Vertical Relationships, Hostages, and Supplier Performance: Evidence from the Japanese Automotive Industry

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Abstract

Drawing on Williamson's (1983) hostage model and recent studies identifying equity affiliation as a robust hostage in the Japanese automotive industry we examine the relationship between automobile assemblers and their suppliers under different demand conditions. Specifically, we explore the extent to which assemblers buffer their equity-affiliated suppliers from demand fluctuations to a greater extent than is the case for unaffiliated suppliers. Our empirical analysis suggests that assemblers buffered their affiliated suppliers from the effects of a negative demand shock in 1992-1995, apparently favoring affiliates over unaffiliated suppliers during this period, as predicted by the model. However, affiliates in our sample also more frequently adjust production to accommodate short-run demand fluctuations faced by the auto assemblers; assemblers compensate their affiliated suppliers for this enhanced flexibility through in-kind transfers or side-payments which smooth supplier returns. We discuss how our findings relate to theoretical alternatives featuring differential capabilities, supply assurance, or risk aversion.

1. Introduction

Since its first appearance, Williamson's (1983) hostage model has been highly influential in guiding analysis and empirical interpretation of a variety of seemingly idiosyncratic 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 exchange relationships in settings as diverse as industrial distribution (Anderson and 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 behavior[1] and, in particular, how the presence of hostages changes the performance outcomes for parties to an exchange relationship under different demand conditions – something that is central to Williamson's original hostage model. Increasing our understanding of this issue 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 and Oxley 2006) to predict how the presence of a hostage arrangement in this context likely impacts buyer behavior – and thus supplier performance - under different demand conditions. We test our predictions using detailed panel data on supply transactions and financial performance for 132 publicly traded automotive parts suppliers, exploring 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, our results also indicate that affiliates more frequently adjust production to accommodate short-run demand fluctuations faced by the auto assemblers, as sales by affiliated suppliers are generally more responsive to changes in realized demand than are those of unaffiliated suppliers. Further analysis suggests that assemblers may 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 go hand in hand in outsourcing relationships.

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 very 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 data and methods are described in Section 3; estimation results are presented in Section 4. In Section 5 we probe the robustness of the empirical regularities observed in our data and explore theoretical alternatives related to supplier capabilities (Asanuma 1989), risk aversion (Kawasaki and MacMillan 1987), and supply assurance in the presence of sticky prices (Carlton 1979). Section 6 concludes.

2. Hostage Arrangements and Supplier Performance in the Japanese Auto Supply Industry

Supply relationships in the Japanese automotive industry provide a fascinating setting for a study of hostage-supported exchange. For many years, Japanese supply networks represented a puzzle to economists and organization theorists: Despite heavy

reliance on external suppliers for a wide variety of sophisticated components, supply relationships were marked by an almost complete absence of detailed contracts. Attempts to explain the combination of intense investment and low opportunism in these exchange relationships led researchers to point to the pervasive trust often associated with Japanese culture (e.g., Dore 1983; Sako 1992), or to the potential role of repeated interaction, and reputation effects in sustaining cooperation (Smitka 1991; Holmstrom and Roberts 1998; Klein 2000), but none of these explanations were deemed sufficient to settle the continued controversy and debate surrounding Japanese industrial organization.

It was in this context that Gilson and Roe (1993) raised the possibility 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. Developing this idea, Ahmadjian and Oxley (2006) argue that even very small equity stakes (less than 5% of the supplier's total equity) can constitute a robust[2] hostage arrangement in the Japanese context, committing the assembler to stable terms of exchange and other ongoing support to affiliated suppliers. Empirical analysis of Japanese automotive supply relationships yields evidence consistent with this interpretation as suppliers in whom assemblers hold equity stakes tend to be those that would otherwise be particularly vulnerable to assembler opportunism.

The claim that equity affiliation serves as a hostage rests on the understanding that equity affiliation linking Japanese automobile assemblers to their suppliers represents a public and visible commitment to ongoing relationships, and 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; in addition, many large firms have special departments (*kanren gaisha* 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 and Beaudet 1998). There is also general agreement that failure to make good on commitments to affiliated suppliers can have a real impact on an auto firm's reputation (Hill 1995), although occurrences of broken ties or unfulfilled obligations are apparently rare.[3]

Executives in the Japanese auto industry themselves rarely speak directly of offering assistance disproportionately to *affiliated* suppliers. Yet, they are also clear the equity affiliation is important, and ties buyers and suppliers together in a meaningful way. In our own interviews,[4] one executive alluded to the reticence on this topic, observing that "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. [5] Business is done based on deep personal relations." Nonetheless, another interview subject alluded to the importance of equity affiliation, noting 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."

In order to gain greater insight into the hostage features of equity affiliation in this context, in the following section we return to Williamson's original (1983) hostage model, draw out implications of the hostage model for assembler behavior and supplier

performance in Japanese auto supply relationships, and derive testable hypotheses regarding supplier revenues and profits.

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 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 the buyer's realized net receipts are lower than the contracted supply price *minus* the value of the hostage (h) will the buyer rationally cancel the order.[6]

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.[7] In this case the hostage model implies that assemblers will favor affiliated suppliers in low-demand states (to avoid transfer of the hostage), 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.[8]

Note that the assertion that assemblers will favor affiliated versus unaffiliated suppliers for a particular part during low-demand states does not in itself 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 more frequent order cancellation by (i) charging a higher per-unit price than affiliates for parts requiring specific investment and/or (ii) using more general-purpose assets in production of the part, 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.***

The original formulation of the hostage model involves the buyer posting a pecuniary bond that is transferred to the supplier upon order cancellation, but in practice such an arrangement may introduce incentives for the supplier to deliberately induce breach. Recognizing this, Williamson 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" (Williamson 1983: 526-7).

As noted above, observations on the Japanese auto supply industry provide concrete examples of the use of in-kind transfers to affiliated suppliers – in this case increased financial, managerial or technical assistance during times of distress. In a similar vein, during the course of our interviews, one executive referred to the provision of side payments to affiliated suppliers through the banking system, wherein an assembler pulls strings with banks to obtain preferable loan terms in the event that the supplier gets into financial difficulties. In this case, the assembler initiates negotiations between 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." Such transfers will be reflected in suppliers' profits rather than revenue and, if they are used to buffer affiliated firms from the negative effects of demand shocks, 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 and 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.[9] 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).[10] 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 Shimbun-sha or *Kaisha Soran*, published by Diamond) tend to have many missing years or report only limited data, and reporting requirements are much less stringent for unlisted firms, rendering the accounting data unsuitable for analysis. Our dataset is thus restricted to132 listed suppliers (out of 468 suppliers listed in the IRC reports). 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 covered by the IRC surveys.[11] None of the firms in our sample experienced failure during the sample period, but data is missing for some of the firms in some years due to slight year-to-year variation in the specific parts included in the IRC survey.[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 and Oxley 2006) which we may not fully observe and which may also influence supplier performance, potentially biasing our empirical results.

We tackle this issue in three 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 years[13] – our fixed effects effectively neutralize any significant selection effects with respect to average firm performance. Second, we 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 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 via a simple "difference in difference" approach.

<Figure 1 about here>

Finally, we may still worry that, if affiliated suppliers are in some sense higher quality producers, or produce more critical inputs, this could also prompt a differential response from assemblers at the time of the demand shock. To account for this possibility we perform robustness checks, adding additional interaction terms based on the number and technical sophistication of the parts that a firm supplies to each assembler. These additional tests also allow us to assess relevant theoretical alternatives for our empirical observations.

3.2. Measures

We use two annual measures of supplier performance as dependent variables in our analysis. LOG SUPPLIER 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] 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. To evaluate the extent to which affiliated and unaffiliated supplier sales track other

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.

Our indicator variable for the presence of a hostage arrangement is equity affiliation. Following Ahmadjian and Oxley (2006) 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 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. Examination of subsequent volumes of *Kaisha Nenkan* confirmed that equity holdings were stable throughout the sample period. Although many of the suppliers in our sample supply to more than one assembler none of the suppliers has an equity affiliation with more than one assembler.

<Table 1 about here>

Table 1 shows, for each of the 11 major Japanese automobile assemblers, the number of suppliers represented in our sample, the proportion of these suppliers that 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.[17]

Given this diversity among the 11 Japanese auto assemblers, in terms of size and equity holdings, we need to allow for possible diversity among assemblers in terms of their relationship with suppliers and recognize the possibility that the 1992-95 demand shock disproportionately impacted some assemblers (and thus their suppliers).[18] We do this in some of the specifications reported below, by including a series of ASSEMBLER EFFECTS indicating the proportion of a supplier's output (in units) sold to each assembler in year t;[19] we also interact this variable with the SHOCK variable to produce assembler-specific shock effects.

To control for possible differences in the sophistication and specificity of parts supplied by affiliated and unaffiliated suppliers we also include in some specifications several control variables that prior research suggests may also be related to supplier performance. Following Monteverde 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).[20] MFG DIFFICULTY$_{it}$ is then calculated by averaging the ordinal ranking across all of the parts

supplied by supplier i in year t. We also account for the complexity of the supplier's overall manufacturing operations with $\#PARTS_{it}$, a count 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 and 1991). In these specifications we also include supplier SIZE (measured as the log of total yen-denominated assets), debt-to-equity ratio ($DEBT/EQUITY_{it}$), and $DEPENDENCE_{it}$, measured as the sum of the squares of the proportion of a supplier's output sold to each of its buyers.

4. Results

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 of a systematic industry-wide relationship between affiliation and average profitability for suppliers during this period: for some assemblers, affiliated suppliers were on average somewhat more profitable than unaffiliated suppliers while for others unaffiliated suppliers appear to have fared better.[21] Unaffiliated firms do tend to be larger than affiliated suppliers, however, with higher average sales revenue.

<Table 2 about here>

It is important to remember that some suppliers are represented in multiple cells of Table 2 since many suppliers supply parts to multiple assemblers. This can be seen

more clearly in the descriptive statistics for suppliers, shown in Table 3a, where there is significant variation in suppliers' dependence on individual assemblers.

<Table 3a and Table 3b about here>

Table 3b presents difference in means between those suppliers who have an equity affiliation with one of the assemblers and those who have no equity affiliation for a variety of characteristics across the sample period. These tests confirm the observations in Table 2 that unaffiliated suppliers tend to be somewhat larger than affiliates; consistent with the observations in Ahmadjian and Oxley (2006) we also see here that affiliates tend to supply a greater number of different parts, but there are few other differences in observable characteristics between affiliated and unaffiliated suppliers.

Our main empirical results are presented in Tables 4 to 6, focusing on hypotheses H1 to H3 respectively. Table 4 examines the impact of the 1992-95 demand shock on the suppliers in our sample. These OLS regressions include annual observations for each supplier; the dependent variable is supplier sales revenue (LOG SUPPLIER $SALES_{it}$); and all of the specifications include supplier fixed effects.[22]

<Table 4 about here>

Model 1 presents the simplest model, with supplier fixed effects and a time trend plus our indicator variable SHOCK, entered alone and in interaction with EQUITY.[23] Evidence of assembler buffering should show up 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). The estimation results in this model are

consistent with our predictions from the hostage model. As expected, 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 is almost halved for affiliates relative to non-affiliates. Thus, when there was a significant reduction in demand during the demand shock, it appears that assemblers favored affiliated suppliers over non-affiliates.

Models 2-4 add other fixed effects and control variables to probe this basic result. Model 2 replaces the time trend with year fixed effects, yielding almost identical results with respect to affiliate buffering (SHOCK*EQUITY); Model 3 adds a series of ASSEMBLER EFFECTS (defined above), and in Model 4 these are also interacted with the SHOCK variable. These specifications allow us to explore the extent to which our Model 2 result may reflect assembler heterogeneity rather than differential treatment of affiliates and non-affiliates. The SHOCK*EQUITY coefficient is very stable across these different specifications.[24]

To explore the relationship between assembler and supplier sales revenues (H2), we shift the unit of analysis to the assembler-supplier dyad. Looking at the estimation results from the fixed-effects regressions in Table 5a and focusing on 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 result holds across various specifications, with the

impact of the demand shock included or excluded, and after controlling for other transaction characteristics: aside from the significant shift towards affiliates during the demand shock, assemblers appear to maintain a relatively steady stream of purchases from unaffiliated suppliers, while affiliated suppliers vary their production quantities (and/or prices) to accommodate current demand conditions faced by the assembler.

<Table 5a and 5b about here>

We round out our analysis of sensitivity to assembler sales by examining these effects for individual assemblers and their suppliers. Table 5b shows the effect of the demand shock as well as sensitivity to assembler sales for affiliates and non-affiliate suppliers for each of the five largest assemblers. The coefficient on ASSEMBLER SALES*EQUITY is positive in each case, although significant for only 3 of the 5 assemblers. The directional effect of SHOCK*EQUITY is also consistent across assemblers and is statistically significant in most cases, further supporting the conclusion that assemblers gave preference to affiliated suppliers when placing orders during this period of reduced demand.[25]

The increased sensitivity of supplier revenues to assembler sales appears to bolster the view that the relationship between an assembler and its affiliated suppliers is one marked by great flexibility (Dyer 1996), a characterization 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. However, before concluding on this issue it is important to also examine movements in supplier profits since, as argued above, assemblers may also use side payments or other in-kind transfers of technological and managerial resources to

buffer affiliated suppliers from the negative effects of a demand shock or other difficulties. As discussed above, these side payments or in-kind transfers will 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.

The relationship between supplier revenues and profits is explored in the regressions reported in Table 6. In these firm-level fixed-effect regressions we examine the sensitivity of suppliers' ROA to changes in own sales revenue. Here we see that, as predicted, affiliated suppliers' profits are 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, holding revenues constant, operating profits were also higher than for non-affiliates during this period.

<Table 6 about here>

Our interviews reinforce this nuanced picture of accommodation and buffering in the relationship between auto assemblers and their affiliated suppliers. One executive at a large auto company, describing the flexible process of price-setting in the industry, put it this way: "There are two common types of negotiation [with suppliers]. One is negotiation to reduce the 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 the dubious legal status of this practice 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: "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." These observations are consistent with our empirical findings, whereby the production accommodations made by affiliate suppliers mean that their revenue streams are quite sensitive to changes in assembler revenues (realized demand), but profits are smoothed via side-payments outside of the official price-setting process.[26]

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, nor is Williamson's hostage model the only potential explanation for the existence of different contracting arrangements. In this section we highlight several relevant theoretical alternatives, examine how the assumptions of these theoretical alternatives fit with the institutional context of the Japanese automotive industry, and explore some additional empirical implications of alternative models in order to further probe and refine our inferences.

The first set of alternative explanations for our empirical observations relates to differences in the characteristics of affiliate and non-affiliate suppliers in our sample – other than equity affiliation - that may affect how they are treated during a downturn. One of the pioneers of research on the Japanese automotive industry, Banri Asanuma, for

example, focuses on the role played by assembler ratings of suppliers and suggests that assemblers tend to favor suppliers who attain higher ratings on accumulated relation-specific skill:

> "... typically there are two or three incumbents who are supplying the *I*th kind of part, if this belongs to customized parts in the automobile industry. ...[The] supplier which has achieved a higher level of the relation-specific skill is ranked higher in comparison to other suppliers of the same kind of part, and tends to be offered more favorable business by the core firm. For instance, the supplier may be able to receive orders for a larger number of different car makes in parallel than any of its competitors receives, or to receive an order for a car make which sells in a larger volume..." (Asanuma 1989: 25)

Under this scenario, if it suppliers with a high level of "relation-specific skill" coincide with those with whom the assembler has an equity affiliation then our observation that affiliated firms are buffered against the negative effects of the 1992-95 demand shock may also reflect assemblers' selection of their most capable suppliers for fulfillment of (reduced) demand during the downturn. And indeed, we can see from Table 3b that affiliate suppliers do tend to supply a greater number of different part types than do non-affiliates, consistent with the development of greater relation-specific skills among affiliates (see also Ahmadjian and Oxley, 2006, for more on this).

From a theoretical perspective there is a close relationship between Asanuma's capabilities perspective and our hostage model of affiliation, since a key premise of our

model is that the presence of an equity tie infuses the trading relationship with confidence, such that a supplier is more willing to make investments which would otherwise make it vulnerable to assembler opportunism. In that sense one may view these two explanations as more complementary than rival. It is nonetheless useful to try to further tease apart how response to the demand shock varies with equity affiliation and supplier capabilities. In particular, we are interested to explore whether the presence of an equity tie is an important predictor of differential supplier performance during the demand shock, independent of other supplier characteristics associated with enhanced capabilities.

From Models 3 and 4 in Table 4 we know that affiliates fared better during the shock than non-affiliates, and that this result holds when we control for the extent to which production capacity is devoted to particular assemblers. We also know that the buffering result holds when we control for within-firm variation in a range of supplier or transaction characteristics that include manufacturing difficulty and number of part types supplied (Model 8, Table 5a). However, since there is little within-supplier variance in the capability-related variables these regressions tell us little about how suppliers of different average capabilities fared during the shock.

To get at this issue, in Models 17-21 in Table 7 we interact capability-related variables, averaged over the sample period for each of the suppliers in the sample, with the shock indicator, to examine whether assemblers appeared to favor more capable suppliers during the downturn. These models produce mixed results: the reduction in revenues during the demand shock is lower for suppliers who produce more different part types, but is higher for suppliers of more sophisticated parts (high manufacturing

difficulty); supplier size is unrelated to the impact of the shock on revenues. Meanwhile the coefficient on Shock*Equity retains significance except in the model in which all of the interactions are entered together. Thus we are not able to fully disentangle the influence of capabilities and equity affiliation on supplier performance during the shock.

<Table 7 about here>

Another possible point of divergence between Asanuma's interpretation of Japanese automotive supply relationships and our own is in the implications for *average* performance of affiliates versus non-affiliates. If it is the case that affiliated suppliers in our sample are simply the most capable suppliers, then we might expect affiliates to achieve greater average performance over the entire sample period. The hostage model, on the other hand, does not imply any systematic difference in average profits for affiliates versus non-affiliates. As discussed in the context of hypothesis H2, in Williamson's (1988) 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, we have no reason to expect a significant difference in the average performance of affiliated and unaffiliated suppliers over time.

Table 8 presents estimation results for random effects regressions that examine whether there is in fact any systematic relationship between equity affiliation and average supplier performance in our data (Sales Revenue in even-numbered models and ROA in odd-numbered models). These specifications allow us to control for various time-invariant supplier characteristics as well as the effect of differential dependence on individual assemblers. 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.[27]

<Table 8 about here>

Taken together the results of these additional tests provide mixed support for Asanuma's contention that assemblers reward more "highly skilled" suppliers with additional business: we see little in the way of a systematic relationship between our measures of firm capabilities and average supplier performance. And during the demand shock, larger suppliers providing more diverse parts seem to fare better, but suppliers of sophisticated parts fared marginally worse. In the end it is not possible to fully disentangle the implications of Asanuma's model of Japanese supply relationships and Williamson's hostage model since it is quite possible that there are other unobserved differences between affiliated and unaffiliated suppliers that make affiliates more high-value suppliers to their affiliated assembler – and indeed we would expect this to be the case, based on the logic of the hostage model, as affiliated suppliers should be more willing to make relationship-specific investments given the presence of a robust hostage supporting exchange.

The analysis in Table 8 allows us to probe a second alternative theoretical perspective on Japanese supply relationships that focuses on differences in risk aversion among supplier firms. Building on Holmstrom and Milgrom (1987), Kawasaki and 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 risk-aversion by using a more cost-based compensation scheme.

However, because cost-based compensation naturally reduces the incentives of suppliers to keep costs low, assemblers will vary the terms of their supply contracts across suppliers, depending on the level of risk aversion of particular suppliers. Asanuma and Kikutani (1992) find some evidence consistent with this logic: in a study of a selection of supply relationships involving four major Japanese auto assemblers[28] they show that the level of "risk absorption" by assemblers is positively related to risk aversion of the supplier, as proxied by firm size and number of customers (dependence). Since our earlier results suggest that affiliates also tend to be more dependent on individual assemblers (Ahmadjian & Oxley, 2006) it is plausible to think that affiliation could correlate with risk aversion. However, Kawasaki and MacMillan's (1987) model also implies that risk-averse suppliers accept lower profits in return for smoother profit streams. As we have shown in the analysis in Table 8, we find no evidence of average profit differences for affiliates and non-affiliates over our sample period, nor is dependence a significant predictor of profitability. Thus it is unlikely that differences in risk aversion are responsible for the regularities observed in our data. Similarly, the lack of a significant profit difference between affiliate and non-affiliate suppliers is inconsistent with earlier characterizations of equity affiliation as supporting a form of "serfdom" in the automotive supply industry (e.g., Clark, 1979; Watanabe, 1985).

A final theoretical alternative of potential relevance here is Dennis Carlton's (1979) model of long term contracting for supply assurance in the presence of "sticky" prices: in this model demand uncertainty increases input supplier costs and because prices are sticky, intermediate input sellers cannot always sell all that they produce and buyers cannot always obtain the inputs needed to fulfil final demand. In this context, long term

contracts reduce uncertainty - and therefore costs - because downstream producers (here assemblers) guarantee that they will accept delivery of inputs at the contracted price for the duration of the contract. Downstream producers who cannot adequately predict demand, or whose needs turn out to be greater than the amount covered by the long term contract, rely on the spot market for net input requirements.

A key feature of Carlton's (1979) model is that in high demand states, upstream suppliers withhold delivery from downstream producers with whom they have a long term contract, in order to reallocate production to the spot market to take advantage of higher spot market prices.[29] Applying Carlton's (1979) model to the Japanese automotive supply context, one interpretation of the difference between affiliated and unaffiliated suppliers could be that automobile assemblers have implicit long-term contracts with affiliated suppliers, while unaffiliated suppliers essentially supply parts on the spot market. And indeed, this interpretation is consistent with our observation that unaffiliated suppliers tend to have lower dependence on particular assemblers. However, it is difficult to reconcile the institutional details of the Japanese automotive supply industry with the core assumption of Carlton's model that, regardless of relative prices, buyers always honor commitments under the long term contract, while suppliers are able to divert production at will away from their "affiliated buyers" to the spot market: First, no true spot market exists for the automotive parts covered in our study. As discussed in detail in Ahmadjian and Oxley (2005), suppliers must go through an extensive vetting period prior to getting their first order, and ramping up of business with a new assembler takes time, as the assembler gains confidence in the capabilities and performance of the supplier. As such, to the extent that suppliers are able to reallocate production away from affiliated

(long-term) to non-affiliated (spot market) buyers at all, it is likely to happen only slowly. Second, given the "Just-In-Time" delivery system commonly governing Japanese auto supply relationships, delivery lags are likely to impose quite high costs on assemblers. Indeed, as noted by Asanuma (1989) and others, this is one of the primary motivations for the redundancies that are built into Japanese auto supply networks. And, in part due to the high potential costs of order delays to assemblers, suppliers who fail to supply parts in a timely manner are rarely awarded significant future orders.[30] In sum, while Carlton's (1979) model may provide useful insights on long-term contracting in many situations, it appears to have little traction in the particular empirical context of the Japanese automotive supply industry.[31]

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 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 maintaining purchases from affiliated suppliers to a greater extent. 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.

Our empirical findings sit comfortably within a small but emerging literature exploring the investment and performance implications of firm boundary decisions (e.g., Mullainathan and Scharfstein 2001; Novak and Stern 2008; Kosova et al. 2007). 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 et al. 1991; Novak and Stern 2008; Kosova et al. 2007). Where we do see significant differences is in the *dynamics* of performance. In a similar vein, Novak and Stern (2008), for example, in a comparison of in-house and external supply transactions in the global luxury car industry, show that supply 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; neither form dominates in terms of the aggregate level of quality measured over the entire lifecycle of a luxury car model.[32]

Looking beyond the hostage model of exchange, our empirical observations challenge some alternative theoretical perspectives that have been advanced in the literature. In particular, we find no evidence of "serfdom" among affiliated suppliers and our results also appear to be inconsistent with a simple insurance model of Japanese supplier relationships, and with models emphasizing the impact of sticky prices on supplier production allocation decisions. There is however, some evidence in our data that assemblers pay attention to the differential capabilities of suppliers when reallocating

production in the face of a demand shock, consistent with Asanuma's (1989) perspective on the Japanese auto industry. Further disentangling the role of hostages or other governance mechanisms from selective matching on firm capabilities represents an important avenue for future research.

Our findings are also in keeping with other 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 and 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 appear to 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. Somewhat paradoxically then, credible commitments and increased flexibility may go hand in hand in outsourcing relationships

Overall, our study contributes directly to research on the organization of the Japanese economy, and also has wider implications. By exploring the operation of a hostage model of exchange in one particular context, we illuminate how suppliers' performance outcomes under varying demand conditions differs between hostage-supported exchange relationships (here equity affiliation) and those without such supports. 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 et al. 1997; Anderson et al. 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 study suggests that a hostage model of exchange can provide a useful tool for understanding the incentives created by different outsourcing arrangements, but also cautions against simple extrapolation of organizational prescriptions across institutional contexts.

[1] A few previous studies have shown that the existence of hostages affects perceived levels of commitment, and that perceived commitment of the exchange partner is positively related to expectations regarding future profitability. See, e.g., Ross, Anderson and Weitz, 1997; Anderson, Ross and Weitz, 1998.

[2] Ahmadjian and Oxley (2006) argue that the robustness of a hostage arrangement rests on the *value, durability* and *observability* of the hostage.

[3] This is consistent with equilibrium strategy in the presence of an efficient punishment system (see, e.g., Perotti, 1992).

[4] Interviews with senior auto industry executives and public relations officials with prior experience in purchasing were undertaken on multiple occasions between 1994 and 1998. 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 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. Regular contact with industry executives in the period since these interviews has also allowed for updating of relevant information.

[5] One apparent reason for reticence in describing selective accommodation for affiliates and non-affiliates is the fear of running afoul of the Japanese Federal Trade Commission (JFTC).

[6] 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 α=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.

[7]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 a specialized technology, and supplement

this capacity with purchases from other suppliers using more general-purpose assets. 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.

[8] While we would like to observe prices and quantities separately in our empirical analysis to provide a more complete picture of the transactions occurring between auto assemblers and their suppliers, these data are unfortunately unavailable; we rely instead on inferences based on changes in revenues and profits.

[9] 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.

[10] 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"]

[11] The listed firms vary significantly in age, size, etc. See Ahmadjian and Oxley (2006) for more detailed comparisons of listed and unlisted firms.

[12] Examination of the 12 firms that disappeared from the sample and did not reappear indicated that they were solid performers that and did not disappear due to bankruptcy or factors related to poor performance. Re-estimating all of our empirical models on a restricted sample that includes firms for which we have data in all of the sample years (92 firms) produces materially identical results.

[13] See Ahmadjian and Oxley (2006) for a discussion of the stability of equity affiliation in the Japanese auto industry through the late 1990s, and Ahmadjian and Lincoln (2001) on the changing situation in more recent years, with the rise in foreign ownership and the partial dismantling of traditional kieretsu networks.

[14] In separate analysis (not reported; available from the authors on request), 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 which suggests that, while the 1986 downturn was seen by industry participants as a short-lived exchange-rate effect, 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.

[16] As a robustness check we also estimated a model (results available from the authors on request) interacting the demand shock variable with an additional dummy variable, CONTROL = 1 if the size of the equity stake exceeds 33.4%, which is the ownership threshold at which the shareholder obtains *de jure* control through veto power over board decisions (see Ahmadjian and Oxley 2006). CONTROL is insignificant in this model, and the estimated effect of equity is unchanged.

[17] 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 (2006), 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 smaller 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%.

[18] As shown in Table 2, some of the largest and most successful assemblers tend to hold equity stakes in more of their suppliers. If these assemblers were able to buffer their suppliers from the downturn more effectively, then this would bias our estimate of the affiliation effect. We thank an anonymous reviewer for this insight.

[19] So, for example, if in year t a supplier i sells half of its output to Toyota 25% to Nissan, 10% to each of Mitsubishi and Mazda and 5% to Isuzu, the values for the assembler effect variables for supplier t in year t will be as follows: TOYOTA = 0.5; NISSAN=0.25; MITSUBISHI=0.10; MAZDA=0.10; ISUZU=0.05; HONDA=0; FUJI=0; SUZUKI=0; DAIHATSU=0; NISSAN DIESEL=0; HINO=0. These data are also derived from the IRC data and thus are available in survey years only; the intervening years are again assigned values from the closest survey.

[20] 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.

[21] See Table 8 and discussion on pp. 22-23 for systematic analysis of average revenues and profitability.

[22] Note that we cannot observe how much of a supplier's revenue is derived from transactions with individual assemblers (unless the supplier devotes 100% of its capacity to a single assembler). As such SUPPLIER SALES is a firm-level variable in these regressions, the unit of analysis is supplier-year, and EQUITY=1 if the supplier has an equity affiliation with *any* assembler. In Tables 5a and 5b (below) we use annual data on the supplier-assembler dyad as the unit of analysis. This has the advantage that the equity variable can be associated with a specific assembler, but in this case, the dependent variable is at a more aggregated level than the observations.

[23] Note that the main effect of equity does not appear in these regressions: since equity holdings are time-invariant in our sample, the effect is absorbed in the firm fixed effects.

[24] As additional robustness checks we reestimated all of the models with the two largest assemblers – Toyota and Nissan – omitted. Results (available from the authors on request) were very similar to those reported in Tables 4-6, with a slight reduction in significance in some models. In addition, we estimated a model replacing the SHOCK*EQUITY variable with a series of dummy variables indicating *which* assembler held equity in supplier_i Although none of the individual coefficients on these assembler-specific SHOCK*ASSEMBLER*EQUITY variables were significant, an F test indicates that the coefficients are jointly significant and greater than zero, providing further support for the notion that the observed effects are related to different treatment of affiliates and non-affiliates rather than to heterogeneity among assemblers.

[25] For the smaller assemblers the coefficient on ASSEMBLER SALES*EQUITY is statistically significant in two out of seven cases; EQUITY*SHOCK is significant in three cases. Note also that the sample size is significantly reduced for some of these assemblers.

[26] Estimation of the relationship between *assembler* sales revenue and supplier profitability in assembler-supplier dyads (results not shown; available from the authors on request) provides additional evidence consistent with this: while non-affiliates saw their ROA drop by an average of almost 1% during the 1992-95 demand shock, the equivalent drop for affiliate suppliers was only one tenth of that amount; moreover,

affiliated suppliers' profits are less correlated with assemblers' sales revenues than are those of non-affiliates.

[27] 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.

[28] 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)

[29] In this sense one might view Carlton's supply assurance model as the inverse of Williamson's hostage model: in Williamson's (1988) model, in the absence of an appropriate hostage, the buyer fails to make good on contractual commitments in low demand states; in Carlton's (1979) model it is suppliers who "renege" in high demand states, albeit that, in the latter case, delivery is delayed, rather than cancelled.

[30] In addition, absent the hostage-based credible commitment implied by the holding of an equity stake (however small) in the supplier, it is not clear why "powerful" Japanese assemblers would honor commitments to accept delivery at the contracted price in all demand states. This issue is also relevant to our discussion of Kawasaki and McMillan's (1987) agency model, above.

[31] Empirically testing Carlton's (1979) model in our empirical context is difficult, since the models' predictions speak to relative movements in long-term contract and spot market prices and we unfortunately do not observe prices in our data. However, if we interpret the observed demand shock as a reduction in long term demand (which is how it appears to have been seen by industry participants), then Carlton's (1979b) model implies a relative reduction in LT prices, i.e. an increase in the price discount associated with long-term contracts. Our empirical observation that revenues of affiliated suppliers fell by *less* than those of non-affiliates during the shock appears to be at odds with this prediction.

[32] Novak and Stern (2007) 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 cutting-edge technological capabilities, but internal transactions providing greater incentives for ongoing improvement and adaptation.

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Figure 1

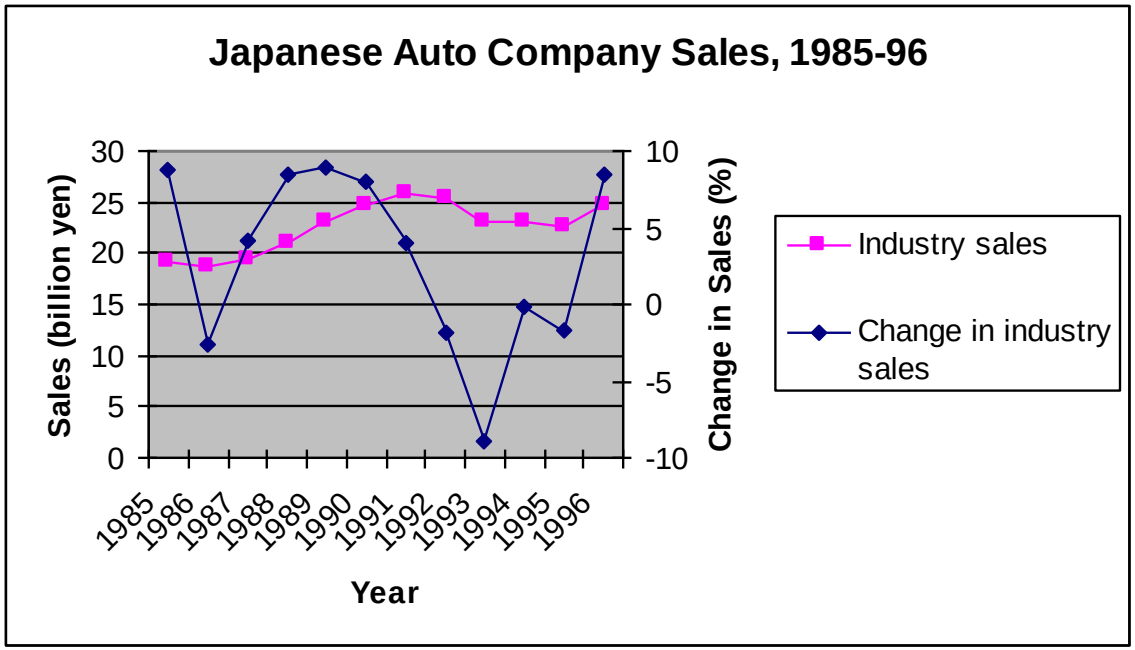
Japanese Auto Company Sales, 1985-96
Sales (billion yen)
30
25
20
15
10
5
0
10
5
0
-5
-10
Change in Sales (%)
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
Year
Industry sales
Change in industry sales

Table 1: Assemblers' Equity Holdings in Suppliers (1987)

Assembler	1. Number of suppliers in our sample	2. % of suppliers for which assembler is a top 10 shareholder	3. Median equity stake, % (dyads with ties only)	4. Range of equity stakes, % (dyads with ties only)
Toyota	59	49	8.6	1.3 – 35.4
Nissan	57	49	13.8	1.5 - 43.1
Honda	49	14	4.7	2.5 – 40.8
Mitsubishi	57	12	3.6	1.7 – 9.5
Mazda	55	5	2.9	2.6-4.7
Isuzu	56	16	6.0	3.0 – 33.9
Suzuki	51	2	3.0	3.0 – 3.0
Fuji	49	4	1.9	1.8 – 2.1
Daihatsu	46	4	6.9	2.9 – 10.8
Hino	36	11	2.2	1.1 – 29.2
Nissan Diesel	43	2	9.5	9.5-9.5

Table 2: Average Annual Sales and Return on Assets (ROA) for Assemblers and their Suppliers, 1984-96

	Assemblers		Affiliated Suppliers		Unaffiliated Suppliers	
	Mean Sales Y billions (std dev)	**Mean ROA % (std dev)**	**Mean Sales Y billions (std dev)**	**Mean ROA % (std dev)**	**Mean Sales Y billions (std dev)**	**Mean ROA % (std dev)**
Toyota	7,711	4.6	165	4.3	318	4.3
	(1,131)	(2.0)	(221)	(2.6)	(720)	(3.0)
Nissan	3,719	1.3	117	4.0	585	4.0
	(287)	(1.4)	(77)	(2.7)	(1013)	(2.5)
Honda	2,536	3.1	58	4.8	385	4.3
	(276)	(1.4)	(43)	(2.5)	(830)	(2.7)
Mitsubishi	2,148	1.3	56	3.8	332	4.2
	(460)	(0.4)	(38)	(2.4)	(692)	(2.6)
Mazda	1,783	0.8	46	6.5	309	4.1
	(314)	(2.3)	(23)	(2.7)	(581)	(2.4)
Isuzu	1,082	0.4	137	3.5	498	4.3
	(133)	(2.6)	(202)	(2.4)	(788)	(2.5)
Suzuki	918	1.5	51	2.5	313	4.2
	(183)	(0.2)	(5)	(1.9)	(639)	(2.8)
Fuji	752	0.4	44	2.7	396	4.2
	(71)	(3.4)	(22)	(1.2)	(823)	(3.0)
Daihatsu	679	1.3	56	4.6	308	4.2
	(99)	(0.8)	(39)	(2.9)	(618)	(2.5)
Hino	537	3.5	71	3.9	236	4.2
	(97)	(1.5)	(29)	(2.9)	(283)	(2.5)
Nissan Diesel	318	0.5	22	2.5	278	4.3
	(51)	(0.1)	(5)	(1.3)	(610)	(2.6)
Total Industry Sales	22,200	n/a				
	(2,701)					

Note: Observation is supplier-year. Unaffiliated suppliers are those suppliers that sell to the assembler in question, but in which the assembler does not hold equity.

Table 3a: Descriptive Statistics - Suppliers

All Suppliers (n=1563)*	Mean	SD	Range
Log Sales	11.477	1.326	8.293 to 15.423
ROA	0.041	0.029	-0.073 to 0.199
MFG Difficulty	1.911	0.591	1 to 3
# Parts	1.986	1.942	1 to 15.583
Log of age in 1990	3.121	0.537	0.693 to 4.407
Debt/Equity	2.546	3.371	-7.976 to 59.443
Dependence	0.563	0.303	0.122 to 1
% output sold to Toyota	0.215	0.301	0 to 1
% output sold to Nissan	0.177	0.285	0 to 1
% output sold to Honda	0.094	0.204	0 to 1
% output sold to Mitsubishi	0.104	0.203	0 to 1
% output sold to Mazda	0.090	0.191	0 to 1
% output sold to Isuzu	0.090	0.218	0 to 1
% output sold to Suzuki	0.066	0.163	0 to 1
% output sold to Fuji	0.060	0.154	0 to 1
% output sold to Daihatsu	0.049	0.137	0 to 1
% output sold to Hino	0.019	0.095	0 to 1
% output sold to Nissan Diesel	0.035	0.145	0 to 1

* Observation is supplier-year

Table 3b: Descriptive Statistics – Affiliate versus Non-Affiliate Suppliers

	Affiliates (EQUITY=1) N=75	Non-Affiliates (EQUITY=0) N=57	Difference in Means	T Statistic (H_o:diff=0)
Log Sales	11.073	11.832	-0.759	-3.170**
	(0.114)	(0.211)	(0.239)	
ROA	0.042	0. 044	-0.002	-0.664
	(0.002)	(0.003)	(0.004)	
MFG Difficulty	1.883	1.954	-0.070	-0.680
	(0.069)	(0.076)	(0.103)	
# Parts	2.185	1.368	0.818	3.143**
	(0.246)	(0.083)	(0.260)	
Debt/Equity	2.458	2.827	-0.369	-0.859
	(0.230)	(0.363)	(0.430)	
Dependence	0.551	0.629	-0.078	-1.513
	(0.032)	(0.042)	(0.052)	
Age in 1990 (Log)	3.085	3.159	-0.074	-0.798
	(0.058)	(0.074)	(0.092)	

- Observation is supplier_i with variables averaged over entire sample period (1984-1996)
- Standard errors in parentheses; t-statistic is based on assumption of either equal or unequal variance, depending on results of equality of variance test

$^{\dagger}p<.10$; $^{*}p < .05$; $^{**}p< .01$, $^{***}p<.001$

Table 4: Effect of Demand Shock on Supplier Revenues (H1)

Fixed Effects Panel Regression on Suppliers, 1984-1996

	LOG SUPPLIER SALES			
	(1)	(2)	(3)	(4)
Demand Shock (1=1992-1995)	-.064*** (.013)		-.068*** (.013)	
Shock * Equity	0.029* (.015)	0.028* (.012)	.032* (.015)	.046*** (.013)
Time trend	0.032*** (.001)		-.032*** (.001)	
Constant	8.61*** (.108)	11.57*** (.010)	8.89*** (.114)	11.51*** (.222)
Supplier Fixed Effects	Y	Y	Y	Y
Year Fixed Effects		Y		Y
Assembler Effects			Y	Y
Assembler*Shock Effects				Y
N	1563	1563	1563	1563
F (d.f.)	293.06*** (3,1428)	164.46*** (13,1418)	64.83*** (14,1417)	67.57*** (35,1396)

Standard errors in parentheses; †p<0.10; *p <0 .05; **p<0 .01, ***p<0.001

Table 5a: Sensitivity to Changes in Assembler Sales: All Dyads (H2)

Fixed Effects Panel Regression on Supplier-Assembler Dyads, 1984-1996

	LOG SUPPLIER SALES			
	(5)	(6)	(7)	(8)
Log Assembler Sales	0.025* (.012)	0.030* (.013)	0.440*** (.012)	0.017 (.010)
Log Assembler Sales * Equity	0.144*** (.022)	0.125*** (.023)	0.189*** (.027)	0.075*** (.018)
Demand Shock			-0.031*** (.004)	
Shock * Equity		0.021** (.006)	0.030*** (.008)	0.016** (.005)
Mfg Difficulty				0.005 (.007)
# Parts				0.019*** (.002)
Dependence				-0.017 (.015)
Size (Log Assets)				0.479*** (.008)
Debt/Equity				-.001* (.001)
Time trend			0.017*** (.001)	
Constant	11.04*** (.182)	11.02*** (.182)	3.43*** (.138)	5.63*** (.175)
Dyad Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y		Y
N	7489	7489	7489	7489
F (d.f.)	928.77*** (14,6795)	868.86*** (15,6794)	1480.66*** (5,6804)	1160.92*** (20,6789)

Standard errors in parentheses; †p<0.10; *p < 0.05; **p<0 .01, ***p<0.001

Table 5b: Individual Assembler Regressions

Fixed Effects Panel Regression on Supplier-Assembler Dyads, 1984-1996

	LOG SUPPLIER SALES				
	(9) TOYOTA	(10) NISSAN	(11) HONDA	(12) MITSUBISHI	(13) MAZDA
Log Assembler Sales * Equity	0.276*** (.046)	0.121 (.087)	0.342** (.104)	0.052 (.051)	0.185† (.102)
Shock * Equity	0.045** (.014)	0.023† (.013)	0.090*** (.023)	0.017 (.022)	0.148*** (.035)
Constant	9.39*** (.374)	11.02*** (.616)	11.05*** (.215)	11.62*** (.102)	11.72*** (.070)
Supplier Fixed Effects	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y
N	780	771	638	777	736
# of suppliers	66	71	58	73	65
F (d.f.)	2650*** (65,700)	2263*** (70,686)	1895*** (57,566)	2327*** (72,690)	1938*** (64,657)

Standard errors in parentheses; †p<0.10; *p < 0.05; **p<0 .01, ***p<0.001

Table 6: Sensitivity of Supplier ROA to Own Revenue (H3)

Fixed Effects Panel Regression on Suppliers, 1984-1996

	SUPPLIER ROA		
	(14)	(15)	(16)
Log Supplier Sales	0.058*** (.005)	0.056*** (.005)	0.101*** (.006)
Log Supplier Sales * Equity	-0.026*** (.005)	-0.034*** (.006)	-0.016* (.006)
Demand Shock		-0.010*** (.002)	
Shock * Equity		0.007** (.002)	0.007*** (.002)
Mfg Difficulty			0.001 (.003)
# Parts			-0.005*** (.001)
Dependence			0.007 (.005)
Size (Log Assets)			-0.064*** (.005)
Debt/Equity			-0.001** (.000)
Time trend		-0.003*** (.000)	
Constant	-0.470*** (.052)	-0.123** (.036)	-0.285*** (.051)
Supplier Fixed Effects	Y	Y	Y
Year Fixed Effects	Y		Y
N	1563	1563	1563
F (d.f.)	41.08*** (14,1417)	94.11*** (5,1426)	45.70*** (20,1411)

Standard errors in parentheses; †p<0.10; *p <0.05; **p<0.01, ***p<0.001

Table 7: Exploring Theoretical Alternatives – Supplier Capabilities

Fixed Effects Panel Regression on Suppliers, 1984-1996

	LOG SUPPLIER SALES			
	(17)	(18)	(19)	(20)
Shock * Equity	0.030** (.012)	0.024† (.013)	0.033* (.013)	0.019 (.014)
Shock * Mfg Difficulty	-0.020† (.010)			-0.023* (.011)
Shock * # Parts		0.008* (.015)		0.009* (.004)
Shock * Size			0.003 (.005)	-0.002 (.005)
Constant	11.65*** (.196)	11.67*** (.196)	11.65*** (.198)	11.66*** (.197)
Supplier Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Assembler Effects	Y	Y	Y	Y
n	1563	1563	1563	1563
F (d.f.)	86.63*** (25,1406)	86.75*** (25,1408)	86.31*** (25,1406)	80.65*** (27,1404)

Standard errors in parentheses; †p<0.10; *p <0.05; **p< 0.01, ***p<0.001

Table 8: Exploring Theoretical Alternatives - Average Performance Differences

Random Effects Panel Regression on Suppliers, 1984-1996

	(21) LOG SUPPLIER SALES	(22) ROA
Equity	-.736*** (.215)	.003 (.004)
Log Sales		.004** (.001)
Mfg Difficulty	-.566** (.019)	.001 (.002)
# Parts	.029*** (.007)	-.002* (.001)
Dependence	.062 (.038)	.003 (.004)
Debt/Equity	.000 (.001)	-.001*** (.000)
Age	.320† (.189)	-.010** (.003)
Constant	11.17*** (.650)	.085* (.038)
Assembler Effects	Y	Y
Year Fixed Effects	Y	Y
n (no of clusters)	1563 (132)	1563 (132)
Chi-square (d.f.)	2167.66 (29)	505.43 (30)

Robust standard errors with clustering on suppliers

Standard errors in parentheses; †p<0.10;*p < 0.05; **p< 0.01, ***p<0.001