Vertical Relationships, Hostages, and Supplier Performance in the Japanese Automotive Industry

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Abstract

Since its first appearance, Williamson's (1983) hostage model of exchange has been highly influential in guiding analysis and empirical interpretation of "non-standard" contracting arrangements. The key insight derived from the model is that buyers' credible commitments to stable terms of exchange can induce specific investments by suppliers, and increase the efficiency of production and exchange. In this paper we examine how, in one particular context, the presence of a hostage impacts supplier performance under different demand conditions. More specifically, we explore the extent to which Japanese automotive assemblers have "buffered" their affiliated suppliers from demand fluctuations to a greater extent than for their unaffiliated suppliers. Our empirical findings are consistent with the spirit of Williamson's model and also highlight the subtlety and complexity of hostage arrangements in practice. In particular we find that assemblers indeed buffered their affiliated suppliers from the effects of the negative demand shock that occurred during the 1992-1995 recession., by shifting orders from unaffiliated to affiliated suppliers. However, we also find evidence of short-run "gap filling" by affiliated suppliers, suggesting that affiliated suppliers more frequently adjust production levels to accommodate assemblers' changing requirements in the course of routine demand fluctuations.

1. Introduction

Since its first appearance, Williamson's (1983) hostage model of exchange has been highly influential in guiding analysis and empirical interpretation of "non-standard" contracting arrangements. The key intuition developed in the hostage model is that buyers' credible commitments to stable terms of exchange can induce specific investments by suppliers, thereby increasing the efficiency of production and exchange. This insight has been applied in studies of seemingly idiosyncratic exchange relationships in a variety of settings, including industrial distribution (Anderson & Weitz, 1992; Fein and Anderson, 1992), retail insurance (Anderson, Ross and Weitz, 1998), automobiles (Bensaou and Anderson, 1999; Ahmadjian and Oxley, 2005) and fisheries (Foss, 1999). In each of these settings, researchers have observed discriminating provision of training, exclusive territories, or other investments that appear to be consistent with buyers' efforts to credibly commit to sustained trading with suppliers of those goods or services requiring significant specific investment by the supplier.

Evidence provided by these prior empirical studies constitutes a compelling case for the *existence* of hostage-type arrangements in many commercial settings, but there is as yet little direct evidence on how these arrangements impact buyer or supplier behavior¹ and, in particular, how the presence of hostages changes the performance outcomes of an exchange relationship under different demand conditions – something that is central to Williamson's original hostage model. Increasing our understanding in this area is particularly important given the increased salience of outsourcing in firm strategy, and continued disagreement about the relative merits of flexibility and commitment in outsourcing relationships (Rothaermel *et al*, 2007)

We build on prior work on hostage arrangements in the Japanese automotive supply industry (Ahmadjian & Oxley, 2005) to examine, in one specific context, how the presence of a hostage arrangement impacts buyer behavior – and thus supplier performance - under different demand conditions. Using detailed panel data on supply

¹ A few survey-based studies have examined how the existence of hostages affects perceived levels of commitment, and how commitment in turn affects expectations of future value creation in the exchange relationship (e.g., Ross, Anderson & Weitz, 1997; Anderson, Ross & Weitz, 1998). These studies show that transacting parties' expectations regarding future profitability are positively related to the perceived commitment of the exchange partner.

transactions and financial performance for 138 publicly traded automotive parts suppliers we explore the extent to which the major Japanese auto assemblers "buffered" their suppliers from demand fluctuations, over a 12 year period (1984-1996). The occurrence of a significant negative demand shock in 1992-1995 allows us to identify how this buffering varied systematically with the presence of a hostage arrangement (in this case a minority equity tie between the assembler and the supplier).

Our empirical findings are consistent with the spirit of Williamson's model and also highlight the subtlety and complexity of hostage arrangements in practice. We find evidence that assemblers buffered their affiliated suppliers by favoring them over unaffiliated suppliers during the 1992-1995 shock. However, we also find evidence of "gap filling" by affiliated suppliers in the context of more short-run demand fluctuations, as sales by affiliated suppliers are generally more responsive to changes in customer demand than are those of unaffiliated suppliers. Further analysis suggests that assemblers compensate affiliated suppliers for these short-run supply adjustments via side payments and in-kind transfers, which tend to smooth the profit streams of affiliated suppliers.

We argue that institutional features of the Japanese automotive industry facilitate the side-payments and redistributions necessary to achieve buffering and profit-shifting, as price-setting processes are highly flexible and relational, managerial and technical transfers from assemblers to affiliated suppliers are commonplace, and even the banking relationships of suppliers are sometimes mediated by major customers. Our study thus suggests that, somewhat paradoxically, credible commitments and increased flexibility may go hand in hand in outsourcing relationships.

In addition to illuminating the workings of the hostage model, our study also sheds light on related research on Japanese supply networks, and on business groups in this and other contexts. In contrast to some prior work on Japanese supply relationships, we find no evidence of "serfdom" among affiliated suppliers (Clark, 1979; Watanabe, 1985), nor does equity affiliation appear to operate as a pure insurance mechanism (Kawasaki & McMillan, 1987; Asunama & Kikutani, 1992). Our findings also contrast with prior evidence on *horizontal* business groups in the Japanese economy, where group affiliation has been associated with lower variability and lower levels of profitability (Nakatani, 1984; Lincoln, Gerlach & Ahmadjian, 1996; Khanna & Yafeh, 2005). Rather than impacting *average* returns to suppliers, affiliation in our setting appears to impact investment decisions and adjustment paths. In this regard our research complements recent studies in investment and performance consequences of vertical integration decisions (e.g., Mullainathan & Scharfstein, 2001; Novak and Stern, 2005; Kosova, Lafontaine & Perrigot, 2007). We discuss our findings in the context of these prior studies and suggest implications for future research later in the paper.

The remainder of the paper is organized as follows: In Section 2 we briefly describe the organization of supply relationships in the Japanese automotive industry, and discuss why equity affiliation between an auto assembler and its supplier can act as a robust hostage arrangement in this context, even when the assembler's stake represents only a small fraction of the supplier's equity. We then draw on Williamson's (1983) hostage model to develop context-specific hypotheses predicting how supplier revenues and profits are likely to respond to variation in demand conditions faced by assemblers, and how this relates to the affiliation status of the supplier. The empirical analysis is described in Section 3; Section 4 displays and discusses the results and Section 5 concludes.

2. Hostage arrangements and supplier performance in the Japanese auto supply industry.

2.1. Japanese auto supply networks

As Japanese companies began to dominate world auto markets in the 1980s, a distinctive set of production and purchasing practices caught the attention of Western management scholars and practitioners (e.g., Womack, Jones and Roos, 1990): Japanese auto assemblers used fewer suppliers than their US counterparts and, instead of switching suppliers at regular intervals, typically maintained relationships with key suppliers for decades (Smitka, 1991). In addition, the range of parts procured externally by Japanese auto assemblers was such that the level of relationship-specific investment required by the supplier was typically much higher than for suppliers to the Big 3 US firms; at the same time, detailed contracts between Japanese buyers and suppliers were generally absent.

This apparent absence of formal governance structures in the Japanese auto supply chain led many observers and researchers to conclude that the combination of intense investment and low opportunism in these supply relationships could only be explained by the pervasive trust often associated with Japanese culture (e.g., Dore, 1983; Sako, 1992). Others focused on the role of reciprocity, repeated interaction, and reputation effects in sustaining cooperation (Smitka, 1991; Holmstrom & Roberts, 1998; Klein, 2000). More recent work (Gilson & Roe, 1993, Ahmadjian and Oxley, 2005) suggests, however, that equity affiliation, wherein an assembler owns a minority equity stake in an otherwise vulnerable supplier, may play an important role in the governance of Japanese supply relationships. Ahmadjian and Oxley (2005) argue that such equity stakes represent a robust hostage arrangement, committing the assembler to stable terms of exchange and other ongoing support to affiliated suppliers. They find evidence consistent with this hostage interpretation of equity affiliation: assemblers make discriminating use of equity affiliation, holding equity stakes only in those suppliers that would otherwise be particularly vulnerable to assembler opportunism.

Ahmadjian and Oxley's (2005) claim, that small minority equity stakes act as robust² hostages in the Japanese auto supply context, rests on the understanding that equity affiliation represents a public and visible commitment to ongoing relationships, and that assemblers are held to a higher standard of behavior vis-à-vis affiliated suppliers relative to unaffiliated suppliers. Certainly equity affiliation is highly visible in this context: a small industry in Japan is devoted to publishing directories that map the equity links between firms and, although finding examples of broken ties and unfulfilled obligations is difficult, there is general agreement that failure to make good on commitments to affiliated suppliers can have a real impact on a firm's reputation (Hill, 1995).

Prior research and our own interviews³ attest to the fact that Japanese auto assemblers' commitments to affiliated suppliers are significant and varied: Many large

 $^{^{2}}$ Ahmadjian and Oxley (2005) argue that the robustness of a hostage arrangement rests on the *value*, *durability* and *observability* of the hostage.

³ Interviews were undertaken by one of the authors on multiple occasions between 1994 and 1998 with senior auto industry executives and public relations officials with prior experience in purchasing. Interviews were conducted at Daihatsu, Denso, Honda, Mazda, Mitsubishi Motors, Nissan, Nissan Auto Body, Takata, and Toyota. During execution of these interviews it was clear that assurances of

firms have special departments (*kanren geisha* departments), which devote themselves to assisting affiliated suppliers, for example, in developing strategy, acquiring technology, and providing managerial or technical assistance, particularly during difficult periods (Nishiguchi, 1994; Nishiguchi & Beaudet, 1998). During an interview, one executive suggested that "in Japan, if a supplier runs into financial troubles or management problems, then the customer will help it, since the technical core - the technical level that has been cultivated over the years - remains, so there is value in saving the supplier." Assemblers can also effect side payments to affiliated suppliers through the banking system, pulling strings with banks for preferable loan terms: according to another executive, if a supplier gets into financial difficulties, the assembler initiates negotiations with the supplier and the supplier's bank, saying, "We'll all make a little less money, but let's get together to solve this problem." According to this executive, "this is just part of doing business, and something that is done in the industry."

Our interviews also reinforce the view that assemblers offer such assistance disproportionately to *affiliated* suppliers, although it is significantly more difficult to get direct quotes to this effect: as one executive noted, "Presidents of suppliers and our company talk about just about everything. There is *omote* and *ura* (the surface story and the real story) and you are unlikely to hear the real story. Business is done based on deep personal relations." One interviewee nonetheless alluded to the importance of equity affiliation, in that "the degree that a buyer follows the business of a supplier depends on how close the supplier is. There are close makers, in other words "keiretsu makers" and non-keiretsu makers. Keiretsu makers tend to have a capital relationship, personnel relationships and high dependence…in general, an equity tie is an indicator of a close relationship."

One reason for reticence in describing selective accommodation granted to affiliates and non-affiliates is apparently fear of running afoul of the Japanese FTC. Another executive, describing the flexible process of price-setting, put it this way: "There are two common types of negotiation [with suppliers]. One is negotiation to reduce the

confidentiality were crucial to gaining access to quality information. As a result, we are unable to attribute specific quotes to individual interviewees or companies. Each interview lasted between 2-3 hours and was open ended, covering various aspects of buyer supplier relationships, including issues surrounding governance, performance, and change.

cost of a part—say from 100 to 90 yen. The other is illegal, and the Japan FTC would be unhappy to hear that it happens. In this case, the buyer looks at the supplier's profitability and says, 'you pay us the equivalent of a cost reduction of 100 to 90 yen since you are making good money, but next period, we will leave the cost officially at 100 yen.'" Despite its dubious legal status the executive speaking here went on to suggest that this type of flexible price-setting is quite common and increases the assemblers' ability to tailor prices and other payments to the needs of particular suppliers:⁴ "We look at the profitability of suppliers carefully. We don't want our suppliers to show a loss; we want our suppliers to have a similar profit level."

The characterization of equity affiliation as a hostage arrangement in Japanese auto supply networks thus finds support in this interview data as well as in the empirical evidence presented in Ahmadjian and Oxley (2005). In order to gain greater insight into the actual operation of this governance arrangement, we need to go further, however, to examine the theoretical and empirical impact of the posited hostage arrangement on supplier revenues and profits under different demand conditions. To do this we turn to Williamson's original (1983) hostage model and derive testable hypotheses linking variation in supplier performance to demand conditions in the presence or absence of a hostage.

2.2. Supplier returns in the hostage model

Williamson's (1983) hostage model addresses a fundamental problem facing many companies wishing to outsource manufacture of an intermediate product: In the presence of stochastic demand, a rational buyer will take delivery of product from a supplier in any given period if *and only if* realized demand is such that net receipts exceed the buyer's costs at the contracted price. Recognizing this, a supplier will price the good so that its expected return, given the anticipated probability of cancellation, reaches some minimum level (zero economic profits, assuming competitive supply). Without credible order guarantees, this implies that suppliers making ex-ante investments in relationship-specific assets will charge a per-unit price that exceeds marginal cost, an

⁴ This discrimination is not always accepted with equanimity. One interviewee complained that "the Japanese parts supply system is, indeed, unfair. Look at the way that Nippondenso sells at a higher price to Mazda than to Toyota."

inefficient outcome. Williamson (1983) shows that efficient exchange can be restored, however, if the buyer adopts an alternative contract, whereby a hostage is posted by the buyer (valued in amount *h* by the buyer and some fraction αh by the supplier) and the hostage is delivered to the supplier in the event of order cancellation. This hostage model works by creating a credible commitment on the part of the buyer to take delivery of product over a wider range of realized demand states: only when demand drops to such a low level that realized net receipts are lower than the contracted supply price *minus* the value of the hostage (*h*) will the buyer rationally cancel the order.⁵

Although the original formulation of the hostage model is restricted to the simple case of one buyer and one supplier, we can extend the intuition to situations, such as the one found in the Japanese auto industry, where a buyer has a mix of hostage-supported (affiliated) and no-hostage (unaffiliated) suppliers for a given set of components. This situation may arise in particular when specific investments take the form of specialized assets and production technology is such that capacity is "lumpy" – in this case it may make sense for a buyer to enter into hostage-supported contracts with dedicated suppliers using the specialized technology, and supplement this capacity with purchases from other suppliers using more general-purpose assets.⁶ In this case the hostage model implies that assemblers will favor affiliated suppliers in low-demand states and unaffiliated supplier will more frequently experience order cancellation. More specifically, in the event that there is a negative demand shock, we would expect that assemblers are more likely to cancel or disproportionately reduce orders from unaffiliated suppliers. Thus we hypothesize:

H1: A negative demand shock will lead to a greater reduction in sales revenues for unaffiliated suppliers than for affiliated suppliers, ceteris paribus.⁷

⁵ Although this implies that the buyer will incur a loss in some realized demand states (net receipts will be less than the price paid to the supplier for the good), this does not imply inefficiency: Williamson (1984: 488) shows that in a simple two-period model with h=k and $\alpha=1$, the supplier is willing to accept a contract price equal to marginal cost and the buyer confirms orders if and only if net receipts are greater than or equal to marginal cost.

⁶ It may still be efficient for unaffiliated suppliers to invest in relationship-specific assets in this case, but they can be expected to charge a higher per-unit price than that charged by affiliated (hostage-supported) suppliers.

⁷ Ideally we would like to observe prices and quantities separately in our empirical analysis as this would provide a more complete picture of the transactions occurring between auto assemblers and their suppliers.

Note that the assertion that assemblers will favor affiliated suppliers during lowdemand states does not imply that affiliated suppliers necessarily earn higher average revenues or profits than unaffiliated suppliers. Indeed, in Williamson's hostage model, in equilibrium, suppliers are assumed to be organized competitively and to break even under each arrangement: "Whatever contracting relation is described, producers will be willing to supply if a break-even condition (expressed in expected value terms) can be projected" (1983: 524). Non-affiliates may reach this break-even condition in the face of morefrequent order cancellation by (i) charging a higher per-unit price than affiliates for parts requiring specific investment and/or (ii) by using more general-purpose assets in production, thus incurring higher marginal costs than producers using specialized assets. Either way, higher per-unit prices charged by unaffiliated firms, coupled with more frequent order cancellations imply that the sales revenues of unaffiliated suppliers will respond more dramatically to changes in realized demand than do those of affiliated suppliers. Assuming that assembler sales revenue is a reasonable proxy for realized demand, this implies the following:

H2: Affiliated suppliers' sales revenues will be less sensitive to changes in the revenues of assemblers to whom they sell than is the case for unaffiliated suppliers, ceteris paribus.

While the original formulation of the hostage model involves the buyer posting a pecuniary bond that is transferred to the supplier upon order cancellation, in practice such an arrangement may introduce incentives for the supplier to deliberately induce breach. Recognizing this, Williamson (1983: 526-7) goes on to consider the use of in-kind hostages, which may or may not be exchanged upon order cancellation. In this case, the buyer as well as the supplier makes non-salvageable investments and, "since buyers who make such investments will thereafter confirm orders in more adverse-demand states than those that do not, such investments constitute credible commitments." In-kind hostages, however, "rarely reduce order cancellation hazards to zero" (1984: 489) and the best feasible hostage arrangement in a particular context may involve some mix of in-kind investments and partial hostage payments.

Unfortunately these data are unavailable, and so we must rely on inferences from available data on revenues and profits.

Our earlier discussion of the Japanese auto supply industry suggests that assemblers indeed use in-kind transfers – in this case managerial or technical assistance, or intervention with financial institutions - to buffer affiliated firms from the negative effects of demand shocks. Because such in-kind transfers will be reflected in suppliers' profits rather than revenue, this should have the effect of weakening the link between revenues and profits for affiliated firms. Comparing affiliated with unaffiliated suppliers we thus offer the following hypothesis:

H3: Covariance of revenues and profits will be lower for affiliated suppliers than for unaffiliated suppliers, ceteris paribus.

3. Data and Methods

3.1. Empirical sample & methods

The empirical sample consists of data on supply transactions and financial performance from 1984-1996 for 132 publicly traded auto parts suppliers, all of which are "first-tier" suppliers to one or more of the 11 major Japanese auto assemblers.⁸ Data on parts transactions come from *Jidosha Buhin no 200 Hinmei no Seisan Ryutsu Chosa* ("A Survey of Manufacture and Distribution of 200 Auto Parts") (IRC, 1987, 1994, 1997).⁹ These surveys report, for each supplier, the volume (in Yen) of 200 distinct part categories sold to each of the 11 Japanese auto assemblers at 3-year intervals (1984, 1987, 1990, 1993, and 1996). The IRC reports include most major part categories, including such parts as engines, brakes, automotive glass, instrument panels, transmissions, and tires.

Financial data for the study come from Nikkei NEEDS, an electronic version of annual corporate reports of publicly listed firms. Unlisted (i.e. privately held) firms are excluded from our analysis due to a lack of reliable data: Published volumes of financial reports for unlisted firms (e.g., *Kaisha Sokan* published by the Nihon Keizai Shimbunsha or *Kaisha Soran*, published by Diamond) tend to have many missing years or report

⁸ Assemblers organize suppliers in a system of "clustered control" (Nishiguchi, 1994) by which a set of direct or first-tier suppliers, source from a second tier, and so on down the supplier chain. All of the suppliers in our sample supply directly to the major auto assemblers and are thus first-tier suppliers in this system.

⁹ The 1987 survey covers 160 rather than 200 parts and is correspondingly entitled *Jidosha Buhin no 160 Hinmei no Seisan Ryutsu Chosa* ["A Survey of Manufacture and Distribution of 160 Auto Parts"]

only limited data, and reporting requirements are in general much less stringent for unlisted firms. Our dataset is thus restricted to132 listed suppliers (out of 468 suppliers listed in the IRC report). However, these 132 listed suppliers represent a significant portion of the automotive supply industry, accounting for approximately one half of the transactions reported for the 200 parts listed in the IRC report. They also vary significantly in age, size, etc.¹⁰ None of these firms experienced failure during the sample period, but because there is slight variation in the parts listed by IRC year-to-year, some firms' supply transactions are omitted in a particular year and these firms disappear and then reappear in the sample during the period.¹¹ For most regressions reported below we therefore limit the sample to those companies for whom we have observations for all years; a total of 92 suppliers.¹²

Our hypotheses predict differential relationships between supplier and assembler revenues and profits depending on the presence or absence of a hostage arrangement (in this case, equity affiliation). Testing these hypotheses is complicated by the fact that we would expect there to be systematic variation in some characteristics of affiliated versus non-affiliated suppliers (Ahmadjian & Oxley, 2005) which we may not fully observe and which may also influence supplier performance, potentially biasing our empirical results. We tackle this issue in two ways. First, we take advantage of the panel structure of our data and include supplier or supplier-assembler dyad fixed effects in our regressions (depending on the unit of observation). Because there is no change in equity affiliation over our sample period – and indeed many equity ties between auto assemblers and their suppliers date back many years¹³ – our fixed effects effectively neutralize any significant selection effects with respect to average firm performance. We also take advantage of the fact that the Japanese auto industry went through a severe downturn in demand during 1992-1995 (See Figure 1). Sales in the Japanese auto industry declined in each of these

¹⁰ See Ahmadjian & Oxley (2005) for more detailed comparisons of listed and unlisted firms.

¹¹ Examination of the few firms that disappeared from the sample and did not reappear (12 in total) indicated that they were solid performers that almost certainly did not disappear due to bankruptcy or factors related to poor performance.

¹² There are no significant differences in the characteristics of included versus excluded firms in the reduced full-rank sample, and re-estimating the models on the full sample produces materially identical results.

¹³ See Ahmadjian & Oxley (2005) for a discussion of the stability of equity affiliation in the Japanese auto industry through the late 1990s, and Ahmadjian & Lincoln (2001) on the changing situation in more recent years, with the rise in foreign ownership and the partial dismantling of traditional kieretsu networks.

years, following the burst of the asset bubble in 1991 which led to an economy-wide recession. In contrast, industry sales revenue grew in every other year in our sample period, with the exception of a slight dip in 1986.¹⁴ This exogenous demand shock allows us to identify the adjustment relationships between supplier and assembler revenues and profits for affiliated versus unaffiliated suppliers.

3.2. Measures

We use two annual measures of supplier performance as dependent variables in our analysis. LOG SALES _{it} is the logged value of total sales revenues for supplier i in year t (in yen); ROA_{it} is operating profits divided by total assets.¹⁵ To evaluate the extent to which affiliated and unaffiliated supplier sales track demand fluctuations faced by the assemblers to whom they sell we use LOG ASSEMBLER SALES_{jt}, the log of total sales revenue for assembler j in year t. The negative demand shock during the 1992-1995 period is captured by a dummy variable, SHOCK, that takes a value of 1 during the years 1992, 1993, 1994 and 1995; 0 in other years.

Our indicator variable for the presence of a hostage arrangement is equity affiliation. Following Ahmadjian & Oxley (2005) we use a binary measure of equity affiliation: EQUITY_{ij} is set to one if assembler j holds equity in supplier i, 0 otherwise.¹⁶ This information was compiled from *Kaisha Nenkan* (1989), a volume of annual corporate reports for fiscal year 1987. *Kaisha Nenkan* reports equity holdings of the top ten shareholders (by size of equity stake). Consequently, our observation of equity ties is restricted to the top ten shareholders. We nonetheless believe that our data includes all

¹⁴ In separate analysis (not reported), we also included a dummy variable for 1986 but found no evidence of revenue shifting from non-affiliates to affiliates in that year. This is consistent with our interview data that suggests that, while the 1986 was seen by industry participants as a routine "blip" in demand, the 1992-1995 recession was viewed as a more structural demand shock.

¹⁵ We also re-estimated all of the regressions using before-tax return on assets after interest and extraordinary items and got similar results. Arguments can be made either way on the more appropriate measure here: operating profit is less susceptible to idiosyncratic accounting events, but may not pick up all possible indirect buyer-to-supplier transfers e.g., those involving intercession with the bank to obtain favorable financing deals. See discussion session for further details.

¹⁶ As a robustness check we reestimated the regressions using a continuous measure of equity affiliation, $STAKE_{ij}$, the number of supplier i's shares held by assembler j, divided by the total shares outstanding (see Ahmadjian & Oxley, 2005). This measure produced materially equivalent results to those reported here and did not provide any evidence that the observed profit buffering was restricted to suppliers in whom the assembler owned a major or controlling stake. We choose to display results using the binary equity measure for ease of interpretation.

equity holdings by the major automobile assemblers, as suppliers have an incentive to report all such stakes: as discussed earlier, publicly reported equity stakes are an important indicator of affiliation, and publicize the fact that a supplier has a large, steady customer. Furthermore, the relatively high concentration of equity ownership in this context means that the equity holdings captured in this data extend in most instances to stakes smaller than 5% of total equity (see Table 1, below). Examination of subsequent volumes of *Kaisha Nenkan* confirmed that equity holdings were stable throughout the sample period.

To control for possible differences in the sophistication and specificity of parts supplied by affiliated and unaffiliated suppliers we also include several control variables that prior research suggests may also be related to supplier performance. Following Monteverdi and Teece (1982) we create a measure of manufacturing difficulty of the parts supplied, based on an ordinal ranking ranging from 1, for very simple-to-manufacture parts, to 3, for parts that are complex, require high levels of skill, and have very stringent specifications (e.g. tight tolerances).¹⁷ MFG DIFFICULTY_{it} is then calculated by averaging the ordinal ranking across all of the parts supplied by supplier i in year t. In addition, we account for the complexity of the total number of part types produced by supplier i in year t. These data are derived from the IRC report, and are therefore only available for 1984, 1987, 1990, 1993 and 1996. Intervening years are given the value from the survey closest to that year (e.g., the 1990 data is used for 1989, 1990 & 1991).

We also include several other firm-level control variables that may be expected to affect supplier performance. These include supplier size (LOG ASSETS_{it}), debt-to-equity ratio (DEBT/EQUITY) and DEPENDENCE_{it} measured as the sum of the squares of the fraction of a supplier's output sold to each of its buyers. Similar to a Herfindahl index of market concentration, a value of dependence close to 1 indicates high reliance on a single

¹⁷ This variable was coded by a research assistant who was an engineer formerly employed in parts procurement by a Japanese assembler. He asked three engineers, responsible for parts procurement for three Japanese assemblers in the United States, to evaluate the specificity and difficulty of manufacture of each of the part types in our sample. Each engineer evaluated those parts with which he had most experience. The research assistant examined the responses and resolved any conflicts.

assembler while lower values indicate that a supplier's output is spread more evenly across assemblers.¹⁸

4. Results

Table 1 shows, for each of the 11 major Japanese automobile assemblers, the number of suppliers represented in our sample; what proportion of these suppliers are affiliated suppliers, i.e. suppliers in whom the assembler owns an equity stake; and the median size and range (% of total supplier equity) of the stakes held by the assembler in its affiliated suppliers. Notice that, while there is significant variation in the proportion of suppliers in whom assemblers hold equity, in all cases, the median size of the equity holding is quite low. In addition, the largest and most powerful assemblers (e.g., Toyota, Nissan, Honda) tend to have more prevalent equity ties. These observations are consistent with prior research, and with the idea that the large and powerful Japanese auto assemblers hold equity stakes in their suppliers to make credible commitments to otherwise vulnerable suppliers.¹⁹

Table 2 reports average sales and profitability for each assembler and for the assembler's affiliated and unaffiliated suppliers over the sample period. As one would expect, there is significant variation in average sales and profitability among the auto assemblers and their respective suppliers. However, there is no evidence in this raw data that affiliation has a systematic effect on average profitability of suppliers across all assemblers: for some assemblers, affiliated suppliers were on average somewhat more profitable than unaffiliated suppliers during this period while for others unaffiliated suppliers appear to have fared better.²⁰ Unaffiliated firms do tend to be larger than affiliated suppliers, however, with higher yearly sales revenue during the sample period.

¹⁸ Our dependence measure is also derived from the IRC data and thus is available in survey years only; the intervening years are again assigned values from the closest survey.

¹⁹ Note that the prevalence of equity holdings in this sample is slightly higher than those documented in the larger sample of listed and unlisted suppliers analyzed in Ahmadjian and Oxley, 2005, but the average size of the equity holding is lower. This is consistent with the observation in that paper, that assemblers are more likely to hold equity stakes in listed suppliers than in unlisted suppliers but that, where an equity tie exists, the fraction of the supplier's total equity held by the assembler tends to be slightly larger for unlisted firms. The distribution of the equity stakes in the current sample reflects the lower stakes associated with listed firms: only 8 out of 94 equity ties involve a stake equal to or greater than 33.4% (the threshold at which the equity holder gains veto power over board decisions), and none exceeds 50%.

²⁰ See Table 6 and discussion on pp 18-19 for systematic analysis of average revenues and profitability.

It is important to note that some suppliers are represented in multiple cells of Table 2 since several suppliers – particularly those without an equity affiliation to any of the auto assemblers – supply parts to multiple assemblers. This can be seen more clearly in the descriptive statistics for suppliers, shown in Table 3, where dependence on individual assemblers varies widely.

Our main empirical results are presented in Tables 4 and 5. Table 4 explores the relationship between supplier and assembler sales revenue, and the impact of the demand shock on supplier revenues, to test hypotheses H1 and H2. These fixed effects regressions use dyadic data with yearly observations for each assembler-supplier dyad; the dependent variable is supplier sales revenue (logged). Evidence of assembler buffering should show up in two places: (i) as a positive interaction between the demand shock indicator variable and equity affiliation, reflecting the less severe impact of the demand shock on affiliated suppliers' sales revenues as customers shifted orders from unaffiliated to affiliated suppliers (H1), and (ii) as a negative interaction between assembler sales and equity affiliation reflecting from short-term demand fluctuations through, on the one hand, less-frequent order cancellation and, on the other, the lower per-unit prices of affiliated assemblers (H2).

Looking first at the effect of the demand shock variable (column 1), the results are consistent with our predictions from the hostage model. Not surprisingly, the main effect of the demand shock was to decrease supplier sales revenue overall, as assemblers tightened their belts, cut orders, and pressured suppliers to reduce prices. This effect is much less pronounced for affiliated suppliers than for non-affiliates, however: the interaction between the demand shock indicator variable and the equity variable is positive and significant such that the magnitude of the negative effect on sales revenue was halved for affiliates relative to non-affiliates.²¹ Thus, when there was a significant reduction in demand during the demand shock, it appears that assemblers favored affiliated suppliers over non-affiliates.²²

²¹ Note that the main effect of equity does not appear in these regressions: since equity holdings are timeinvariant in our sample, the effect is absorbed in the firm fixed effects.

²² This pattern was confirmed in year-by-year regressions with similar specifications to those in Table 4 (results not shown; available from authors upon request) – the effect of equity affiliation on performance is positive during all of the recession years and either insignificant or negative during other years. The results

Looking at the relationship between supplier and assembler revenues for affiliates and non-affiliates we see that, contrary to our expectations, there is a *positive* relationship between equity affiliation and the strength of this relationship. This relationship still holds if we omit the demand shock variable (column 2) or replace it with year dummies (results not shown, available from authors on request). Thus assemblers appear to maintain a relatively steady stream of purchases from unaffiliated suppliers, while affiliated suppliers are used to "gap-fill," varying production quantities (or prices) according to the demand conditions faced by the assembler. These results would seem to bolster the view that the relationship between an assembler and its affiliated suppliers is one marked by extraordinary flexibility (Dyer, 1996); something that stands in contrast to the spirit of Williamson's hostage model, with its emphasis on credible commitment and moves which effectively "tie the hands" of the buyer in order to induce specific investments by the supplier.

The effect of control variables in these regressions is largely as one would expect: inter-temporal variation in a supplier's sales is positively related to variations in assembler sales and to supplier size (log assets) and number of different parts supplied. Other supplier characteristics, such as the sophistication of the parts supplied (captured by our measure of manufacturing difficulty) or assembler dependence do not have any observable relationship with sales revenue, in these within-firm regressions, however.

Our interviews and other case data suggest that, at least in the Japanese context, financial side payments or in-kind transfers of technological and managerial resources may also be used to buffer suppliers from the negative effects of demand shock or other difficulties. As discussed above, these side payments or in-kind transfers would not be reflected in revenue, but may nonetheless have the effect of smoothing affiliate supplier profitability, essentially loosening the connection between revenues and profits for affiliated suppliers, as predicted in hypothesis H3. This possibility is explored in the regressions reported in Table 5, where we examine the sensitivity of suppliers' ROA to own sales revenue. Here we see that, as predicted, affiliated suppliers' profits are

in Table 4 are also robust if we re-estimate the model using a more restricted sample that includes only the largest assemblers (Toyota, Nissan, Honda, Mazda, Isuzu and Mitsubishi). Individual assembler regressions also give consistent results, although with reduced levels of significance in some cases.

significantly less correlated with revenues than is the case for non-affiliates, all else equal. This is true in the context of routine demand fluctuations as well as in response to the structural shift represented by the 1992-95 demand shock – not only did affiliated suppliers see a less severe reduction in sales revenue during the shock, but operating profits were also higher than for non-affiliates with similar revenues during this period.

To round-out this picture of potential buffering behavior we also examine the relationship between *assembler* sales revenue and supplier profitability. Using assembler-supplier dyads as the unit of analysis, there is once again strong evidence of buffering during the recession years of 1992-1995: while non-affiliates saw their ROA drop by an average of almost 1% during these years, the equivalent drop for affiliate suppliers was only one tenth of that amount. The effect of equity affiliation on supplier ROA during *routine* demand fluctuations is less clear-cut: the main effect of assembler sales is insignificant, while the coefficient on the interaction between assembler sales and equity is negative and significant. This is not surprising, however, in light of the fact that the relationship between assembler revenues and supplier ROA is mediated by supplier sales, and we have already established that supplier and assembler sales are particularly highly correlated for affiliated suppliers. Thus, the fact that affiliated suppliers' profits are less correlated with assemblers' sales revenues than are those of non-affiliates is consistent with the claim that assemblers make in-kind payments to affiliates to compensate them for varying production to accommodate routine demand fluctuations.

5. Alternative explanations

Our study is not the first to observe that Japanese auto assemblers have a tendency to buffer some suppliers from demand fluctuations or other uncertainties. Building on Holmstrom and Milgrom (1987), Kawasaki & McMillan (1987) argue that, in general, suppliers are more risk-averse than assemblers and so are willing to accept lower compensation in exchange for insurance against some of the risk associated with future demand and production-cost uncertainties. Assemblers can accommodate this riskaversion by using a more cost-based compensation scheme. However, since cost-based compensation naturally reduces the incentives of suppliers to keep costs low, assemblers can be expected to vary the terms of their supply contracts to balance this trade-off,

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depending on the level of risk aversion of particular suppliers. Asanuma & Kikutani (1992) find some evidence consistent with this story: in a study of a selection of supply relationships involving four major Japanese auto assemblers²³ they show that the level of "risk absorption" by assemblers is positively related to proxies for risk aversion of the supplier.

Despite some commonalities between the hostage model explored in our study, and the principal-agent approach adopted by Kawasaki & McMillan (1987) and Asanuma & Kikutani (1992) there are important differences between the two approaches. Most salient is the implication of the two models for average profitability: Kawasaki & MacMillan's (1987) model implies that risk-averse suppliers accept lower profits in return for smoother profit streams. The hostage model, on the other hand, does not imply lower average profits for affiliates versus non-affiliates. As discussed above, in the formal model suppliers are assumed to be competitively organized and to break-even under each arrangement. Generalizing from this idea, and assuming that an auto assembler keeps all of its suppliers at their participation constraint, then, holding the characteristics of the parts supplied constant, there should be no significant difference in the average performance of affiliated and unaffiliated suppliers over time.

Table 6 presents estimation results for random effects regressions that examine whether there are any systematic effects of equity affiliation on average supplier performance in our data (sales in column 1 and return on assets in column 2). These specifications allow us to control for various supplier characteristics, including the percentage of output sold to each assembler. The results show that, although unaffiliated suppliers tend to be larger than affiliated suppliers, all else equal, there are no significant differences in the average profitability of the two groups.²⁴ We also want to make sure

²³ The auto assemblers included in the study are Toyota, Nissan, Mazda and Mitsubishi Motors. Asanuma and Kikutani limit their sample to so-called "satellite" suppliers. It is unclear precisely how satellite suppliers are defined in the data, but the intention is to exclude "such firms that can receive orders from this [assembler] only intermittently," and to focus on those suppliers with whom the assembler "seeks to develop close and longstanding relations…placing orders as continuously as possible." (1992, p. 5)
²⁴ Significant coefficients on the percentage of output devoted to particular assemblers (omitted from the table due to space considerations) indicate that, not surprisingly, those suppliers whose output disproportionately goes to the most profitable assemblers are themselves more profitable. These results are also robust to the inclusion of a set of dummy variables representing the 9 major parts groups produced by suppliers in our sample.

that unobserved differences between affiliated and unaffiliated suppliers are not obscuring the relationship between affiliation and performance. To explore this possibility we adopt an instrumental variables approach with a continuous measure of equity affiliation, STAKE_{ij} (the number of supplier i's shares held by assembler j, divided by the total shares outstanding (see Ahmadjian & Oxley, 2005)). Column 3 & 4 first show un-instrumented random effects regressions with STAKE as the measure of equity for easy comparison with the results in column 1 and 2; the results are essentially identical.²⁵ Columns 5 & 6 show results of the instrumental variables regression with random effects.²⁶ The results are again consistent with the column 1 and 2 results: there are no significant differences in the average profitability of affiliated and unaffiliated suppliers.

One possible explanation for Asanuma and Kikutani's (1992) result of lower profitability for buffered firms (which roughly correspond to our affiliates) is that their sample focuses on the 1980s, a period that did not include any major recessionary episodes for the Japanese auto industry: As our previous analysis shows, the nonaffiliates in our sample tend to do better during good times while affiliates do better during downturns in demand. With respect to routine adjustments, our results suggest that affiliates experience greater fluctuation than non-affiliates in sales revenue, but sidepayments or in-kind transfers ensure that the profit profiles of affiliates and non-affiliates remain quite similar.

Another feature of the hostage model (and of our empirical approach), which seems more appropriate for the Japanese auto context than the simple principal-agent / insurance model, is its explicit consideration of credible commitment mechanisms. In the principal-agent model, risk absorption by the assembler is achieved via a share parameter which, if set at a high value, means that ex post price adjustments will be used to compensate the supplier for unforeseen demand fluctuations or cost overruns (Asanuma & Kikutani, 1992: 9). Given the dearth of detailed contracts in the Japanese setting,

²⁵ As noted in footnote 16, re-estimation of the empirical models shown in Tables 4 and 5 using SHARE also produce materially equivalent results.

²⁶ Supplier dependence is used as the instrument for STAKE. As shown in Ahmadjian and Oxley (2005), supplier dependence is strongly associated with the presence of an equity tie, and it is not strongly associated with performance in any of our regressions.

however, it is not immediately clear what makes commitments to such ex-post adjustments credible.²⁷ The hostage model, focusing on the commitment features of minority equity investments in the Japanese context, and the correspondingly differential responsibilities that assemblers have towards affiliated versus unaffiliated suppliers, provides a solution to this dilemma. The fact that equity affiliation is systematically associated with buffering by auto assemblers in our analysis is therefore most consistent with the hostage model of exchange.²⁸

6. Conclusion

The picture of the relationship between Japanese auto assemblers and their suppliers that emerges from our empirical analysis is consistent with the spirit of Williamson's (1983) hostage model; not surprisingly, the relationship also appears to be more subtle and complex than that captured in the original formal model. We provide evidence that, as predicted by the hostage model, assemblers were more inclined to reduce purchases from unaffiliated suppliers during the prolonged downturn in demand that hit the automotive industry during 1992-1995, while largely maintaining purchases from affiliated suppliers. We also show evidence that is consistent with the use of in-kind transfers or side-payments to affiliated suppliers during the low demand period, and also on a more routine basis, as a means of compensating affiliates for greater flexibility in adapting production and/or prices to accommodate demand fluctuations. Finally, affiliated and unaffiliated suppliers do *not* differ significantly in their average performance over the period of our study – 1984-96 – a finding that appears to be inconsistent with a simple insurance model of Japanese supplier relationships.

It is interesting to contrast our empirical findings with other streams of prior research on organization of the Japanese economy. For example, a once-prevalent view

²⁷ A high share parameter also implies ex-post price adjustments in the event of significant unforeseen cost reductions, in order that assemblers can benefit from the cost savings. As Holmstrom & Roberts (1998) point out, assemblers ability to monitor suppliers and adjust purchase volumes to reward good behavior (and punish bad behavior) appears to have been an effective mechanism for curbing supplier opportunism so obviating the need for explicit credible commitments to disclosure of cost savings by suppliers.

²⁸ In separate analysis (not reported; available from the authors on request), we also looked at the impact of dependence on the relationship between demand fluctuations and supplier performance, since this is a key determinant of risk aversion in Asanuma and Kikutani's (1992) study. Dependence has no systematic relationship with buffering in our sample, however, independent of equity affiliation.

of Japanese subcontracting relations was as an outcome of large manufacturers' exploiting their position as near-monopsonists and using outside suppliers as a buffer against business fluctuations.²⁹ This "risk shifting hypothesis" or "dual economy" view (Clark, 1979; Watanabe, 1985; van Wolferen, 1989) is clearly at odds with the results reported here, since we show evidence of assemblers buffering affiliated suppliers from demand fluctuations, even though these are precisely the kinds of suppliers who would appear to be most vulnerable to assembler opportunism (Ahmadjian & Oxley, 2005). Our findings also contrast with prior evidence on *horizontal* business groups in the Japanese economy, where group affiliation has been associated with lower variability and lower levels of profitability (Nakatani, 1984; Lincoln, Gerlach & Ahmadjian, 1996; Khanna & Yafeh, 2005).

Our findings are more in keeping with recent studies of subcontracting relationships in the Japanese automotive industry that emphasize the enhanced flexibility and responsiveness of these relationships (e.g., Clark and Fujimoto, 1991; Dyer, 1996; Dyer & Nobeoka, 2000). Our results suggest that affiliated firms are particularly responsive in terms of adjusting production to accommodate short-run demand fluctuations faced by the auto assemblers. What our study highlights, however – in contrast to prior work in this vein – is the important role that minority equity investments play in this picture: even small equity investments act as robust hostages that credibly commit assemblers to in-kind transfers and assistance, particularly during significant downturns in demand, so compensating affiliated suppliers for their enhanced flexibility.

Finally, our paper contributes to a small but emerging literature exploring the investment and performance implications of firm boundary decisions. Our results confirm previous observations that, given the endogeneity of the choice of organization, we should not expect – nor do we observe – significant differences in overall performance across organizational forms (Masten, Meehan & Snyder, 1991; Shaver, 1998; Novak & Stern, 2005; Kosova, *et al*, 2007). Where we do see significant differences is in the dynamics of performance. In a similar vein, Novak & Stern (2005) show in a comparison of in-house and external supply transactions in the global luxury car industry, supply

²⁹ See Sako (1989) for a relevant historical survey of research on Japanese business practices and their impact on small and medium-sized firms.

transactions associated with a particular model that are organized internally experience lower performance (quality) at the time the model is introduced, but show greater improvement in performance over the model life-cycle. Novak & Stern suggest that these different dynamic adjustment patterns are indicative of the costs and benefits of different organizational forms, with outsourced transactions providing greater access to cuttingedge technological capabilities, but internal transactions providing greater incentives for ongoing improvement and adaptation; neither form dominates in terms of the aggregate level of quality measured over the entire lifecycle of a luxury car model.

Overall then, our study contributes directly to research on the organization of the Japanese economy, but it also has wider implications. By exploring the operation of a hostage model of exchange in one particular context, we illuminate how the presence of hostages changes the performance outcomes of an exchange relationship under different demand conditions. This central feature of the hostage model has been overlooked in much of the recent empirical work inspired by Williamson's ideas and has led to a perhaps inappropriate focus on average returns to participants in hostage-supported exchanges (Ross, Anderson & Weitz, 1997; Anderson, Ross & Weitz, 1998). Our research suggests that understanding the role of hostages in the governance and operation of vertical relationships requires analysis of performance outcomes over a relatively long period of time, encompassing a variety of industry conditions.

More broadly, with the increased prevalence of outsourcing relationships in manufacturing industries worldwide in recent years, effective organization of supply relationships is becoming a central component of firm strategy. Moreover, as the complexity and sophistication of outsourced parts increases, the potential for costly disputes and/or supply disruptions becomes a focal concern. Understanding how to create appropriate structures to safeguard supply relationships is critical within this context. Our research suggests that a hostage model of exchange can provide a useful tool for understanding the incentives created by different outsourcing arrangements, but it also cautions against simple extrapolation of organizational prescriptions across institutional contexts.

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	1.	2.	3.	4.
Assembler	Number of suppliers in our sample	% of suppliers for which assembler is a top 10 shareholder	Median equity stake, % (dyads with ties only)	Range of equity stakes, % (dyads with ties only)
Toyota	50	54	9.1	1.3 – 35.4
Nissan	49	49	13.1	1.5 - 43.2
Honda	41	15	4.4	2.5 - 40.8
Mitsubishi	51	16	3.6	1.7 - 9.5
Mazda	49	4	2.7	2.6-2.9
Isuzu	47	17	5.9	3.0 - 25.0
Fuji	46	2	1.8	1.8 - 1.8
Suzuki	47	2	3.0	3.0 - 3.0
Daihatsu	40	8	3.0	1.7 - 10.9
Nissan Diesel	48	2	9.5	9.5-9.5
Hino	35	14	2.6	1.1 – 29.2

Assemblers' Equity Holdings in Suppliers (1987)

	Assemblers		Affiliated Suppliers		Unaffiliated Suppliers	
	Mean Sales	Mean	Mean Sales	Mean	Mean Sales	Mean
	Y billions	ROA %	Y billions	ROA %	Y billions	ROA %
	(std dev)	(std dev)	(std dev)	(std dev)	(std dev)	(std dev)
Toyota	7,711	4.6	182	4.3	204	4.2
	(1,131)	(2.0)	(234)	(2.6)	(246)	(2.8)
Nissan	3,719	1.3	114	4.1	547	4.3
	(287)	(1.4)	(76)	(2.5)	(886)	(2.4)
Honda	2,536	3.1	63	4.8	330	4.4
	(276)	(1.4)	(43)	(2.5)	(658)	(2.7)
Mitsubishi	2,148	1.3	56	3.7	299	4.4
	(460)	(0.4)	(39)	(2.4)	(509)	(2.5)
Mazda	1,783	0.8	56	7.4	350	3.9
	(314)	(2.3)	(20)	(2.2)	(628)	(2.2)
Isuzu	1,082	0.4	72	2.8	344	4.0
	(133)	(2.6)	(69)	(2.6)	(601)	(2.3)
Fuji	752	0.4	62	2.8	347	4.5
	(71)	(3.4)	(41)	(1.4)	(693)	(2.9)
Suzuki	918	1.5	51	2.5	339	4.3
	(183)	(0.2)	(52)	(1.9)	(677)	(2.8)
Daihatsu	679	1.3	56	4.6	249	4.2
	(99)	(0.8)	(39)	(2.9)	(278)	(2.4)
Nissan Diesel	318	0.5	22	2.5	292	4.3
	(51)	(0.1)	(5)	(1.3)	(630)	(2.7)
Hino	537	3.5	71	3.9	264	4.2
	(97)	(1.5)	(29)	(2.9)	(298)	(2.5)
Total Industry Sales	22,200 (2,701)	n/a				

Annual Sales and Return on Assets (ROA) for Assemblers and their Suppliers, 1994-96

Note: Observation is supplier-year and sample is limited to suppliers with observations in all years. Unaffiliated suppliers are those suppliers that sell to the assembler in question, but in which the assembler does not hold equity.

Descriptive Statistics - Suppliers

All Suppliers (n=1196)*	Mean	Std. dev	Range
Log Sales	11.565	1.263	8.293 to 15.277
ROA	0.042	0.027	-0.064 to 0.199
MFG Difficulty	1.892	0.584	1 to 3
# Parts	2.218	2.148	1 to 15.6
Log of age in 1990	3.117	0.593	0.693 to 4.276
Debt/Equity	2.577	3.207	-7.976 to 41.637
Dependence	0.529	0.292	0.122 to 1
% output sold to Toyota	0.214	0.292	0 to 1
% output sold to Nissan	0.178	0.280	0 to 1
% output sold to Honda	0.107	0.219	0 to 1
% output sold to Mitsubishi	0.094	0.172	0 to 1
% output sold to Mazda	0.080	0.165	0 to 1
% output sold to Isuzu	0.072	0.174	0 to 1
% output sold to Fuji	0.058	0.136	0 to 1
% output sold to Suzuki	0.079	0.179	0 to 1
% output sold to Daihatsu	0.055	0.151	0 to 1
% output sold to Nissan Diesel	0.045	0.164	0 to 1
% output sold to Hino	0.015	0.074	0 to 0.725

* Observation is supplier-year and sample is limited to suppliers with observations in all years.

	LOG SUPPLIER SALES		
-	(1)	(2)	
Demand Shock	029***		
(1=1992-1995)	(.003)		
Shock * Equity	.017**		
	(.006)		
Log Assembler Sales	.152***	.160***	
	(.010)	(.010)	
Log Assembler Sales *	.083***	.105***	
Equity	(.021)	(.020)	
Mfg Difficulty	.002	.003	
	(.007)	(.008)	
# Parts	.013***	.013***	
	(.002)	(.002)	
Size (Log Assets)	.560***	.561***	
	(.008)	(800.)	
Debt/Equity	0001	0003	
	(.001)	(.001)	
Dependence	018	017	
	(.018)	(.018)	
Year	006***	009***	
	(.001)	(.001)	
Constant	3.364***	3.391***	
	(.114)	(.115)	
N F (d.f.)	6271 1722.08*** (10,5722)	6271 2109.15*** (8,5724)	

Sensitivity of Supplier Sales to Assembler Sales (Fixed Effects Panel Regression on Supplier-Assembler Dyads, 1984-1996)

*p < .05; **p< .01, ***p<.001 (2-tailed tests)

Note: Regression includes fixed effects for supplier/assembler dyad; sample is limited to suppliers with observations in all 13 years.

	SUPPLIER ROA		
	(1)	(2)	
Demand Shock (1=1992- 1995)	011*** (.002)	009*** (.001)	
Shock * Equity	.009*** (.002)	.007*** (.001)	
Log Supplier Sales	.045*** (.005)		
Log Supplier Sales * Equity	020** (.006)		
Log Assembler Sales		.0005 (.002)	
Equity * Log Assembler Sales		008** (.004)	
Mfg Difficulty	.001 (.003)	.000 (.002)	
# Parts	007*** (.001)	005*** (.000)	
Debt-Equity ratio	.000* (.000)	.000* (.000)	
Dependence	004 (.006)	003 (.004)	
Year	003*** (.000)	002*** (.000)	
Constant	.089*** (.040)	.223*** (.024)	
N	1196	6271	
F (d.f.)	51.50 (9.1095)	237.62 (9.5723)	

Sensitivity of Supplier ROA to Revenue (Fixed Effects Panel Regressions, 1984-1996)

*p < .05; **p< .01, ***p<.001 (2-tailed tests)

Note: Column 1 regression includes supplier fixed effects; column 2 regression is based on supplier/assembler dyads and includes dyad fixed effects. In each case, sample is limited to suppliers with observations in all 13 years. Adding the set of variables measuring dependence on each individual supplier does not materially change these results.

Performance (Random Effects Panel Regression, 1984-1996)						
	(1) LOG SALES	(2) ROA	(3) LOG SALES	(4) ROA	(5) LOG SALES	(6) ROA
Equity	663**	.003				
	(.215)	(.004)				
Share			-1.011	.008	-6.031	029
			(.925)	(.018)	(5.40)	(.316)
Log Sales		.007***		.007***		.007*
		(.002)		(.002)		(.004)
Mfg Difficulty	064**	.0003	062**	.0003	062**	.0003
	(.020)	(.002)	(.022)	(.002)	(.022)	(.003)
# Parts	.024*	002**	.023**	002**	.023**	002
	(.008)	(.001)	(.008)	(.001)	(.008)	(.003)
Age	.347	011**	.350	011**	.350	013**
	(.177)	(.003)	(.196)	(.004)	(.196)	(.011)
Debt/Equity	.002	001*	.002	001*	.002	001**
	(.002)	(.0002)	(.002)	(.0002)	(.002)	(.0002)
Dependence	.103*	.0001	.109*	.000		
	(.048)	(.005)	(.048)	(.005)		
Constant	11.275***	.053	10.970***	.052	12.364***	.057
	(.629)	(.039)	(.683)	(.039)	(.592)	(.086)
Firm-specific dependence ^a	Yes	yes	yes	yes	yes	yes
Year dummies	Yes	yes	yes	yes	yes	yes
Instrumental variables	No	no	no	no	yes	yes
N (no of clusters) Chi-square	1196 (92)	1196 (92)	1196 (92)	1196 (92)	1196 (92)	1196 (92)
	1718.80	458.84	1729.85	460.16	1683.24	462.85
(u.i.)	(29)	(30)	(29)	(30)	(29)	(29)

Robustness Checks: Effect of Equity Affiliation on Average Supplier Performance (Random Effects Panel Regression, 1984-1996)

*p < .05; **p< .01, ***p<.001 (2-tailed tests)

^a A set of 12 continuous variables measuring dependence on each assembler are included in the regressions but coefficients are not shown for ease of exposition. Fixed effects for year are also included (coefficients not shown).