Specialized Supplier Networks as a Source of Competitive Advantage: Evidence from the Auto Industry

Author(s): Jeffrey H. Dyer

Source: *Strategic Management Journal*, Apr., 1996, Vol. 17, No. 4 (Apr., 1996), pp. 271-291

Published by: Wiley

Stable URL: https://www.jstor.org/stable/2486951

Strategic Management Journal, Vol. 17, 271–291 (1996)

SPECIALIZED SUPPLIER NETWORKS AS A SOURCE OF COMPETITIVE ADVANTAGE: EVIDENCE FROM THE AUTO INDUSTRY

JEFFREY H. DYER
The Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania, U.S.A.

This study examines the relationship between interfirm asset specificity and performance in the auto industry. More specifically, I examine the extent to which differences in supplier–automaker asset specialization may explain performance differences between Japanese automakers (Nissan and Toyota) and U.S. automakers (Chrysler, Ford, General Motors). The findings indicate a positive relationship between supplier–automaker specialization and performance. In particular, the data suggest a positive relationship between interfirm human asset cospecialization and both quality and new model cycle time. Moreover, site specialization is found to be positively associated with lower inventory costs. The findings suggest that in the auto industry a tightly integrated production network characterized by proximity and a high level of human cospecialization will outperform a loosely integrated production network characterized by low levels of interfirm specialization.

INTRODUCTION

The strategy field is fundamentally concerned with explaining differential firm performance. Indeed, understanding why some firms succeed while others fail is perhaps the central question in strategy. Proponents of the resource-based view (RBV) of the firm have argued that differential firm performance is fundamentally due to firm heterogeneity (Rumelt, 1984, 1991; Wernerfelt, 1984). Firms that are able to accumulate resources and capabilities that are valuable, non-substitutable, and difficult to imitate will achieve a competitive advantage over competing firms (Barney, 1991; Dierickx and Cool, 1989). By definition, then, firms must do something specialized or unique in order to develop a competitive advantage. As Amit and Schoemaker (1993: 39) argue, the specialization of assets is 'a necessary condition for rent' and 'strategic assets by their very nature are specialized'.

Along a similar vein, economists have long recognized that 'resource owners increase productivity through cooperative specialization' (Alchian and Demsetz, 1972: 777). In advanced modern economies the value chain has become characterized by interfirm specialization such that individual firms engage in a narrow range of activities which are embedded in a complex chain of input–output relations with other firms. Productivity gains in the value chain are possible when firms are willing to make transaction-specific investments (Williamson, 1985). As Perry (1989: 213) notes: 'Gains from trade are enhanced by investments in assets which are specialized to their exchange'. This suggests that transactors (not just individual firms) who make specialized investments may realize an advantage over competing transactors who forego specialized investments. Thus, *interfirm specialization* may be a source of relational quasi rents and competitive advantage.

This line of argument suggests that creating valuable and nonimitable specialized assets is a fundamental challenge for firms—both individually and *in combination with other firms*. It also

Key words: suppliers; networks; asset specificity; competitive advantage

CCC 0143–2095/96/040271–21

Received 15 April 1994
Final revision received 5 July 1995

suggests a fundamental challenge for RBV strategy researchers who must attempt to identify and measure those unique *intra-* and *inter*firm resources and assets that lead to high performance. Unfortunately, to date few empirical studies have attempted to identify and measure those specialized assets that lead to high performance.[1] A primary reason for the lack of empirical work is that measuring 'asset specificity' has proved to be extremely difficult and most empirical studies have used subjective measures (Monteverde and Teece, 1982; Walker and Weber, 1984; Masten, 1984; Parkhe, 1993). For example, Parkhe (1993) finds a positive relationship between 'nonrecoverable investments' and performance in a sample of strategic alliances; however, there is no exploration of what the investments are or how they lead to high performance. Thus, the results are of limited value.

To further the empirical exploration of firm-specific resources and capabilities that influence performance, I propose that an important dimension on which firms differ is the extent of interfirm (production network) specialization.[2] The performance of a firm is linked to the extent to which the firm and its suppliers make site, physical, and human asset-specific investments. In particular, *firms may realize a competitive advantage when they develop a tightly integrated production network characterized by a high degree of interfirm specialization.*[3] This paper examines the relationship between supplier–assembler asset specialization and performance in the automobile industry. More specifically, I examine the extent to which differences in interfirm asset specialization may explain performance differences between Japanese automakers and their suppliers, and U.S. automakers and their suppliers.

[1] In fact, a central criticsm of the RBV is the difficulty in identifying and measuring firm-specific factors which result in high performance. Indeed, it has been suggested that if factors that produce economic rents are observable and identifiable, then they cease to be sources of competitive advantage (See Conner, 1991; Godfrey and Mitchell, 1994).

[2] A firm selling to an end market is essentially the culmination of a production network or value chain. For example, Toyota manages a production network which produces the inputs to an automobile. Some of these inputs are produced internally but most are produced by external suppliers. Thus, the performance of a firm (Toyota) is a function of (or reflective of) the performance of a production network (Toyota and its supplier group).

[3] This proposition is contingent on the industry environment and final product characteristics. The conditions under which this proposition is likely to hold are discussed in the following section.

THEORETICAL PERSPECTIVES ON ASSET SPECIFICITY AND PERFORMANCE

There is considerable theoretical (and some empirical) support for the assertion that performance is enhanced through investments in specialized assets (Alchian and Demsetz, 1972; Klein, Crawford, and Alchian, 1978; Williamson, 1985; Asanuma, 1989; North, 1990; Dyer and Ouchi, 1993). In particular, as Schoemaker and Amit (1994: 28) argue, rent-producing assets by their very nature are specialized:

> By converting *general assets* (such as money, raw materials, commodities, general people skills) into *specific assets* and capabilities, firms attempt to obtain economic rents . . . If a firm does not convert its general assets (such as labor, capital, technology) into specific assets, stockholders will rightly ask why the firm controls these assets. The firm's added value stems from the conversion of general into specific assets.

Moreover, a firm may choose to seek efficiency advantages by creating assets which are specialized in conjunction with the assets of a trading partner. As Sako (1992: 36) observes, '*inter-firm* X-efficiency is about the efficiency of a pair of trading partners put together'. We might think of these *co*specialized or relation-specific assets as the vehicle through which trading partners are able to generate *relational quasi rents* (Aoki, 1988).[4]

However, as recognized in transaction cost economics (TCE), increased specialization within a production network cannot be achieved without a cost. Although investments in specialization boost productivity, the incentive to make transaction-specific investments is tempered by the fact that the more specialized a resource becomes, the lower its value in alternative uses. The contingent value of a specialized resource exposes its owner to a greater risk of opportunism than the owner of a generalized resource (Klein *et al.*, 1978).

[4] Peteraf (1994: 155) defines quasi rents as 'returns that exceed a factor's short run opportunity cost . . . quasi rents are an excess over the returns to a factor in its next best use'.

According to the TCE perspective, if transactors make transaction-specific investments, then they must safeguard against the hazards of opportunism. The TCE paradigm, which is rooted in legal centralism, suggests that dispute resolution requires access to a third party enforcer, whether it be the state (i.e., through contracts) or a legitimate organization authority (Williamson, 1991). However, although contracts are viewed as the primary means for safeguarding transactions in western economies, alternative means have been offered by scholars from various fields. These 'self-enforcing agreements' include informal safeguards, such as *relational or goodwill trust* (Dore, 1983; Sako, 1991) and *reputation* (Weigelt and Camerer, 1988), as well as formal safeguards such as *financial and investment hostages* (Klein, 1980; Williamson, 1985). Further, some scholars have argued that self-enforcing safeguards (i.e., relational trust) are a more effective and less costly means of safeguarding specialized investments (Sako, 1991; Smitka, 1991; Hill, 1995). In particular, Japanese transactors are believed to incur lower transaction costs than U.S. transactors because they have developed an institutional environment which fosters relational trust (Sako, 1991; Hill, 1995). States Hill (1995: 129): 'The informal constraints of Japanese society have lowered the transaction costs of adopting economically efficient organizational arrangements'. Following North (1990), one can argue that the institutional structure of a society can either raise or lower the transaction costs that must be borne to achieve a given level of specialization. Thus, the ability to employ specialized assets as a source of advantage is contingent on the costs associated with safeguarding those investments.

Furthermore, the value of specialized investments will vary according to the task environment, notably the degree of task interdependence. Interdependence refers to 'the extent to which the items or elements upon which work is performed or the work processes themselves are interrelated so that changes in the state of one element affect the state of the other' (Scott, 1981: 211). The need for coordination increases with an increase in transactor interdependence, notably reciprocal interdependence[5] (Thompson, 1967; Alchian and Demsetz, 1972). The higher the degree of interdependence, the more resources (i.e., specialized assets) must be devoted to coordination (Thompson, 1967; Scott, 1981). Within this context, 'mutual adjustment and effective coordination' are 'important to achieve a higher performance system' (Scott, 1981: 212). Thus, in industries where the problem of coordination is particularly acute, the benefits of specialization are likely to be greater.

In summary, we propose a positive relationship between investments in interfirm asset specialization and the performance of the production network.[6] However, transaction-specific investments are more likely to result in competitive advantage when: (1) transactors have developed safeguards which can control opportunism at relatively low cost (such that the gains from specialization are not outweighed by the costs); and (2) task activities are characterized by a high degree of interdependence.

HYPOTHESES

Williamson (1979) identified three types of asset specificity: site, physical, and human asset specificity. *Site specificity* refers to the situation whereby successive production stages that are immobile in nature are located in close proximity to one another to improve coordination and economize on inventory and transportation costs. *Physical asset specificity* refers to transaction-specific capital investments (e.g., in customized machinery, tools, dies). Physical asset specialization allows for product differentiation and may improve quality by increasing product integrity (fit). *Human asset specificity* refers to transaction-specific know-how accumulated by transactors through long-standing transactor relationships (e.g., dedicated supplier engineers who learn the systems, procedures, and individuals that are idiosyncratic to the buyer). Human cospecialization increases as transactors develop experience working

[5] 'Reciprocal interdependence requires the use of mutual adjustment or coordination by feedback, in which the interrelated parties must communicate their own requirements and be responsive to the needs of the other group ... (for example, design decisions regarding the weight and thrust of a jet engine and the aerodynamic design of the fuselage and wings must be made taking each other into account)' (Scott, 1981: 212–213).

[6] Throughout the remainder of the paper we assume an industry environment in which task activities are characterized by a high degree of reciprocal interdependence.

together and accumulate specialized information, language, and know-how that allows them to communicate efficiently and effectively.

Each type of transaction-specific investment is likely to have differential effects on performance. For example, site-specific investments economize on inventory and transportation costs but may have little direct effect on quality. On the other hand, investments in human specificity (e.g., dedicated engineers) are not likely to economize on inventory or transportation costs, but could have a substantial impact on increasing quality and reducing new model cycle times. We chose to examine the relationship between site, physical, and human asset specificity and four performance measures: quality, speed of new product development, inventory costs, and profitability. These particular performance measures were chosen because: (1) each of these measures of performance had a direct theoretical link to asset specificity (Williamson, 1985; Schonberger, 1982; Clark and Fujimoto, 1991; Stalk and Hout, 1990), (2) each performance measure was viewed as important in the strategy field and management literature (Dean and Bowen, 1994; Stalk and Hout, 1990), and (3) objective data were available for each performance measure that was comparable across suppliers/automakers. The specific propositions regarding how site, physical, and human asset specific investments influence quality, speed to market, inventory costs, and profitability are as follows.

Asset specificity and quality

'The most pervasive definition of quality currently in use is the extent to which a product or service meets and/or exceeds a customer's expectations' (Reeves and Bednar, 1994: 423). Products that meet customer quality expectations are characterized by design quality (designs which incorporate the needs of customers and produce an effective interface among components) and conformance quality (produced parts conform to specifications) (Juran, 1989; Clark and Fujimoto, 1991). Studies have shown that quality increases when there is:

1. less variation in organizational processes; when there are fewer suppliers (Anderson, Rungtasanatham, and Schroeder, 1994; Deming, 1986);
2. an increase in the speed of feedback and reliability of data both within and across firms in the production network (Juran, 1989; Dean and Bowen, 1994); and
3. effective collaboration between functions and 'between customers and suppliers' (Dean and Bowen, 1994; Womack, Jones, and Roos, 1990).

A key way to reduce variation, increase the reliability of feedback, and improve collaboration is to increase human cospecialization between supplier and customer. Previous studies suggest that effective coordination in design and manufacturing can enhance quality (Clark and Fujimoto, 1991). In particular, when supplier and buyer engineers develop relation-specific know-how and have substantial experience working together they are less likely to misread blueprints or misinterpret information (Nishiguchi, 1994; Clark and Fujimoto, 1991). As human cospecialization increases, the feedback loop becomes more efficient. Fewer communication errors and more effective feedback, in turn, results in higher quality. Further, human cospecialization increases the absorptive capacity (Cohen and Levinthal, 1990) of the supplier–automaker dyad, thereby increasing the ability of both parties to learn from prior experience. Thus, suppliers and automakers are better able to improve quality because 'prior related knowledge confers an ability to recognize the value of new information, assimilate it, and apply it' (Cohen and Levinthal, 1990: 128). The more transactors share information regarding the factors that influence quality (i.e., learn from prior cumulative experience) the higher the expected quality.

Hypothesis 1: The greater the interfirm human asset cospecialization, the higher the product quality (fewer defects).

Some researchers have argued that products achieve high reliability when there is a high degree of product 'integrity' or 'fit' (Clark and Fujimoto, 1991; Rommel, Kempis, and Kaas, 1994). For example, Rommel *et al.* (1990: 58) found that in the auto industry 70 percent of product defects 'result from the design process (including insufficient consideration of customer wishes and poor product/process fit)'. Clark (1989) has argued that Japanese products achieve high integrity because suppliers are more willing (or are required) to make customized parts. Consequently, Japanese automakers achieve a higher level of quality than U.S. automakers because the final product is comprised of parts which have been customized to fit the vehicle rather than standardized parts which the final product is designed around. However, in order for suppliers to create customized parts, they must make investments in customized tools, dies, jigs, etc. Thus, we hypothesize as follows:

Hypothesis 2: The greater the interfirm physical asset specialization, the higher the product quality (fewer defects).[7]

Asset specificity and new model cycle time

The ability to develop new products rapidly is an important source of competitive advantage in many industries (Stalk and Hout, 1990). Historically car model sales (in units) have increased substantially in both the U.S.A. and Japan after a major model change (Clark and Fujimoto, 1991). Thus, automakers who are able to develop new models more quickly than competitors have an advantage because their current models are more advanced and include the latest in technology (Stalk and Hout, 1990; Clark and Fujimoto, 1991). Since the majority of automotive parts are produced by suppliers, the ability to develop new models quickly is expected to correlate strongly with the ability of automakers to coordinate design and manufacturing effectively with suppliers. Close linkages between design and manufacturing (both internally and with suppliers) are often credited for the relative success of Japanese firms in rapidly developing new products (Westney and Sakakibara, 1986; Clark and Fujimoto, 1991).

Williamson (1985: 54) has argued that a supplier who wins an initial contract will have an advantage in the next stage due to 'learning, including the acquisition of undisclosed or proprietary technical and managerial procedures and task-specific labor skills'. The acquisition of such knowledge allows the initial supplier to subsequently perform tasks more quickly than a supplier who must come up to speed and develop the requisite know-how. Further, a high level of interfirm human asset specificity translates into knowledge of who knows what, who can help with what problem, or who can exploit new information. It includes awareness of where useful expertise resides within the two firms engaging in exchange. In turn, this increases the speed with which organizations can solve the problems associated with new product development. Consequently, interfirm human asset cospecialization should facilitate the ability of automakers to develop new models rapidly.

Hypothesis 3: The greater the interfirm human asset cospecialization, the faster the new model cycle time.

Asset specificity and inventory costs

It has been suggested that transactors make site-specific investments in order to economize on inventory holding costs and transportation (Williamson, 1985). If so, then suppliers and automakers that make site-specific investments (e.g., locate their plants close to each other) should have lower buffer stocks and lower inventory costs than those that do not.

Hypothesis 4: The greater the interfirm site specificity, the lower the joint investment by suppliers and automakers in inventories.

Asset specificity and profitability

If relation-specific investments can increase quality, reduce new model cycle times, and minimize inventory costs, then these benefits should translate into higher profits. Consequently, we would expect the automaker (and its supplier group) with the highest asset specialization to realize the highest profits.

Hypothesis 5: As site, physical, and human

[7] The assumption of a high degree of reciprocal interdependence among components is especially critical to this hypothesis. Standardization of inputs may actually lead to higher conformance quality when there is a low level of interdependence among components. It is not unusual for conformance quality to increase the longer a part has been in production. However, conformance quality does not necessarily result in higher quality as perceived by customers who do not know or care about internal specifications. For example, an automaker may use standardized parts that have high conformance quality, yet the overall product (vehicle) still may not work well as a system and may not perform up to customer expectations. A part may meet specifications but not deliver what the customer perceives as high quality (Reeves and Bednar, 1994).

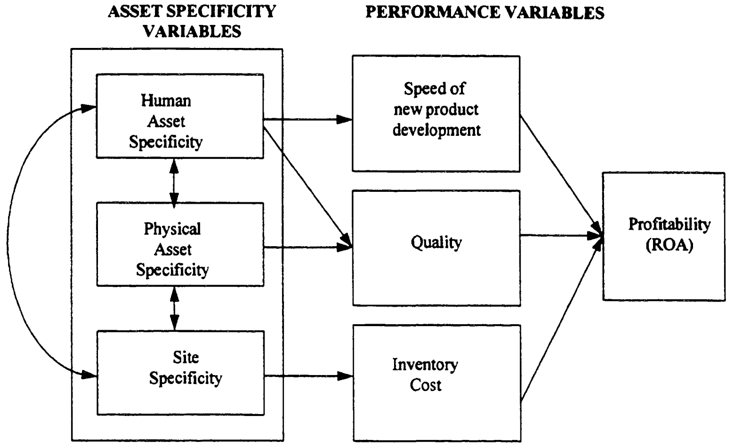


Figure 1. Model of hypothesized relationships among asset specificity and performance variables

asset specificity between an automaker and its suppliers increases, so does the combined profitability of the transactors (production network).[8]

Finally, we should note that site, human, and physical asset specificity are likely to be correlated. For example, site-specific investments which increase proximity are likely to increase interaction, thereby increasing human cospecialization (Enright, 1995; Saxenian, 1994). Further, some studies suggest that site specialization and just-in-time deliveries result in a higher level of physical asset specialization between transactors (Schonberger, 1982) which is also accompanied by greater human asset specificity (See Figure 1 for a model of the hypothesized relationships).

RESEARCH METHOD

Research setting

The auto industry was deemed an appropriate research setting for two primary reasons. First, the automobile industry is the largest in both countries and both the U.S. and Japan have more than one major producer. We can examine whether or not there are significant differences between firms from the same country (e.g., between Nissan and Toyota) as well as between countries (e.g., between Nissan and Ford).

Second, the automobile is a complex product with components that must work together as a system. Since each component is part of a larger system, mutual adjustment and coordination is required on the part of suppliers and automakers in order to produce a well-functioning vehicle. For example, designing an air-conditioning unit is not a stand-alone activity. Its efficiency is negatively correlated to fuel consumption, which also affects a catalytic converter's performance. Moreover, a larger passenger compartment and/or more glass requires a more powerful air conditioner if the same efficiency is to be maintained. Finally, design configurations must take into account dash-panel and front body geometric constraints. In short, this is an industry setting in which interfirm specialization is likely to be important because suppliers and automakers are reciprocally interdependent.

Sample and data collection

The sample consists of two Japanese automakers (Nissan and Toyota) and all three U.S. automakers and a sample of their suppliers. The unit of analysis is the supplier–automaker relationship. Each purchasing department general manager selected a sample of 50 domestic supplier relationships which included 25 of their closest relationships with outside suppliers (defined as 'supplier partners with whom you work most closely') and 25 of their 'most typical arms-length relationships' with outside suppliers (defined as

[8] It is important to recognize that these propositions hold true *ceteris paribus*. Of course, other factors (e.g., price, specific product attributes) influence performance as well. Even a highly cospecialized production network might still perform poorly—at least in financial terms—if it persisted in trying to sell overpriced and unattractive products.

'arms-length' or 'independent' suppliers).[9] This sampling method ensured that one automaker did not select a sample of only 'close' supplier relationships (with whom they presumably coordinate well and have made specialized investments) while another automaker chose a random sample or a sample biased towards arms-length suppliers (i.e., in Japan I wanted a sample of *keiretsu* as well as non-*keiretsu* suppliers).

I interviewed sales and engineering vice presidents at 50 suppliers (20 Japanese and 30 U.S.) during which a survey was developed and pretested. The survey was then sent to the supplier executive identified by the automaker purchasing department as most responsible for managing the day-to-day relationship. Usable responses were received from 36 Nissan suppliers (72% response rate), 38 Toyota suppliers (76% response rate), 31 Ford suppliers (62% response rate), 24 General Motors suppliers (48% response rate) and 23 Chrysler suppliers (46% response rate) with roughly equal response from 'arms-length' and 'partner' suppliers. In addition, the purchasing agent at the automaker most responsible for the supplier relationship was asked to complete a survey to provide the automaker perspective. Usable surveys were received from purchasing agents for 192 of the 250 suppliers.[10] On objective questions (e.g., distance between the supplier and automaker plant), suppliers and purchasing agents were asked the same question. In these instances, purchasing agent responses were used only if the supplier did not respond. Consequently, for some questions the response rate was as high as 48 out of 50 for a particular automaker.

OPERATIONAL MEASURES AND DATA ANALYSIS

Measures of specialized assets

Williamson (1985) describes site, physical, and human asset-specific investments as durable investments in support of particular transactions. Operational measures of each type have been included in this study.

Site specificity

Site specificity (SITE) was operationalized as the distance (miles) between the supplier plant (manufacturing the highest volume component) and the automaker's small and midsize passenger car plants. Greater site specificity is presumed when a supplier plant is located 50 miles from an automaker plant, compared to a supplier plant located 500 miles from an automaker plant.

Physical asset specificity

Physical asset specificity (PHYSICAL) was operationalized as the percentage of the supplier's total capital investments which would have to be scrapped if the supplier were prohibited from conducting any future business with the automaker. This percentage was estimated by supplier respondents. Physical asset specificity was assumed to increase with an increase in the percentage of capital investment which could not be redeployed. Since some suppliers sold the majority of their output to the automaker while others sold only a small percentage, an adjusted measure of physical asset specificity (PHYSICAL/SALES) was created to control for the volume of exchange between the supplier and automaker. This was done by dividing the percentage of total capital equipment which was not redeployable by the percentage of the supplier's total sales which went to that particular automaker. For example, if a supplier designated 25 percent of its investment as nonredeployable and 50 percent of its sales went to that automaker, the ratio of physical specificity to sales would be 0.25/0.50 or 0.50. This would be equivalent to the supplier with 12.5 percent of its capital investment designated as nonredeployable and 25 percent of its sales going to that particular automaker (0.125/0.25 = 0.50).

Human asset specificity

Supplier–automaker human asset cospecialization was operationalized in three ways:

1. The annual 'man days' that the supplier–automaker spent in face-to-face contact in

[9] In Japan, partner or affiliated suppliers are referred to as *kankei kaisha* (e.g., Nippondenso is a Toyota affiliate) and independent suppliers are referred to as *dokuritsu kaisha* (e.g., Bridgestone).

[10] One U.S. automaker decided to limit its participation in this part of the study and did not have purchasing agents fill out a survey for its 50 suppliers.

1991.[11] This construct (FACE) includes face-to-face contact between supplier sales and engineering personnel and automaker purchasing and engineering personnel. Days of contact was calculated by having the supplier's sales VP identify the number of sales people that worked directly with the particular automaker. Then, he or she indicated the average number of days per week that the typical salesperson would spend having a face-to-face meeting with automaker personnel. Engineering VPs provided the same information for engineers. The assumption behind this measure is that as the number of days of face-to-face contact increases, so does human asset specificity. Face-to-face communication has been described as having a high knowledge-carrying capacity because it presents immediate feedback opportunities and makes use of both visual and audio channels of communication (Daft and Lengel, 1986). To normalize for the volume of exchange between supplier and automaker, total man days of contact was divided by the supplier's sales (in millions of dollars) to the automaker (FACE/SALES). Thus, if one supplier had 1000 man days of face-to-face contact and $100 million in sales to the automaker, the ratio of days of contact to sales would be 1000/100 or 10. This would be equivalent to a supplier with 10 times the absolute face-to-face contact, or 10,000 man days of contact, and $1000 million in sales to the automaker (10,000/1000 or 10).

2. The average number of colocated or 'guest' engineers (GUEST). Greater human asset specialization is expected when more engineers are colocated and completely dedicated to a particular customer. Again, to normalize for the volume of exchange, the number of guest engineers was divided by the supplier's sales (in millions) to the automaker (GUEST/SALES).
3. Measures of information sharing were developed to measure the extent to which suppliers and automakers shared relevant task-related information.[12] In particular, the degree of information sharing between the supplier–automaker was operationalized by measuring the extent to which suppliers shared confidential information (TRUST) and information on their production costs (PCOST). Supplier respondents reported the extent to which they shared this type of information on a Likert scale (1 = Not at all, 7 = To a very great extent). In addition, supplier respondents indicated the extent to which they received information and assistance from the automaker to: lower production costs (COSTASST), improve quality (QUALASST), and improve delivery and inventory management (DELASST). An overall measure of information sharing was developed by averaging the scores on the five information-sharing questions (INFO.SHARE).

Measures of performance

The four performance measures used in this study were operationalized as follows:

1. *Quality*: The 3-year (1990–92) weight average defects (problems) per 100 vehicles as reported in J.D. Power & Associates New Car Initial Quality Studies.
2. *New model cycle time*: The average number of months between a major model change for each automaker's top selling models (in 1992 units) in five car sizes/classes (see Dyer, 1993: Appendix 3-A for a list of the models included).
3. *Inventory holding costs*: The buffer stock between an upstream supplier and downstream assembler is the sum of the supplier's finished goods and the assembler's raw materials inventory. Thus, supplier inventory costs were measured as the ratio of finished goods inventory to sales (average 1982–91) and automaker inventory costs were measured as the ratio of

[11] We would expect that the length of the supplier–automaker relationship would be important in operationalizing human asset specificity. However, we found no significant differences across automakers (in terms of length of supplier relationships) and thus chose to exclude it from our operationalization of interfirm human asset specificity.

[12] All face-to-face contacts are not of equal quality, which is why measures of information sharing were included in this study. A sample of U.S. suppliers who worked with both Japanese and U.S. automakers claimed that they spent considerably more of their face-to-face time with U.S. automakers on unproductive activities (e.g., bargaining and negotiating contracts) whereas face-to-face time spent with Japanese automakers was on productive activities (e.g., sharing technical information, problem solving; see Dyer, 1993).

raw materials to sales (average 1982–1991). Unfortunately, these data were only available for Nissan and Toyota and their suppliers. U.S. automakers and suppliers only report total inventories. Since more detailed data were not available, the ratio of total inventories to sales was used to compare inventory costs for the U.S. and Japanese firms.[13]

4. *Profitability*: Automaker profitability (AUTOROA) was measured as the 10-year average pretax return on assets from 1982 to 1991. Supplier profitability (SUPPROA) was measured as the 5-year average pretax ROA from 1988 to 1992.

Data analysis

One-tailed *t*-tests were used to test for differences in supplier–automaker asset specificity. For example, the site specificity (plant distance) supplier group mean for Toyota's suppliers was compared to the site specificity supplier group mean for each of the other automakers.

Testing for the relationship between asset specificity and performance was more problematic. Ideally, the relationship between the asset specificity (independent) variable and the performance (dependent) variable would have been tested by using a simple linear regression model. However, this was only possible when examining the relationship between site specificity (plant distance) and supplier inventory costs (H4). In this case both an asset specificity and performance measure were available for each supplier. Consequently, I had a large enough sample to meet the conditions for regression. Thus, we can regress the inventory/sales ratio (inventory costs) on plant distance.[14] However, the performance measures of quality and new model cycle time are for the automaker (production network) as a whole, not for each supplier. Thus, for the year (1991) the asset specificity data were gathered, I only have data on a sample of five automakers. One way to handle this problem would be to use multiple years of data to increase the sample size. However, I do not have multiple years of data for the asset specificity variables. Although I expect a high degree of stability in the asset specificity measures over time (e.g., plant distance is unlikely to change at all), the data are not available for multiple years. As a result, employing regression is not possible for testing Hypotheses 1–3. Thus, I opted for a more straightforward, albeit less rigorous, approach to analyzing and presenting the data. I simply plot the asset specificity and performance variable means for each automaker on a chart as though doing a linear regression. Since the performance data represent an average (mean) over multiple years, and since the asset specificity means are likely to be highly stable over multiple years, these charts are reflective of multiple years of data for each automaker. While not as powerful or rigorous as regression, these data approximate the plotted results of a regression using data from multiple years. I caution that these data are suggestive rather than definitive.

Finally, rank order correlation (Spearman's *r*) was used to test the relationship between site, physical, and human specificity and profitability (H5). Each supplier was ranked on each of the three specificity measures, which were then equally weighted to create an overall specialization rank for each supplier (SUPPSPEC). This overall specificity ranking was then correlated to automaker and supplier profitability using Spearman's *r*.

RESULTS

Differences in asset specificity by automaker

Table 1 presents the supplier group sample means for each automaker on the various asset specificity

[13] This appears to be a reasonably good proxy for interfirm inventories because an analysis of the ratio of finished goods to total inventories (for Japanese suppliers) and raw materials to total inventories (for Japanese automakers) revealed a consistent ratio. For example, Toyota's total inventory to sales ratio (from 1982 to 1991) was 2.3 percent, significantly lower than Nissan's at 5.1 percent. Toyota's raw materials as a percentage of total inventories was 0.17, while Nissan's was 0.19. Similarly, Toyota's work-in-process inventories as a percentage of total inventories was 0.20, while Nissan's was 0.21. Thus, the aggregate measure of inventories is considered a reasonable proxy for the relative difference in interfirm buffer stocks for each automaker.

[14] When I am able to use OLS regression (i.e., with supplier plant distance and supplier inventory costs) the statistical results confirm a significant relationship between the independent and dependent variables; I believe these results are suggestive of what we would find had it been possible to use regression analysis in testing each of the hypotheses.

Table 1. Comparison of sample means on asset specificity variables (by automaker)

Variable	Chrysler	Ford	Gen. Motors	Nissan	Toyota
SITE	543.9	508.8	427.0*	113.9†	59.2**
PHYSICAL	18.1%	19.5%	13.6%**	21.4%	21.2%
PHYSICAL/SALES	0.67	0.53	0.35**	0.55	0.53
FACE	756.9**	1206.2	1106.9	3344.2†	7235.8**
FACE/SALES	7.9	8.9	6.8**	9.9†	10.6**
GUEST	0.44	0.66*	0.17	1.8†	6.8**
GUEST/SALES	0.0044	0.0049	0.0011	0.0053	0.010**
TRUST	4.3*	3.6	2.6**	5.4†	6.1**
PCOST	4.1	4.5	4.0	5.3†	4.9†
COSTRASST	2.0	2.0	2.1	3.3†	3.3†
QUALASST	3.1	3.7*	2.2	3.5	3.7*
DELASST	2.8	2.2	1.9	2.8	3.8**
INFO.SHARE	3.2	3.2	2.6**	4.1†	4.4†

Tests of group differences are one-tailed *t*-tests assuming unequal variances.
** Significantly lower/higher than all other automakers ($p < 0.05$).
† Significantly lower/higher than all U.S. automakers only ($p < 0.05$).
* Significantly lower/higher than other U.S. automakers only ($p < 0.05$).

variables. The key differences are summarized below:

Site specificity: Toyota's supplier plants were located an average distance of 59.2 miles from Toyota assembly plants and therefore were most specialized. In contrast, 'Big Three' supplier plants were an average of roughly 500 miles from automaker plants. Nissan's suppliers were an average distance of 113.9 miles away—considerably farther than Toyota's but still much closer than U.S. automaker suppliers.

Physical asset specificity: Toyota and Nissan's suppliers indicated that approximately 21 percent of their capital equipment investments were not redeployable, compared with 19.5 percent for Ford suppliers, 17.7 percent for Chrysler suppliers, and 13.6 percent for GM suppliers. These results suggest slightly greater absolute physical asset specialization between Japanese automakers and suppliers, although there is no difference between Nissan and Toyota. When adjusted for the volume of transactions (PHYSICAL/SALES) between the supplier and automaker, we find that Chrysler's suppliers appeared to have the highest level of specificity per dollar of exchange (0.67), followed by Nissan (0.55), Toyota (0.53), Ford (0.53), and finally GM (0.35). Chrysler's relatively high score on the PHYSICAL/SALES measure may be partly attributed to the fact that Chrysler suppliers sold only 26 percent of their output to Chrysler, while other automaker's suppliers sold roughly 36–40 percent of their output to the automaker. It may be that suppliers need to make some minimum threshold of physical asset investment to service an automaker regardless of the volume of exchange.

Human asset specificity: Toyota and its suppliers had the highest level of human cospecialization on each of the human specificity variables. Toyota and its suppliers engaged in an average of 7236 man days of face-to-face contact each year. By comparison, Nissan engaged in 3344 man days of contact and U.S. automakers averaged 1025 man days (Chrysler 757, Ford 1206, GM 1107). When adjusted for sales volume, the differences between Japanese and U.S. automakers were smaller but still significant. In addition, Toyota's suppliers had an average number of 6.8 guest engineers compared with 1.8 for Nissan and less than one for each of the U.S. automakers. Even after adjusting for volume, Toyota employed twice the number of guest engineers as Nissan and the U.S. automakers.

Finally, on every measure of information sharing Toyota and Nissan exchanged more information with suppliers than did U.S. automakers.

The only exception was the Ford rating on providing quality assistance. Ford was rated equal to the Japanese automakers and significantly higher than Chrysler and GM. When asked about this finding, many U.S. suppliers reported that Ford had taken the lead in promoting quality within the U.S. supply base. The two significant differences between Toyota and Nissan were on sharing confidential information and delivery assistance. In both cases Toyota received a higher rating from suppliers than Nissan. It is also interesting to note that of the U.S. automakers Chrysler was most likely to be trusted with confidential iformation. Perhaps this is due to Chrysler's lower level of integration into parts production (since suppliers are less likely to compete with Chrysler parts divisions, they may be more willing to share key information).

In summary, on virtually every asset specificity measure, Japanese automakers and their suppliers were more specialized than their U.S. counterparts. Moreover, with regard to site and human asset specificity, Toyota's supplier group was more specialized than Nissan's supplier group.

Performance differences by automaker

Table 2 presents performance data for each of the automakers. The key findings are as follows:

Quality: Toyota's cars reportedly had the fewest defects per 100 vehicles (78.6), with Nissan second (110.6), Ford third (120.9), GM fourth (131.7) and Chrysler fifth (148.4).

New model cycle time: Toyota's new model cycle time was the shortest (50.0 months), followed by Nissan (51.4 months), Ford (77.7 months), Chrysler (80.7 months), and GM (86.5 months).

Inventory costs: Toyota had the lowest total inventory to sales ratio at 2.3 percent, followed by Nissan (5.1%), GM (8.1%), Ford (8.4%) and Chrysler (9.8%). Similarly, Toyota's suppliers had the lowest total inventory to sales ratios at 7.3 percent, followed by Nissan's suppliers (8.8%). U.S. suppliers had inventory to sales ratios of roughly 10–11 percent.

Profitability (ROA): Toyota had the highest average pretax ROA at 13.0 percent, followed by Nissan (5.5%), Ford (4.2%), Chrysler (4.1%) and GM (2.8%). Similarly, Toyota's suppliers had the highest weight average ROA at 7.1 percent, while GM's had the lowest at 4.8 percent—which was not significantly different from Ford or Chrysler's suppliers. Indeed, given that U.S. suppliers do not seem to be specialized to any particular automaker, we would not expect significant profit differences among the suppliers of U.S. automakers. In summary, Toyota and its suppliers have been more profitable than the other automakers and their suppliers. It is also interesting to note that Toyota receives a higher split of the combined profit pie.[15]

Asset specificity and automaker (production network) performance

Earlier we hypothesized (H1) a positive relationship between human asset specificity and quality.

[15] Assuming we weight automaker and supplier's value added equally, Toyota appears to get roughly 65 percent of the profit pie, while other automakers only get about 50 percent.

Table 2. Performance data by automaker

Variable	Chrysler	Ford	Gen. Motors	Nissan	Toyota
QUALITY†	148.4	120.9	131.7	110.6	78.6
CYCLE TIME (months)	80.7	77.7	86.5	51.4	50.0
AUTO. INVENTORY/SALES	9.8%	8.4%	8.1%	5.1%	2.3%
SUPPL. INVENTORY/SALES	10.7%	10.1%	11.2%	8.8%	7.3%
AUTOMAKER ROA	4.1%	4.2%	2.8%	5.5%	13.0%
SUPPLIERS ROA††	5.4%	5.5%	4.8%	5.6%	7.1%

† Defects per 100 vehicles (1990–92).
†† Supplier's pretax ROA is a weight average (by assets) of all suppliers.

Figure 2(a) plots the relationship between quality and the adjusted measure of face-to-face contact (FACE/SALES). These data suggest a positive relationship between face-to-face contact and quality. Toyota engages in more face-to-face contact with suppliers and also has significantly higher quality than Nissan, which in turn has more contact and higher quality than the U.S. makers. A similar relationship is found when plotting quality vs. guest engineers as well as the information-sharing variables. These data provide preliminary support for H1.

We also hypothesized (H2) a positive relationship between physical asset specificity and quality. Figure 2(b) plots the relationship between physical asset specificity and quality. Contrary to H2, the data do not suggest a relationship between physical asset specificity and quality.

The third hypothesis (H3) proposed a positive relationship between human asset specificity and new model cycle time. Figure 3 shows that new model cycle time appears to decrease as suppliers–automakers engage in more face-to-face contact. Thus, the data provide preliminary support for H3.

The relationship between plant distance and inventory holding costs (H4) is shown in Figure 4. Figure 4(a) plots supplier inventories as a

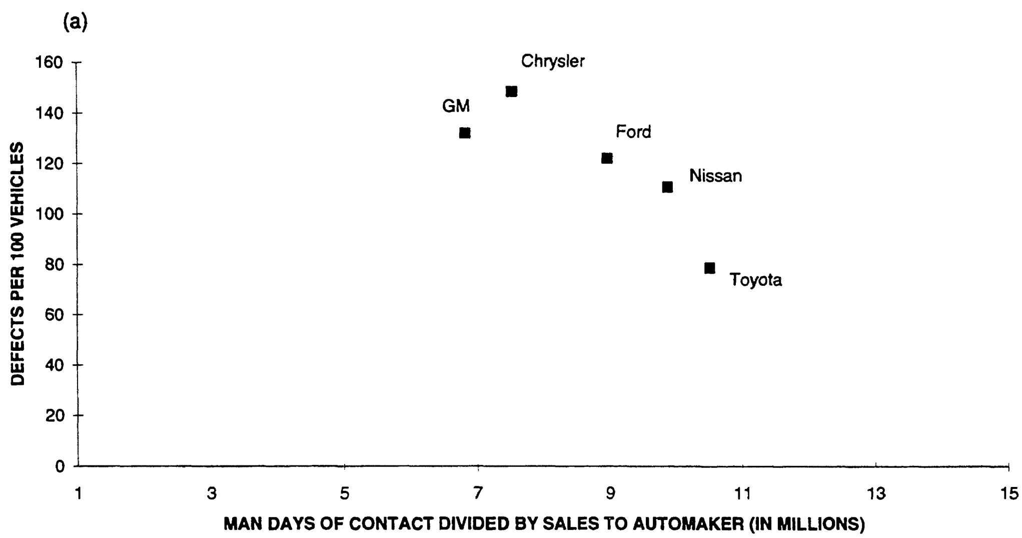


Figure 2(a). The relationship between face-to-face contact and quality

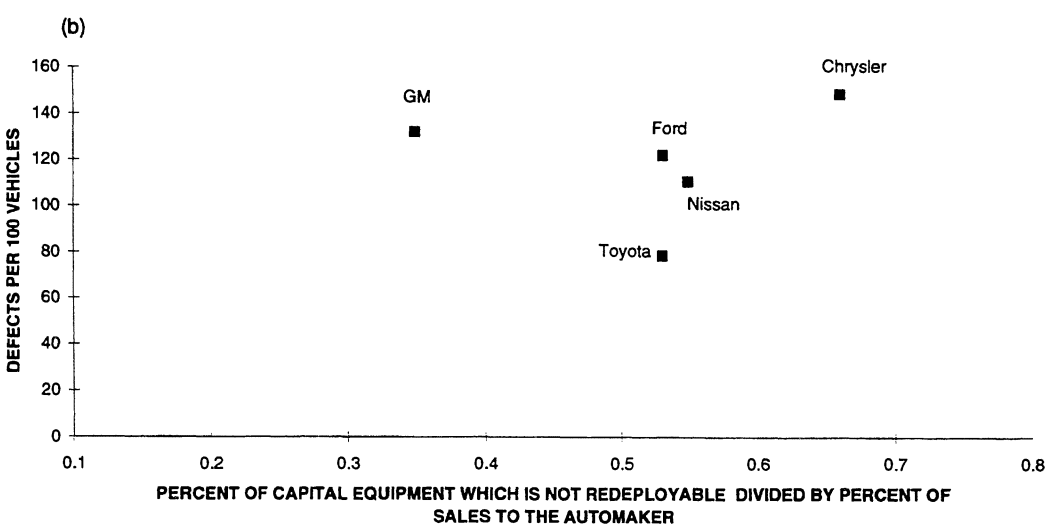


Figure 2(b). The relationship between physical asset specificity and quality

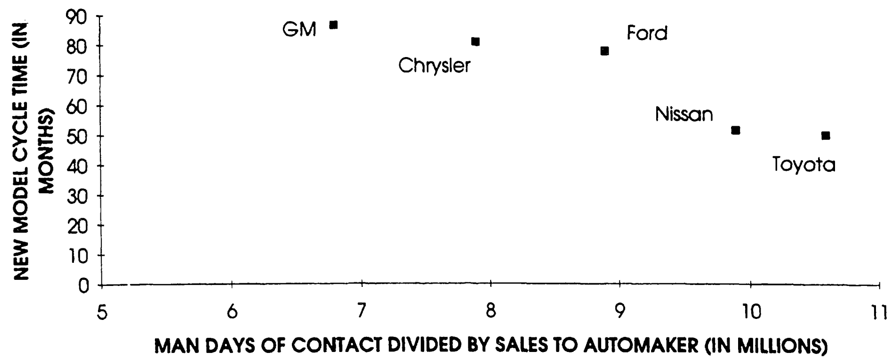


Figure 3. The relationship between face-to-face contact and new model cycle time

percentage of sales along with plant distance. The data suggest that as the plant distance between suppliers and automakers decreases, so do inventories. Also, since these data meet the conditions for regression analysis, we use simple linear regression to test the relationship between plant distance and inventory/sales (see bottom of Figure 4(a) for results). The regression shows an R^2 of 0.101 and an F-value of 8.28 which is significant at the 0.01 level.[16] Figure 4(b) plots plant distance and automaker inventories as a percentage of sales. These data indicate that automaker inventories also decrease as plant distance decreases. These data provide strong support for H4.

Finally, we hypothesized (H5) that as interfirm asset specificity increases, so does the combined profitability of the transactors (production network). Since there is no single measure of 'overall' asset specificity, we do not attempt to plot the relationship between asset specificity and profitability. However, Figure 5 shows supplier and automaker profitability. The rank order correlation shows a high correlation (0.55) between supplier specialization and automaker profitability (see bottom of Figure 5). However, the rank order correlation between supplier specialization and supplier profitability indicates that more specialized suppliers are not significantly more profitable than less specialized suppliers. Thus, it appears that automakers appropriate most of the gains from specialization.[17] Although these data provide preliminary support for H5, we caution that these results are from a small automaker sample.[18]

DISCUSSION

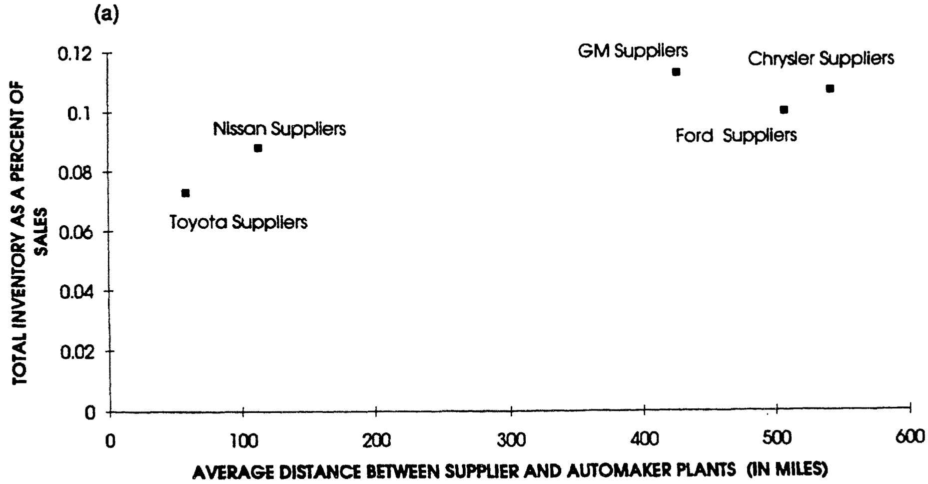
The findings from this study indicate that automakers are not homogeneous in the degree of supplier group specialization. Interestingly, while Japanese automakers and suppliers were more specialized than their U.S. counterparts, in many cases there were actually greater differences between Toyota and Nissan than there were between Ford, GM, and Chrysler. These data suggest that differences in asset specialization may be attributed to both firm-specific factors (e.g., to Toyota's management decisions regarding supplier–automaker cospecialization) as well as to country-specific factors (e.g., Japanese automakers have more specialized suppliers than U.S. automakers).

Although the data provide support for Hypotheses 1, 3, 4, and 5, it is important to note several

[16] The strength of the relationship between plant distance and inventory to sales is likely to be understated since suppliers who produce bulky products (i.e., where the cost of holding inventories is high) are more likely to locate their plants in close proximity to customer plants. If we had been able to control for the weight/size of the supplier's product, the correlation between plant distance and inventories would likely have been much stronger. Further, it is worth noting that the relationship is still significant ($p<0.01$) after controlling for country effects.

[17] Automakers are able to appropriate most of the specialization gains due to superior bargaining power (Porter, 1980). However, it is also worth noting that some studies have found that keiretsu suppliers have more stable earnings than independent suppliers (Gerlach, Lincoln, and Ahmadjian, 1992); thus, suppliers may trade some of the profit gains from specialization for stability of earnings.

[18] To test the robustness of these findings, we ran a separate rank order correlation between SUPPSPEC and automaker ROA for each year beginning with 1982. The results indicate a positive corrrelation in 9 of 10 years, with 5 being statistically significant at the $p<0.001$ level.



Results of Regression Analysis (Inventory/Sales vs. Plant Distance)

Variables	N	Mean	
Plant Distance	197	291.4	R-squared = 0.101
Invent./Sales	83	0.091	

Parameter Estimates

Parameters	Estimates	Std. Error	T test	Prob. > |T|
Intercept	0.081	0.005	15.1	0.0001
Plant Distance	0.000041	0.000014	2.88	0.0052

Figure 4(a). The relationship between plant distance and supplier inventory costs

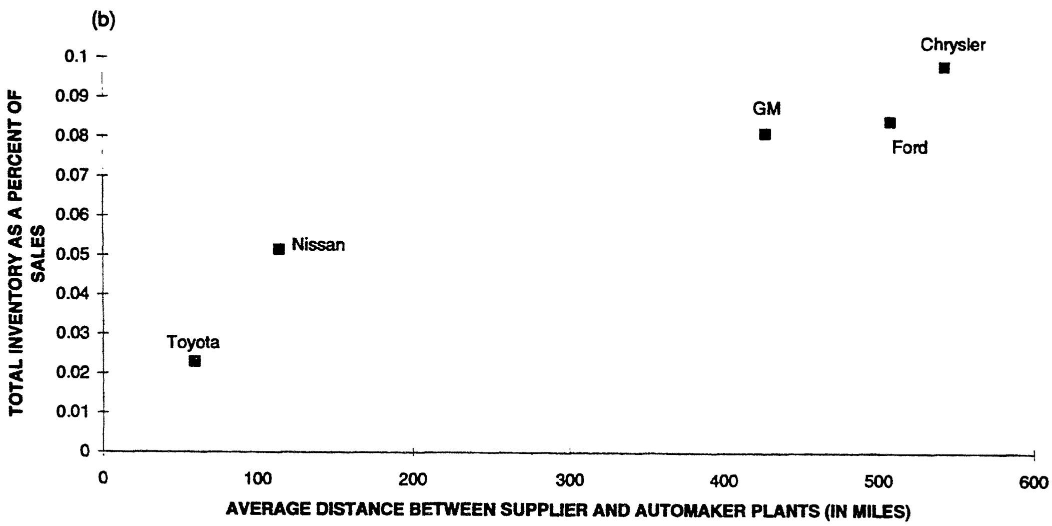
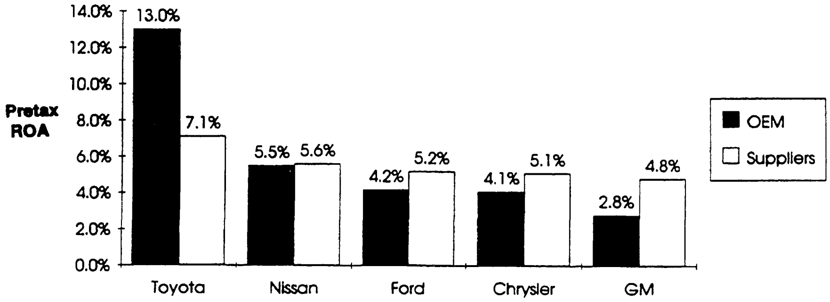


Figure 4(b). The relationship between plant distance and automaker inventory costs

limitations in this study. One is that this study focuses on a single industry. On the one hand, focusing on one industry allows us to control extraneous variation and create more accurate, context-specific measures. On the other hand, focus on a single industry limits generalizability. Readers should keep in mind potential limits to generalizability. Second, data limitations made it impossible to use regression analysis to test each of our hypotheses. While the findings from this study suggest a positive relationship between various types of asset specificity and performance,



RANK ORDER CORRELATION ANALYSIS

VARIABLE	N	MEAN
SUPPSPEC	129	78.3
SUPPROA	83	39.3
AUTOROA	129	2.9

SPEARMAN CORRELATION COEFFICIENTS:

	SUPPSPEC	SUPPROA	AUTOROA
SUPPSPEC	1.0		
SUPPROA	0.008 (.96)	1.0	
AUTOROA	0.563 (.0001)**	0.004 (.97)	1.0

** Significant at p<.001

Figure 5. Automaker and supplier profitability and asset specificity rankings

these findings should be interpreted cautiously.[19] Since each measure of asset specificity typically covaries with the other measures of asset specificity, we cannot be sure that they have direct causal relationships with the performance variables. In other words, while it appears that human asset specificity has a link to quality, it may be that there is another variable, (i.e., geographic proximity), which is influencing all the other relationships. Finally, since the sample did not control for differences in vertical integration, and since U.S. automakers are more vertically integrated than Japanese automakers (Cusumano, 1985), we might question whether the reported differences are simply a function of differences in vertical integration. Because in-house suppliers were not included in the sample (which presumably are the most specialized U.S. suppliers) and because U.S. automakers are more likely to use in-house suppliers, the reported differences might disappear if in-house divisions are included. To test this hypothesis, I compared a sample of vertically integrated divisions for the U.S. automakers with the partner suppliers of the Japanese automakers. The findings suggest that vertically integrated U.S. suppliers are more specialized than external U.S. suppliers, but still not as specialized as Japanese *kankei kaisha* or in-house divisions (see Table 3). Thus, it seems reasonable to assume that the reported differences are not simply a function of differences in vertical integration.

To further test the hypothesis that significant differences in supplier–automaker specialization exist, I examined the assembly plant configuration

[19] For simplicity, the data were presented as a bivariate relationship between the asset specificity and performance variables; however, it would be misleading to suggest that asset specificity is the only, or even the primary, factor that contributes to performance differences among automakers. Undoubtedly numerous other factors not captured in the model contribute to performance differences.

Table 3. Differences in supplier–automaker asset specificity (U.S. in-house divisions vs. Japanese partners and divisions)

	U.S. divisions $N=8$	Japanese partners $N=45$	Japanese divisions $N=7$
Site specificity			
SITE	275.6	41.1**	11.5**
Physical specificity			
PHYSICAL	30.8%	30.6%	N/A
PHYSICAL/SALES	0.34	0.50**	N/A
DELIVERY FREQUENCY†	7.7	32.4**	34.4**
Human specificity			
FACE	8723	7270	N/A
FACE/SALES	7.9	10.6**	N/A

** Significantly lower/higher than U.S. divisions ($p < 0.01$).
† Number of deliveries per week.
Note: This sample of U.S. divisions is from two U.S. automakers, four divisions from each. These divisions are very large, with average sales of roughly $2.1 billion; on average, 93.7 percent of those sales were to other internal divisions. The sample of Japanese divisions is from Nissan and Toyota but only selected data were available.

of each of the automakers. The findings indicate that Toyota's value chain is significantly different from that of competitors, notably more geographically concentrated. To illustrate the differences, the plant configurations of Toyota, Nissan, and GM (as of January 1992) are depicted in Figures 6, 7, and 8. Figure 6 indicates that Toyota's assembly plants in Japan are concentrated in Toyota City and every plant is located within 32 miles of Toyota's corporate headquarters. Moreover, Toyota's suppliers are clustered around the Toyota plants, with affiliated supplier plants only an average of 30.7 miles away, while independent suppliers are approximately 86.6 miles away. Toyota's internal parts suppliers are even closer, averaging less than 12 miles from the plants to which they deliver. To deliver just-in-time, suppliers average more than eight deliveries per day. Toyota houses roughly 350 guest engineers at its technical center, where it does most of the design work for the models it sells around the world. Moreover, Toyota transfers engineers and managers to work at suppliers on either a permanent or temporary basis. Roughly 20 percent of the top managers (*yakuin*) at Toyota's affiliated sup-

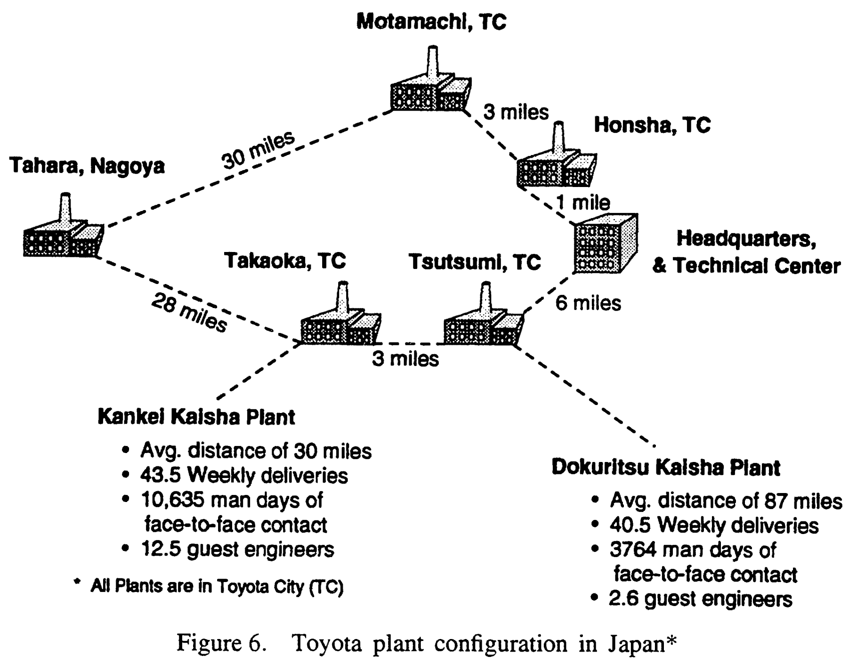


Figure 6. Toyota plant configuration in Japan*

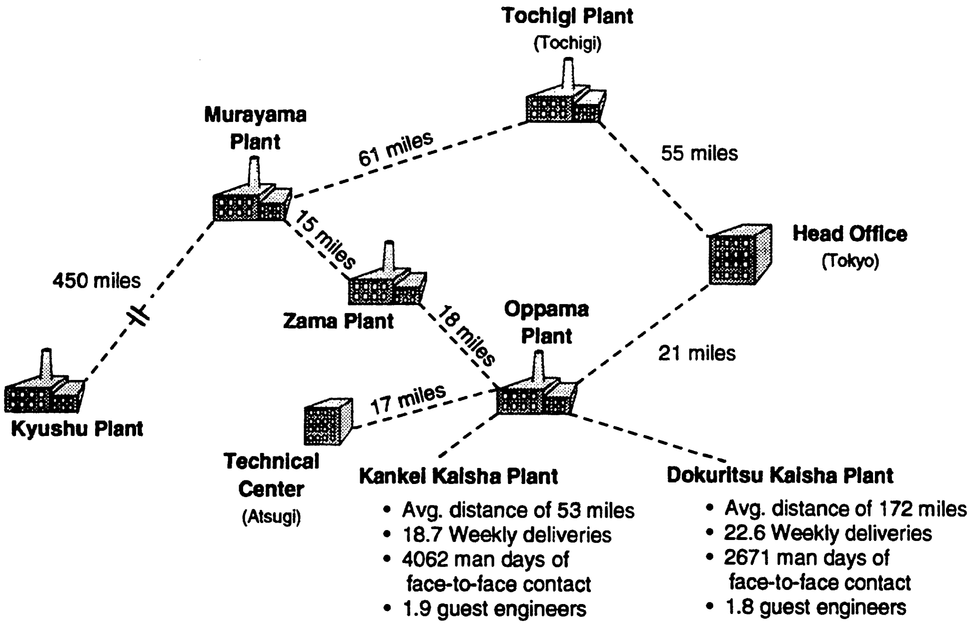


Figure 7. Nissan plant configuration in Japan

pliers are former Toyota employees and these individuals help suppliers coordinate effectively with Toyota.[20] Daily face-to-face contact is the norm and information flows freely between Toyota and its suppliers.

Nissan's plant configuration is not nearly as concentrated as Toyota's. Nissan's assembly plants are spread primarily around the Tokyo area, with plants typically between 20 and 50 miles apart. Nissan's affiliated and independent supplier plants are located farther away than Toyota's suppliers, with the average plant distance being 53 and 172 miles respectively. Consequently, Nissan suppliers make fewer daily deliveries and have less face-to-face contact with Nissan when compared to Toyota suppliers.

In stark contrast to Toyota, GM's assembly plants are scattered around the U.S.A. from California to New York. The average distance between GM's internal parts division plants and the primary GM assembly plants to which they deliver is more than 350 miles. External supplier plants sit an average of 427 miles away. To illustrate the difference between GM and Toyota, consider that *Toyota's entire production network could almost fit inside the distance between GM's two closest car plants in Michigan.* Due in part to the longer distances between plants, GM suppliers deliver an average of only 1.5 times a day. Moreover, GM utilizes fewer guest engineers and engages in significantly less face-to-face contact with suppliers.

In summary, Toyota's value chain is more specialized, and more productive, than Nissan's or GM's, and a key factor seems to be the geographic proximity of Toyota's production network. Indeed, we might expect a geographically concentrated production network to have advantages because proximity facilitates the formal and informal dissemination of information and technology across firms (as evidence, our survey found that Toyota and its suppliers engaged in the most information sharing). Moreover, proximity makes available a range of human-intensive (high media) communication mechanisms which facilitates the flow of tacit and complex knowledge across firms (Daft and Lengel, 1986; Almeida and Kogut, 1994). Thus, Toyota's network may simply learn faster than Nissan's or GM's network.[21] This finding is consistent with recent

[20] Since these employee transfers were not included in the human specificity measures, human cospecialization has probably been underestimated for Japanese automakers and their suppliers (Nissan does this as well).

[21] Toyota's supplier association has been the most stable (fewest entrants and exits) of all Japanese automakers and Toyota's suppliers are more likely than Nissan's suppliers to 'receive useful technical assistance from the customer through

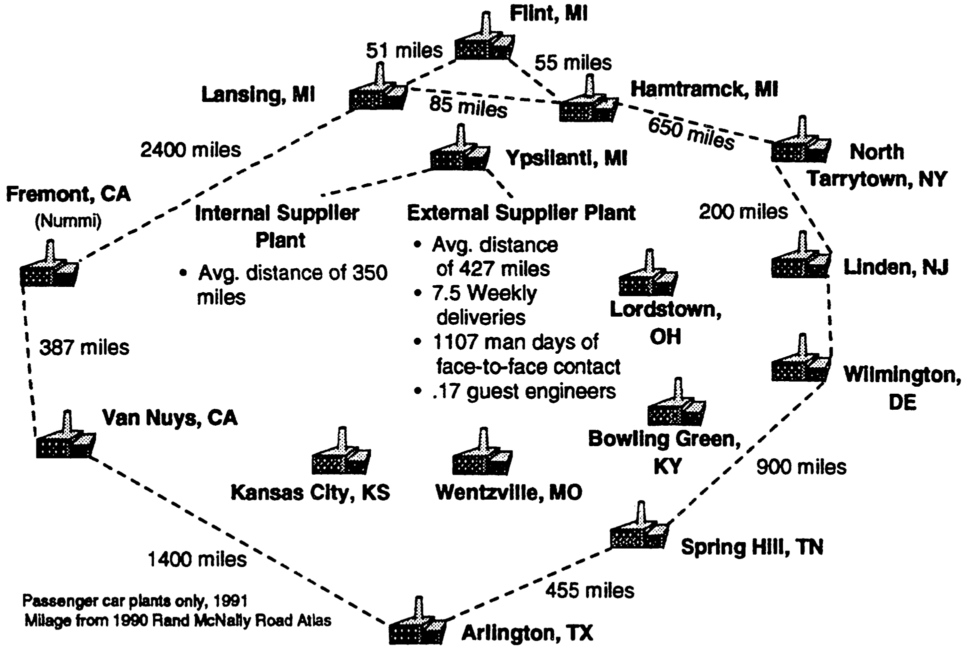


Figure 8. GM plant configuration in the U.S.A.*

work by scholars from various fields who have identified significant information sharing and learning benefits associated with geographic concentration of work activities (Enright, 1995; Scott, 1987; Saxenian, 1994).

Of course, from a strategic perspective the issue of imitability is important. How easily can competitors imitate the specialization advantages of Toyota's production network? The answer is that imitating some aspects of the Toyota strategy may be relatively easy (e.g., colocating engineers to increase human specificity), while imitating other aspects would be extremely costly (e.g., relocating plants). For example, the Toyota network configuration of plants represents a remarkable concentration of site-specific investments made by Toyota and its key suppliers. By comparison, U.S. suppliers rationally refuse to locate their plants next to GM's plants because: (1) the minimum efficient scale plant sizes are often different for component and assembly production; thus, suppliers need other customer plants nearby, and (2) they don't trust GM (see Table 1). Thus, Toyota has an intangible asset (i.e., its capability at building suppliers' trust) which GM must also learn how to imitate. Consequently, it would be very costly (if not impossible) for GM to imitate the site specialization of Toyota and its suppliers due to path dependence and time compression diseconomies (Dierickx and Cool, 1989). The irreversibility of past investments places constraints on strategies for the future. This analysis suggests that firm-specific advantages may well persist even though competitors can identify and measure them. The fact that imitation is costly, though not infeasible, may be sufficient for sustainability (Ghemawat, 1991). This contradicts arguments that if rent-producing differences among companies are observable and measurable then they cease to be sources of competitive advantage.

the association' (Sako, 1994: 19). Further, according to suppliers the second most important benefit of being an association member is 'learning from other members through the exchange of technical information.' Sako (1994: 4) speculates that Toyota's association is more stable and more effective at knowledge transfers (both between Toyota and suppliers and across suppliers) because of the geographic concentration of Toyota's network.

CONCLUSION

This study's central hypothesis—that there is a positive relationship between value chain asset specificity and performance—is generally supported. Moreover, a cursory examination of the features of some high performing firms in other 'complex product' industries suggests that the central hypothesis applies to other situations as well. For example, Trek has emerged as a leader in high-performance bicycles with an astounding 48.4 percent annual growth rate since 1990. Trek rapidly develops state of the art designs faster than competitors at its 'all in one' campus in Waterloo, Wisconsin where all marketing staff, engineers, designers, and manufacturing personnel work within a 10-minute walk of one another. Similarly, Saxenian (1994) describes how Hewlett Packard, and other Silicon Valley firms, have greatly improved performance by developing long-term partnerships with physically proximate suppliers. Saxenian (1990: 101) claims that 'proximity greatly facilitates the collaboration required for fast-changing and complex technologies which involve ongoing interaction, mutual adjustment, and learning'. As Sun Microsystems Materials director Scott Metcalf observes, 'In the ideal world, we'd draw a 100 mile radius and have all our suppliers locate plants into that area' (Saxenian, 1991: 430). Bartmess and Cerny (1993) offer similar examples from the semiconductor, disk drive, and business imaging industries.

In terms of a conceptual framework, I appear to be advocating a 'more specialization is better' approach. However, it may not always be appropriate to invest in transaction-specific assets. For example, undoubtedly there is a point at which additional face-to-face contact merely consumes additional resources. Thus, it is important to consider the boundary conditions under which these propositions are likely to hold. Three factors which may influence the efficacy of transaction-specific investments as a source of competitive advantage are: (1) the institutional/contracting environment, (2) industry uncertainty or volatility, and (3) product/task interdependence.

First, the optimal level of interfirm asset specificity will depend on the costs of safeguarding specific investments. If the safeguard costs are particularly high (i.e., due to an unfavorable institutional environment) then the gains from specialization may be outweighed by the costs. The fact that Japanese affiliated suppliers exhibited greater asset specificity than U.S. in-house divisions is intriguing. These findings suggest that common ownership of production network activities does not necessarily equate to high levels of asset specificity. As suggested by Sako (1991), trust may be a highly effective and low-cost means for safeguarding specialized investments. Indeed, one can argue that informal constraints on opportunism within the Japanese institutional environment allow Japanese firms to more frequently, and effectively, generate relational quasi rents (Hill, 1995).

Second, it can be argued that cospecialized transactors are disadvantaged in industry environments which experience large exogenous shocks. The logic behind this proposition is that large shocks may render previous specialized investments obsolete; thus, cospecialized transactors are disadvantaged relative to independent firms who can respond with greater flexibility. However, the counter argument is that firms in a cospecialized production network may have advantages relative to independent firms because their partners offer resources and information that are valuable in responding effectively to exogenous shocks. Indeed, there is some empirical support for this argument. For example, Mitchell and Singh (1994) found that firms in the hospital information systems industry that had entered into market-oriented collaborative agreements were more likely to survive the exogenous shock of government-imposed cost controls (DRGs) than were independent firms. Similarly, Saxenien (1991: 427) found that in the rapid-change environment of the computer industry the most successful U.S. firms (mostly in Silicon Valley) have moved away from arms-length supplier relationships and now 'designate a group of "privileged" suppliers with whom they build close relationships'. Thus, future research might address the ambiguity that exists with regard to the relationship between interfirm specialization and performance in volatile environments.

Finally, the optimal level of specialization between transactors is likely to be contingent on the task activities and degree of interdependence. Generally speaking, the greater the interdependence, the more both parties will benefit from investments in specialized assets. Our findings suggest that when work activities are highly interdependent as they are in the auto industry, the Japanese (notably Toyota) are closer to the optimum while the Americans are below. Indeed, *U.S. automakers may systematically underestimate the importance of human and site cospecialization.* Findings from this study indicate that transactors can develop a sustainable competitive advantage through cooperative specialization.

ACKNOWLEDGEMENTS

The National Association of Purchasing Management (NAPM) and Center for International Business and Education Research (CIBER) are gratefully acknowledged for their support of this research. I would also like to thank Geoff Brooks, Hal Gregorson, Bill Hesterley, Bruce Kogut, Marvin Lieberman, Julia Liebeskind, Toshi Nishiguchi, Richard Rumelt, and Harbir Singh for their valuable comments on earlier drafts.

REFERENCES

Alchian, A. A. and H. Demsetz (1972). 'Production, information costs, and economic organization', *American Economic Association*, **62**(5), pp. 777–795.

Almeida, P. and B. Kogut (1994). 'Technology, regions, and R&D spillovers: Knowledge diffusion in the semiconductor industry', Wharton School working paper.

Amit, R. and P. Schoemaker (1993). 'Strategic assets and organizational rent', *Strategic Management Journal*, **14**(1), pp. 33–46.

Anderson, J. C., M. Rungtasanatham and R. G. Schroeder (1994). 'A theory of quality management underlying the Deming Management Method', *Academy of Management Review*, **19**(3), pp. 472–509.

Aoki, M. (1988). *Information, Incentives, and Bargaining in the Japanese Economy*. Cambridge University Press, New York.

Asanuma, B. (1989). 'Manufacturer–supplier relationships in Japan and the concept of relation-specific skill', *Journal of the Japanese and International Economies*, **3**, pp. 1–30.

Barney, J. B. (1991). 'Firm resources and sustained competitive advantage', *Journal of Management*,**17**, pp. 99–120.

Bartmess, A. and K. Cerny (1993). 'Building competitive advantage through a global network of capabilities', *California Management Review*, **35**(2), pp. 2–27.

Clark, K. B. (October, 1989). 'Project scope and project performance: The effect of parts strategy and supplier involvement on product development', *Management Science*, pp. 1247–1263.

Clark, K. B. and T. Fujimoto (1991). *Product Development Performance*. Harvard Business School Press, Boston, MA.

Cohen, W. M. and D. A. Levinthal (1990). 'Absorptive capacity: A new perspective on learning and innovation', *Administrative Science Quarterly*, **35**, pp. 128–152.

Conner, K. R. (1991). 'A historical comparison of resource based theory and five schools of thought within industrial organization economics: Do we have a new theory of the firm?', *Journal of Management* **17**, pp. 121–124.

Cusumano, M. A. (1985). *The Japanese Automobile Industry: Technology and Management at Nissan and Toyota*. Harvard University—Council on East Asian Studies, Cambridge, MA.

Daft, R. and R. Lengel (1986). 'Organizational information requirements, media richness and structural design', *Management Science*, **32**(5), pp. 554–571.

Dean, J. W., Jr. and D. E. Bowen (1994). 'Management theory and total quality: Improving research and practice through theory development', *Academy of Management Review*, **19**(3), pp. 392–418.

Deming, W. E. (1986). *Out of the Crises*. MIT Press, Cambridge, MA.

Dierickx, I. and K. Cool (1989). 'Asset stock accumulation and sustainability of competitive advantage', *Management Science*, **35**(12), pp. 1504–1513.

Dore, R. (1983). 'Goodwill and the spirit of market capitalism', *British Journal of Sociology*, **XXXIV**(4), pp. 459–482.

Dyer, J. H. (1993). 'Four papers on governance, asset specialization, and performance: A comparative study of supplier–automaker relationships in the U.S. and Japan', unpublished doctoral dissertation, University of California at Los Angeles.

Dyer, J. H. and W. G. Ouchi (1993). 'Japanese style business partnerships: Giving companies a competitive edge', *Sloan Management Review*, **35**(1), pp. 51–63.

Enright, M. J. (1995). 'Organization and coordination in geographically concentrated industries'. In N. Lamoreaux and D. Raff (eds.), *Coordination and Information: Historical Perspectives on the Organization of Enterprise*. University of Chicago Press for the NBER, Chicago, IL, pp. 103–142.

Fruin, W. M. (1992). *The Japanese Enterprise System*. Oxford University Press, New York.

Gerlach, M. L., J. R. Lincoln and C. Ahmadjian (1992). 'Interorganizational networks and corporate performance in Japan', paper presented at the American Sociological Association, Pittsburgh, PA.

Ghemawat, P. (1991). *Commitment: The Dynamic of Strategy*. Free Press, New York.

Godfrey, P. and R. Mitchell (1994). 'Socially constructed language and the resource based view of the firm', Brigham Young University working paper.

Hill, C. W. L. (1995). 'National institutional structures, transaction cost economizing, and competitive advantage: The Case of Japan', *Organization Science*, **6**(2), pp. 119–131.

Juran, J. A. M. (1989). *Juran on Leadership for Quality*. Free Press, New York.

Klein, B. (1980). 'Transaction cost determinants of "unfair" contractual arrangements', *American Economic Review*, **70**(2), pp. 356–362.

Klein, B., R. G. Crawford and A. A. Alchian (1978). 'Vertical integration, appropriable rents, and the competitive contracting process', *Journal of Law and Economics*, **21**, pp. 297–326.

Masten, S. E. (1984). 'The organization of production: Evidence from the Aerospace Industry', *Journal of Law and Economics*, **27**, pp. 403–417.

Mitchell, W. and K. Singh (1994). 'Survival of businesses using collaborative relationships to commercialize complex goods', paper presented at the Wharton School, University of Pennsylvania.

Monteverde, K. and D. J. Teece (1982). 'Supplier switching costs and vertical integration in the automobile industry', *Bell Journal of Economics*, **13**, pp. 206–213.

Nishiguchi, T. (1994). *Strategic Industrial Sourcing*. Oxford University Press, New York.

Nobeoka, K. (1993). 'Multi-project management: Strategy and organization in automobile product development', unpublished Ph.D. dissertation, MIT.

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, Cambridge, UK.

Parkhe, A. (1993). 'Strategic alliance structuring: A game theoretic and transaction cost examination of interfirm cooperation', *Academy of Management Journal*, **36**(4), pp. 794–829.

Perry, M. K. (1989). 'Vertical integration'. In R. Schmalensee and R. Willig (eds.), *Handbook of Industrial Organization*. North-Holland, Amsterdam, pp. 185–255.

Peteraf, M. (1994). 'Commentary'. In P. Shrivastava, A. Huff and J. Dutton (eds.), *Advances in Strategic Management*. JAI Press, Greenwich, CT, Vol. 10B, pp. 153–158.

Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. Free Press, New York.

Reeves, C. A. and D. Bednar (1994). 'Defining quality: Alternatives and implications', *Academy of Management Review*, **19**(3), pp. 419–445.

Rommel, G. K., R. D. Kempis and H. W. Kaas (1994). 'Does quality pay?', *The McKinsey Quarterly*, No. 1, pp. 51–63.

Rumelt, R. P. (1984). 'Towards a strategic theory of the firm'. In R. B. Lamb (ed.), *Competitive Strategic Management*. Prentice-Hall, Englewood Cliffs, NJ, pp. 556–571.

Rumelt, R. P. (1991). 'How much does industry matter?', *Strategic Management Journal*, **12**(3), pp. 167–185.

Sako, M. (1991). 'The role of "Trust" in Japanese buyer–supplier relationships', *Ricerche Economiche*, **XLV** (2–3), pp. 449–474.

Sako, M. (1992). *Prices, Quality, and Trust*. Cambridge University Press, Cambridge, MA.

Sako, M. (1994). 'Kyoryokukai (Suppliers' Association) in the Japanese auto industry: Collective action for technology diffusion', London School of Economics and Political Science, working paper.

Saxenian, A. (1990). 'Regional networks and the resurgence of Silicon Valley', *California Management Review*, Fall, pp. 89–112.

Saxenian, A. (1991). 'The origins and dynamics of production networks in Silicon Valley', *Research Policy*, **10**, pp. 423–437.

Saxenian, A. (1994). *Regional Advantage*. Harvard University Press, Cambridge, MA.

Schoemaker, P. and R. Amit (1994). 'Investment in strategic assets: Industry and firm level perspectives'. In P. Shrivastava, A. Huff and J. Dutton (eds.), *Advances in Strategic Management*. JAI Press, Greenwich, CT, Vol. 10A, pp. 3–33.

Schonberger, R. J. (1982). *Japanese Manufacturing Techniques*. Free Press, New York.

Scott, A. (1987). 'Industrial organization and location: Division of labor, the firm, and spatial process', *Economic Geography*, **63**, pp. 214–231.

Scott, W. R. (1981). *Organizations: Rational, Natural, and Open Systems*. Prentice-Hall, Englewood Cliffs, NJ.

Smitka, M. J. (1991). *Competitive Ties: Subcontracting in the Japanese Automotive Industry*. Columbia University Press, New York.

Stalk, G. and T. M. Hout (1990). *Competing Against Time*. Free Press, New York.

Thompson, J. D. (1967). *Organizations in Action*. McGraw-Hill, New York.

Walker, G. and D. Weber (1984). 'A transaction cost approach to make-or-buy', *Administrative Science Quarterly*, **29**, pp. 373–391.

Weigelt, K. and C. Camerer (1988). 'Reputation and corporate strategy: A review of recent theory and applications', *Strategic Management Journal*, **9**(5), pp. 443–454.

Wernerfelt, B. (1984). 'A resource-based view of the firm', *Strategic Management Journal*, **5**(2), pp. 171–180.

Westney, D. E. and K. Sakakibara (1986). 'The role of Japan-based R&D in global technology strategy'. In M. Hurowitch (ed.), *Technology in the Modern Corporation*. Pergamon, London, pp. 217–232.

Williamson, O. E. (1979). 'Transaction-cost economics: The governance of contractual relations', *Journal of Law and Economics*, **22**, pp. 233–261.

Williamson, O. E. (1985). *The Economic Institutions of Capitalism*. Free Press, New York.

Williamson, O. E. (1991). 'Strategizing, economizing, and economic organization', *Strategic Management Journal*, Winter Special Issue, **12**, pp. 75–94.

Womack, J. P., D. T. Jones and D. Roos (1990). *The Machine that Changed the World*. Harper Perennial, New York.