for Assembler A requires heavy idiosyncratic equipment. A could itself pay for the equipment, or Supplier S could pay. Either way, in order to plan for the investment A and S will communicate with each other extensively. Provided the idiosyncratic investment generates returns to scale, they will also try to maximize S's sales to A. Supplier size held constant, S will then be more likely to sell a large fraction of its output to A.

If production involves large RSIs for which S pays, then by RSI theory S will need protection against A's ex post opportunism. Inter alia, it could try to obtain a controlling equity interest in A. This does not happen. Even the largest Japanese suppliers do not buy controlling interests in Toyota, Nissan, or even Suzuki.[38] Neither do they seem to negotiate other contractual controls.

Alternatively, assembler A could pay for the RSI. To prevent opportunistic action by S, it might then negotiate a controlling equity interest in (or other control mechanisms over) S. Our testable hypothesis follows: if large RSIs structure the Japanese automobile industry, assemblers will tend to negotiate control over those suppliers who have the closest ties with them.

[38] The exception may be Toyoda Automatic Loom, which assembles some Toyota atomobiles. This firm (founded by the father to the founder of Toyota Motor) antedates Toyota Motor. It initially specialized in producing automated weaving machines for Japan's booming pre-war cotton textile industry. With 5.1 percent of the stock, it is the largest shareholder of Toyota Motor; Toyota Motor owns 24.7 percent of Toyoda Automatic Loom. In January 1999, Toyoda Automatic Loom's interest in Toyota Motor was worth about 560 billion yen; Toyota Motor's interest in Automatic Loom was worth about 140 billion yen.

b. The test. To examine whether suppliers with the closest ties to an assembler are subject to extra-contractual governance mechanisms, we regress:

an assembler's equity investment in a supplier (both a dummy for investments of 10 percent or more [**SubEqInv**] and a continuous variable [**Eq%**]), *on*

(i) the fraction of its output which that supplier sells to the assembler (both a dummy for sales of 50 percent or more [**SubAssSales**] and a continuous variable [**Sales%**]), *and*

(ii) whether the suplier is a member only of that assembler's supplier association (**LoneClub**).

For controls, we include:

(x) a dummy for whether S lists its stock on an exchange (**Listed**),

(y) a dummy for whether S is a member of no supplier association (**NoClub**), *and*

(z) as a measure of firm size, the number of employees at S (**Employees**).[39]

Because many observers claim that Toyota maintains unusually close ties with its suppliers, we add a dummy for whether the assembler involved is Toyota (**Toyota**).[40] We include more precise definitions of the variables in Table 2, summary statistics and sources in Table 3, and regression results in Table 4.

[Insert Table 2 about here.]

[Insert Table 3 about here.]

[Insert Table 4 about here.]

c. The results. Perhaps the biggest surprise in Table 4 involves the radically different effects that **SubAssSales** (and **Sales%**) and **LoneClub** have**.** On the one hand, the coefficients to **SubAssSales** (and **Sales%**) suggest that the parties do adopt extra-contractual governance mechanisms: the coefficients are consistently positive and significant in regressions (a), (c), (d) and (f). On the other, the coefficients on **LoneClub** suggest nothing of the sort: the coefficients are insignificant in all specifications, and do not even consistently have the same sign.

The difference between **SubAssSales** and **LoneClub** surprises, because one might have thought that the variables identified roughly the same suppliers. One would have thought, for example, that if S were affiliated only with A's supplier association (**LoneClub**) it would disproportionately sell to A (**SubAssSales**). If so, then the two variables would be heavily correlated and generate similar results in Table 4. In fact, the correlation coefficient between the two is only 0.13.[41]

For our purposes, the resulting question becomes: if there were significant RSIs in the industry, would **SubAssSales** or **LoneClub** more likely proxy for their presence? If the answer is **SubAssSales**, then Table 4 suggests that the transactions involve substantial RSIs. If the answer is **LoneClub**, then the very absence of equity investments suggests either that large RSIs do not exist or that they do not structure governance patterns.

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[39] We also used total sales by the firm, but did not generate qualitatively substantially different results.

[40] According to Table 4, Toyota is distinctive only in the way it is located in the same prefecture (Aichi) as many of its suppliers.

[41] Adding a variable interacting LoneClub and SubAssSales results in a positive and significant coefficient on SubAssSales, but insignificant results for both LoneClub and the interaction term.

Preliminarily, reasons linked to technological innovation suggest that **LoneClub** more plausibly proxies for RSIs than **SubAssSales**. We discuss that hypothesis in Subsection 3 below. We turn to the possibility that **SubAssSales** better proxies for RSIs in Subsection 4.

3. RSIs and technological innovation. -- a. Introduction. Firms that invest heavily in RSIs will prefer to deal with suppliers who avoid selling customized components to their competitors. All else equal, off-the-shelf technology is cheaper than new. As a result, firms will not invest in idiosyncratic technology unless doing so generates a competitive advantage. If it does generate that advantage, they (the investing firms) will want to do what they can to keep that technology from their rivals.

Once an investing firm's supplier sells similarly sophisticated products to the investing firm's competitors, however, the odds that the technology will leak increase dramatically. After all, given the new improved technology, the supplier has an incentive to adapt the technology in a way that will let it win business from those competitors. Only by limiting its ties to suppliers who restrict their other customized sales to buyers outside the industry can the investing firm slow the technological leak. The conclusion: large RSIs will most likely exist (if they exist anywhere) in situations where the supplier sells customized components only to one automobile assembler.

b. An example. Perhaps an illustration would help. Suppose a subcontractor, with the aid of Toyota engineers, develops a new, more cost-effective Camry shock absorber. Given that Nissan and Honda do not use such a shock absorber (the technology is still secret, after all), the production process is by defintion specific to Toyota trades. Like virtually all automobile parts, though, shock absorbers themselves are common to all assemblers. As a result, even if only Toyota cars used this improved technology, the supplier could potentially win sales with Honda and Nissan by adapting it to Accords and Maximas. Often, Toyota would want to keep this technology from its competitors.[42] To lower the risk of a technological leak, in turn, it may have an incentive to develop the new technology only with suppliers who do not make customized components for those competitors.

What this logic ignores, of course, are those RSIs that are simple adaptations to model size and shape rather than real technological improvements. For these RSIs, the assembler will not worry about technological leaks to competitors. No matter how mundane a shock absorbor it may be, a Maxima shock absorber will not fit an Accord. In that sense, the technology behind any Maxima shock absorber is specific to trades with Nissan, but is also technology that Nissan will not try to keep secret.

Crucially, however, for such size- and shape-specificities, the amount of the RSI is also quite small. Given the essential interchangeability of most shock-absorber technology, most suppliers who now make Maxima shock absorbers will be able to shift production to Accord shock absorbers with relative ease. They will incur some transitional costs, to be sure, but probably little more than they would incur in shifting among Toyota models -- from, for instance, a Camry shock absorber to a Corolla shock absorber.

[42] Not always, of course. Sometimes Toyota will be happy letting the supplier market it elsewhere, in exchange for a lower price on the new technology.

c. Technology and Table 4. (i) Introduction. Consider, then, the implications of this analysis for the importance of **SubAssSales** and **LoneClub**. Firm size held constant (as in Table 4), when **SubAssSales** and **LoneClub** firms differ, they will differ primarily in whether they:

(a) sell customized products to multiple automobile assemblers, *or*

(b) sell customized products only to one automobile assembler, and fill the rest of their output with either general open-market products within the automobile industry, or products for buyers outside the industry.

To see this, consider several possibilities:

(ii) SubAssSales = 1, LoneClub = 1 (30 firms). If most suppliers sold primarily to one assembler and no one else, then for most suppliers both **SubAssSales** and **LoneClub** would equal 1. In Table 4, the two variables would then have similar coefficients. They do not.

(iii) SubAssSales = 1, LoneClub = 0 (58 firms). Suppose a supplier sells more than half its output to one assembler, but is a member of multiple supplier associations (**SubAssSales** = 1, **LoneClub** = 0). That it has ties to other assemblers sufficiently close to justify association membership indicates that it probably sells significant amounts (even if less than half) of sophisticated, customized goods to others in the industry.

(iv) SubAssSales = 0, LoneClub = 1 (69 firms). By contrast, suppose a supplier sells a low fraction of its sales to its principal automobile assembler buyer, but is a member only of one supplier association (**SubAssSales** = 0, **LoneClub** = 1). That it has joined only one association suggests it produces few customized products for other assemblers in the industry. That it nonetheless sells a high fraction of its output to other firms suggests that it must either (i) be selling outside the industry, or (ii) be selling to other assemblers non-customized goods readily available on the open market.

(v) The result. Consequently, the factor driving the different coefficients on **SubAssSales** and **LoneClub** in Table 4 would seem to lie in the degree of intra- and extra-industry (or non-customized intra-industry) sales. If a supplier sells to firms other than its lead assembler buyer, does it sell customized goods to other buyers in the industry? Or does it instead sell only either generally available open-market goods or customized goods to those outside the automobile industry? If production involves large RSIs, then the assembler should prefer the latter group of suppliers over the former. If so, the key variable for our purposes would be **LoneClub** rather than **SubAssSales**. From the coefficients to **LoneClub** in Table 4, a simple bottom line then follows: RSIs do not explain equity cross-holdings in the automobile industry.

4. Sales diversification and RSIs. -- We hesitate to push this interpretation too hard. Readers of earlier versions complained (perhaps justifiably) that in doing so we were belitting inconvenient results. Might it not be, they asked, that the lack of sales diversification did signal the presence of RSIs, while the supplier associations were trivial social clubs? If the associations performed no significant function, might the lack of sales diversification not signal the presence of RSIs after all? And is not the stability of the relationships itself evidence of large RSIs?

a. Equity investments. Perhaps -- but in pursuing this line of attack one can easily miss several key bits of evidence. Most basically, one can exagerrate the pervasiveness of the extra-

contractual governance mechanisms in place. More specifically, one can exagerrate the pervasiveness of the cross-shareholdings in the industry. For in truth, the level of cross-shareholdings is low.

We have equity ownership data on 462 suppliers (162 listed firms and 300 unlisted). In 57 percent of the suppliers (262 firms) the lead automobile assembler buyer owns no equity. In an additional 15 percent (68 firms), it owns under 10 percent. In only a quarter of the suppliers does it have at least a 10 percent interest, and in only 5 percent does it own a majority interest.

One might plausibly ask whether equity investments are not more pervasive in the suppliers on whom we lack the data. After all, we have data disproportionately on the larger firms. And yet, stock exchange listing held constant, the assemblers are more likely to invest in the larger firms than the smaller (as we will show in Table 4, regressions (a)-(c)). If we have data disproportionately on the larger firms, then we have little reason to think equity investments are more common among suppliers as a whole.[43]

b. Sales diversification. One can also exagerrate the extent to which suppliers fail to diversify their sales. We have sales data on 249 suppliers (firms with 67 to 11,574 employees; mean employees of 1,260). In only 127 of these firms (51 percent) did the lead assembler buyer buy 50 percent or more of the supplier's output. In only 74 (30 percent) did it buy 70 percent or more.

Given that we disproportionately have information on the larger, listed firms, here too we should worry about sample bias. Curiously, stock listing held constant, the bigger firms are less likely to diversify sales; more predictably, firm size held constant, the listed firms are more likely to diversify sales:

Sales% = 55.00 + 0.0011Employees - 24.35Listed + e,
(23.92) (2.48) (6.49)

where n = 249, the absolute value of the t-statistics are in parentheses, and the adjusted R2 is 0.14.

Because we have data disproportionately on the larger, listed firms, the effect among suppliers as a whole is hard to predict. Other surveys (Table 5) do indicate that the smaller, unlisted firms tend to diversify less than the larger firms. Bear in mind, however, both that these smaller firms produce a relatively minor fraction of the industry output, and that even they do still diversify significantly. According to Table 5, for instance, firms with less than 10 billion yen in sales constituted the smallest 40 percent of the firms but produced less than 7 percent of the industry total. Even these firms, however, still diversified: only a quarter sold all their output to one firm, and over half sold to 3 or more firms.

[Insert Table 5 about here.]

c. Relational stability. Nor does the stability of these relationships reflect large RSIs. First, so long as switching costs are not zero, people generally expect most relations to be stable. This holds in a wide variety of setttings and for a wide variety of reasons -- whether employment contracts, marriages, or a businessman's loyalty to his barber. In equilibrium, stability will be the norm.

[43] Note, however, that the effect is still ambiguous: disproportionately, we have information on the listed firms, and Regressions (b) and (d) suggest that size held constant, the Assemblers are more likely to invest in unlisted firms.

Second, Japanese subcontracting relations are ruthlessly competitive. To the extent that they are stable, they are stable only because -- in equilibrium -- the existing trading partners will be the firms that do the job better than their potential rivals. As one Toyota director explained:[44]

> Our policy of maintaining double- and multiple-sources is not an opportunistic one. It follows from the notion that a reasonable level of competition is good. We're all human, after all. It's through competition that we'll get improvements in quality, in price, in managerial coordination.

Suppliers understand this. Only by winning the perpetual tournament will they maintain -- much less expand -- their business with any given assembler. Take one stamp press firm in the Toyota network. It sold a variety of stamped and plastic products to Toyota, and had for years. But it did not wait for Toyota to place orders. At its own cost, on its own initiative, and with no explicit or implicit commitment from Toyota, it regularly and aggressively explored new technologies. When it found something it thought Toyota might want, it proposed it. If Toyota liked the idea, it obtained a contract. If Toyota did not, it went back to the lab.[45]

Third, in the end, the relationships are not necessarily stable anyway. Although firms often do keep their existing trading partners, often is not always -- or even nearly always. Second- and third-tier firms are particularly prone to shift partners. These firms are frequently family firms. Like family firms everywhere, they come and go as the talents and interests of family members ebb and flow in generational cycles. Even first-tier contractors shift subcontracting ties. In 1998, the JAPIA listed 189 suppliers in the Toyota supplier network. Of these, only 122 (65 percent) had been members in 1973. Conversely, of the 150 firms in the association in 1973, 28 (19 percent) had disappeared by 1998.

5. Board seats. -- Equity investments are not the only extra-contractual governance mechanisms that assemblers can use. They can also take positions on their suppliers' boards. Primarily, however, whether an assembler obtains such a seat depends simply on its equity investment.

Again, one can exagerrate the prevalence of assembler representatives: only exceptionally do assemblers put their representatives on supplier boards. Among Japanese automobile parts suppliers, we have information on the board composition of 209 firms. In 132 of these firms (63 percent) the assemblers had no board representative. When an assembler did have a board member, the modal number was 1 (26 firms, or 12 percent). At only 27 of the suppliers (13 percent) did principal buyer among the automobile assemblers have 5 to 9 board members, and at only 5 (2 percent) did it have 10 or more.

Whether an assembler has a representative on a supplier's board depends critically on the equity stake that the assembler holds in the supplier. If we compare the predictive effect on the number of assembler representatives (**NumDir**) of (i) the fraction of S's sales made to A (**Sales%**) and (ii) A's equity investment in S (**Eq%**), the latter predicts far better:

NumDir=-2.85+0.090Eq%+0.019Sales%+0.0003Employees+2.89Listed+e,
(4.96) (5.79) (1.93) (2.99) (5.79)

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[44] Shoichi Matsuo, Buhin seisaku wa ikkan shita "koyzon kyoei" [Consistency Turns Parts Policy into One of "Co-existence and Co-prosperity], in JAPIA, supra note (1973 ed.), at 138-39.

[45] Interview by Yoshiro Miwa, fall 1999.

where n=120, the absolute value of the t-statistics are in parenthesis, and the adjusted R2 = 0.55.[46] Moreover, a regression of **NumDir** on **Eq%** yields a coefficient of 0.10, a t-statistic of 12.25 and an adjusted R2 of 0.42; a regression on **Sales%** yields a coefficient of 0.05, a t-statistic of 6.01 and an adjusted R2 of 0.23. For predicting the presence of assembler representatives on a supplier board, the investment an assembler makes in a supplier's stock matters greatly. The fraction of its output the supplier sells to the assembler matters far less. Obviously, one does not need RSI theory to explain why director seats should correlate with stock holdings.

IV. Conclusions

Within industrial organization, scholars increasingly integrate RSI theory into their analysisof the way firms structure their affairs with each other. Suppose both that production requires large idiosyncratic investments, and that detailed contracts are infeasible. In such a world, production would generate quasi-rents, and the quasi-rents would in turn create the risk of ex post opportunism. To mitigate that risk, scholars reason, firms may negotiate governance mechanisms they would otherwise avoid.

To be sure, the theory sparked a promising research program that generated a wide variety of empirical work. Yet scholars in the field have found less evidence of large-scale RSIs than one might suppose -- particularly of physical-asset specificity, and particularly in industries outside of aerospace, defense, or public utilities. Within this empirical context, the Japanese automobile industry has promised hope. There, at least, observers thought they would find the combination of large RSIs and extra-contractual governance mechanisms (particularly equity cross-holdings) that RSI theory had suggested.

In fact, in the Japanese automobile industry RSIs are low, and so are equity cross-holdings. To make this point, we offer a mix of indirect evidence. We are the first to admit that we lack firm-level direct measures of RSIs. Instead, we bring to the enterprise a wide-ranging mix of observational evidence and industry data. To that mix, we add a set of supplementary regressions.

From this evidence, two points stand out. First, among the smaller firms (which is to say, most firms), the levels of RSIs are low for a simple reason: all investment levels are low. This simply is not a capital intensive sector. Second, among the larger firms (which is to say, the most productive firms), investment levels are higher -- but these investments seem not to be idiosyncratic and cross-holdings are low. These larger suppliers broadly diversify their sales outlets, and seldom issue significant equity blocks to assemblers.

Through this, we do not purport to disprove RSI theory. After all, the theory predicts that firms will create distinctive governance mechanisms when RSIs are large and contractual solutions infeasible. If production technology is standard and contracting straightforward, they will solve any problems by contract. And in the end, that is pretty much what we show in Japan. Our claim is instead more modest: that perhaps RSI theory explains a narrower band of phenomena than we have thought.

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[46] Running the same regression with the Toyota dummy as well does not substantially change the results; the t-statistic on Toyota is 0.018.

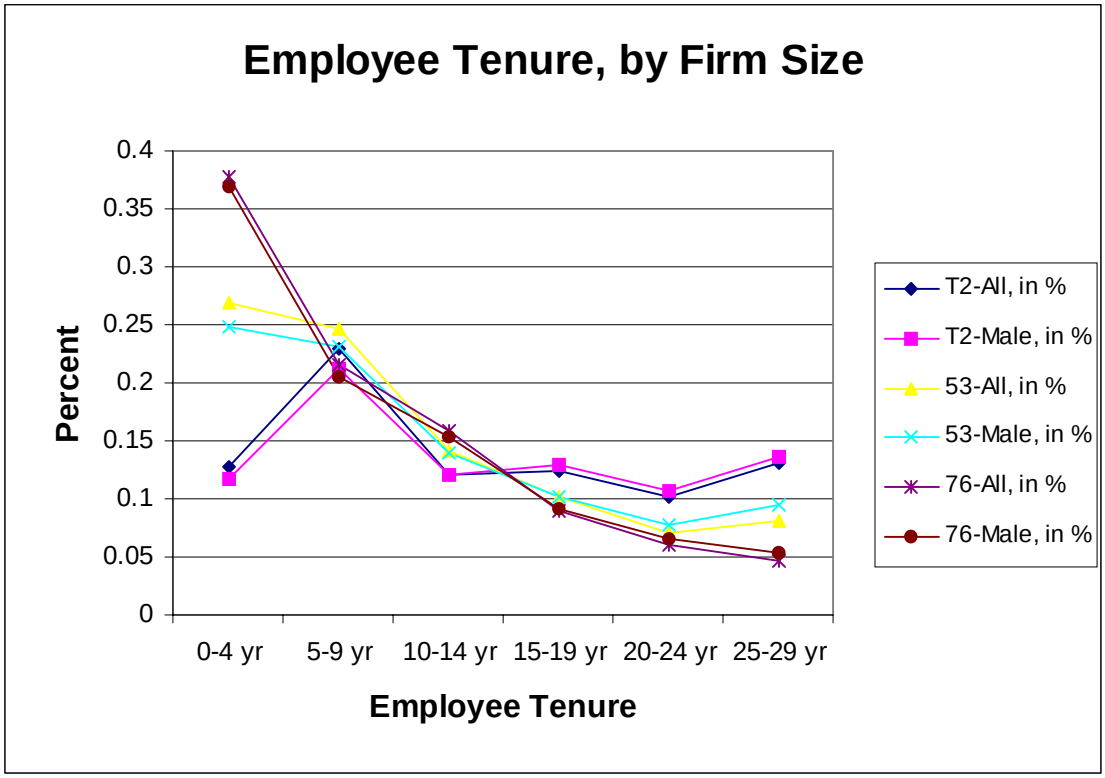
Table 1: Establishment Size and Investment Levels in the Transportation Equipment Sector (1997)

A Estab. size (emp's)	B Capital	C Employees	D Establishments	B/C	B/D
10-29	302,800	76,410	4,236	3.96	71.5
30-49	192,900	39,093	1,000	4.93	192.9
50-99	421,900	72,251	1,032	5.84	408.8
100-199	547,900	80,549	589	6.80	930.2
200-299	373,700	48,422	198	7.72	1,887.4
300-499	637,400	72,940	186	8.74	3,426.9
500-999	1,160,700	116,503	164	9.96	7,077.4
1000-	3,766,900	363,618	128	10.36	29,428.9

Notes: Capital is in million yen, excluding land.
Establishments are those in the 2-digit transportation equipment sector.

Source: Tsusho sangyo sho, ed., Heisei 9 nen, Kogyo tokei hyo: sangyo hen [Census of Manufactures: Report by Industry, 1997] (Tokyo: Tsusho sangyo sho, 1999).

Figure 1:
Employee tenure in the Transportation Equipment Sector (1997)



Note: T2 -- firms with 1000 or more employees; 53 -- firms with 100-999 employees; 76 -- firms with 10-99 employees.

Source: Rodosho, Chingin sensasu, Heisei 9 nen chingin kozo kihon tokei chosa [Basic Survey on Wage Structure 1997] (Tokyo: Rodo sho, 1998). In compiling this figure, we use data provided to us by the ministry that disaggregate the industry into categories smaller than those used for the final published survey.

Table 2: Regression Variables -- Definitions

Dir: 1 if the assembler that buys the largest fraction of a supplier's output has a seat (including a seat held by a former assembler employee) on the supplier's board of directors; 0 otherwise.

Employees: the number of full-time employees at a supplier.

Eq%: The percentage of a supplier's stock held by the assembler that buys the largest fraction of the supplier's output.

Listed: 1 if a supplier lists its stock on either the Tokyo or Osaka Stock Exchange; 0 otherwise.

LoneClub: 1 if a supplier is listed in JAPIA data as a member of one supplier association; 0 otherwise.

NoClub: 1 if a supplier is listed in JAPIA data as a member of no supplier association; 0 otherwise.

NumDir: The number of directors that the assembler which buys the largest fraction of a supplier's output has on the supplier's board (including seats held by former assembler employees).

Sales%: The percentage of a supplier's output bought by the assembler that buys the largest fraction of the supplier's output.

SamePref: 1 if the supplier's headquarters are in the same prefecture as that of the principal place of business of the assembler which buys the largest fraction of the supplier's output; 0 otherwise.

SubAssSales: 1 if a supplier sells 50 percent or more of its output to an assembler; 0 otherwise.

SubEqInv: 1 if the assembler that buys the largest fraction of a supplier's output owns 10 percent or more of the supplier's stock; 0 otherwise.

Toyota: 1 if the assembler that buys the largest fraction of the supplier's output is Toyota; 0 otherwise.

Table 3: Regression Variables -- Summary Statistics

	n	Min	Mean	Max .
Dir	209	0	0.368	1
Employees	700	7	1,848	68,947
Eq%	462	0	11.750	100
Listed	1,648	0	0.150	1
LoneClub	1,648	0	0.447	1
NoClub	1,648	0	0.346	1
NumDir	209	0	1.536	14
Sales%	249	0.6	48.7	99.8
SamePref	477	0	0.344	1
SubAssSales	249	0	0.510	1
SubEqInv	462	0	0.286	1
Toyota	479	0	0.251	1

Sources: The data -- when possible from 1998 -- is variously assembled from the relevant years of Nihon keizai shimbun sha, Nikkei kaisha joho [Nikkei Company Information] (Tokyo: Nihon keizai shimbun sha); Shukan toyo keizai, Kigyo keiretsu soran [Overview of Firm Keiretsu] (Tokyo: Toyo keizai shimpo sha); Toyo keizai shimposha, Shikiho: Mijojo gaisha ban [Seasonal Reports: Unlisted Companies] (Tokyo: Toyo keizai shimposha, relevant years); Nihon keizai shimbun sha, Kaisha soran [Annual Corporation Reports] (Tokyo: Nihon keizai shimbun sha); Nihon jidosha buhin kogyo kai & Oto toreedo jaaneru, eds., Nihon no jidosha buhin kogyo (1998 nen ban) [Japanese Automotive Parts Industry, 1998] (Tokyo: Oto toreedo jaaneru).

Table 4: Probit Regressions --
Sales Diversification and Equity Investments

RHS:	SubEqInv			Eq%		
	(a)	(b)	(c)	(d)	(e)	(f)
SubAssSales	.421		.435			
	(6.02)		(6.02)			
Sales%				.361		.358
				(7.65)		(7.39)
LoneClub		.011	-.067		2.716	.736
		(0.22)	(0.85)		(1.24)	(0.26)
Employees	.0001	.00001	.0001	.002	.0005	.002
	(3.48)	(2.07)	(3.30)	(2.49)	(1.57)	(2.50)
Listed	.061	-.089	.054	.860	-5.678	.938
	(0.74)	(1.86)	(0.65)	(0.29)	(2.55)	(0.31)
NoClub	-.031	-.124	-.067	1.86	-3.667	2.239
	(0.19)	(1.53)	(0.42)	(0.35)	(0.97)	(0.41)
Toyota	.052	.085	.039	2.298	3.116	2.447
	(0.71)	(1.67)	(0.52)	(0.82)	(1.34)	(0.86)
Constant				-6.261	11.340	-6.554
				(1.91)	(5.93)	(1.89)
Adjusted R2	0.19	0.02	0.19	0.23	0.02	0.22
n	248	462	248	248	462	248
	Probit	Probit	Probit	OLS	OLS	OLS

Notes: For the OLS regressions, we give the coefficients, followed by the absolute value of the t-statistics on the line line below.

For probit regressions, we give the probability of a change in the dependent variable given a one-unit change in the independent variable. We give the absolute value of the z values for the underlying coefficients on the line below.

For probit regressions, we give the pseudo-R2 rather than the adjusted R2.

Sources: See Table 3.

Table 5:
Sales Diversification in the Automobile Sector,
by Firm Size (1996)

Firms, by Sales Vol. (billion yen)	A	B	C	D	E	F
	Number of Domestic Buyers to Whom Firm Sells					Output
	1	2	3-4	5 or more	Total firms	
10 or less	42 (27.1%)	23 (14.8%)	40 (25.8%)	50 (32.3%)	155 (40.9%)	920 (6.8%)
10-30	21 (18.9)	12 (10.8)	24 (21.6)	54 (48.6)	111 (29.3)	2,101 (15.5)
30-50	3 (6.3)	3 (6.3)	4 (8.3)	38 (79.2)	48 (12.7)	1,916 (14.2)
50-100	1 (2.4)	0 (0)	7 (16.7)	34 (81.0)	42 (11.1)	3,158 (23.3)
100-200	0 (0)	1 (7.1)	0 (0)	13 (92.9)	14 (3.7)	2,007 (14.8)
over 200	0 (0)	0 (0)	0 (0)	9 (100)	9 (2.4)	3,436 (25.4)
Total firms	67 (17.7)	39 (10.3)	75 (19.8)	198 (52.2)	379 (100)	13,538 (100.0)

Notes: For all but the numbers in two far-right column, the table gives the number of firms in each row (firm size) that sell to the number of sellers given at the top of each column, followed by percentage of all firms in that row. Column E gives the number and percentage of all firms (379) in that size category. Column F gives the output in billion yen (and percentage of total industry output) produced by firms it that row.

For reasons of data availability, Column 7 includes firms that do not directly sell to assemblers. This distinction is primarily relevant only to the top two rows. Thus, Column F row 1 includes data on 237 firms rather than 155 firms; row 2 on 121 firms; row 3 on 50 firms, row 4 on 43 firms, row 4 on 15 firms, and row 5 on the same 9 firms.

Source: Nihon jidosha buhin kogyo kai & Oto toreedo jaaneru, eds., Nihon no jidosha buhin kogyo (1998 nen ban) [Japanese Automotive Parts Industry, 1998] 16-17 (Tokyo: Oto toreedo jaaneru, 1998).