A STUDY OF SUPPLIER RELATIONSHIPS

IN

THE AMERICAN AND JAPANESE AUTOMOTIVE INDUSTRIES

by

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ABSTRACT

Changing supplier relationships has been a primary concern of American automakers in gaining and sustaining a competitive advantage in the international market. Stimulated by competition from Japanese automakers, who enjoy effective supplier relationships in Japan, American automakers have begun since the early 1980s to restructure their supplier relationships. Operating under a different set of circumstances, Japanese automaker transplants in the United States are also seeking new supplier relationships applying Japanese approaches.

This thesis attempts to clarify the current situation of the supplier relationships of American automakers, Japanese automakers and Japanese transplants through a comparative analysis based on an international questionnaire survey. It also attempts to examine the applicability of Japanese approaches to the United States, focusing on pricing practices, based on field interviews with 27 Japanese transplants.

This thesis finds that American supplier relationships have changed from traditional to new approaches which have several features in common with the Japanese. Their performance in pricing practices and quality, however, is still behind that of Japanese automakers as well as Japanese transplants, indicating that American automakers must exert themselves to establish more effective supplier relationships. In particular, dynamism towards improvement is what they need most in order to compete with Japan. Also the performance of Japanese transplants is behind the Japanese, though ahead of the American. The field interviews reveal that Japanese supplier relationships are built on a large integrated system including competitive second-tier subcontractors and manufacturing infrastructure, some of which do not exist in the United States. The performance of Japanese transplants will gradually improve as transitional obstacles are removed. To cope with structural obstacles, however, these transplants will have to cultivate new supplier relationships on American soil.

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Introduction

Changing supplier relationships has been a critical issue in American manufacturing industries. Rather than remaining as traditional arm's-length adversaries, firms have begun to seek cooperative long-term relationships as a new paradigm.[1]

In the automotive industry, in particular, restructuring supplier relationships has become a primary concern to create and sustain a competitive advantage in face of increasingly intensified international competition. For this industry, where more than 15,000 parts are assembled to produce a single vehicle, supplier relationships have historically been an important concern since the birth of the industry. In the early 1980s, however, facing increasing competitive pressure mainly from Japanese automakers and finding that they took different approaches to supplier relationships, the American automotive industry began giving much greater weight to the issue. One U.S. automaker, for instance, estimated that between 20 -33% of the cost advantage of the Japanese was supplier-related. One consequence of these findings was a reevaluation of supplier relationships with close examination of the Japanese model.[2]

Another phenomenon making this issue interesting and timely is the flood of Japanese car manufacturers' transplants to the United States. In a different industrial environment with different history these transplants are currently seeking competitive supplier relationships both with American parts suppliers and with Japanese parts supplier transplants in the U.S, applying Japanese approaches possibly with some modification.

The purpose of this thesis is to clarify the current situation of supplier relationships in the American and Japanese automotive industries. The primary questions the thesis attempts to answer are:

1For example, see Dertouzos et al. (1989), 120-121, 150, and Hayes et al. (1988), 206-210.
2Cole et al.(1984), 151.

Question (1) *What are the features of the current supplier relationships of U.S. automakers, and how are they different from their traditional ones, and from those in Japan?*

Question (2) *What are the features of the current supplier relationships of Japanese automaker transplants, and how are they different from American ones and those in Japan?*

Question (3) *If there are some differences between Japanese transplants' relationships and Japan's, what are the reasons that Japanese transplants cannot fully apply Japanese approaches in the United States?*

Examining these questions, the thesis provides some insight into competitive supplier relationships as well as the applicability of Japanese approaches to the United States. The thesis offers a descriptive but quantitative data set based on an international questionnaire survey for the analysis of those issues raised in question (1) and (2), which most of the previous studies analyzed largely in an anecdotal and qualitative fashion. For question (3), this thesis analyzes the issue based on my field interviews with Japanese transplants, primarily focusing on pricing practices, where distinctions between Japanese and American approaches have been observed.

The first chapter of this study compares supplier relationships in the two countries, reviewing the existing literature. Chapter 2 presents the research methods for evaluating the findings produced in previous studies, and for obtaining answers to the questions I addressed above. The methods are two. One is the collection of comparative data on supplier relationships observed for four specific types of parts, in Japan and in the United States including Japanese transplants. The other is field interviews with 27 Japanese transplant car producers and parts suppliers in the United States. Chapter 3 presents the results and analysis of the survey data in detail to clarify the current situations in the two countries (for question (1) and (2)). Focusing on pricing practices, Chapter 4 examines why Japanese transplants are unable to fully apply Japanese approaches in the United

States, based on the field interviews (for question (3)). The concluding chapter provides a summary of findings and their implications, and then suggests future research directions.

CHAPTER I Comparison of American and Japanese Approaches (Literature Review)

Since the early 1980s, several studies have analyzed supplier relationships in the American and Japanese auto industries. Reviewing the existing literature, this chapter describes the differences in approaches to supplier relationships between the two countries.

What makes the comparison complex is that American automakers have been in the process of restructuring their supplier relationships. To clarify the overall contrast, this chapter proceeds by first comparing Japanese approaches with traditional U.S. approaches in terms of structure and practices, and then describing the new relationships being sought by American automakers.[3]

1.1. Japanese approaches vs. traditional American approaches

Structure

The degree of vertical integration differed between the two countries. American automakers, with the exception of Chrysler, were more vertically integrated than the Japanese. The often-cited in-house production ratio was 60-70% for GM, 50% for Ford, and 30% for Japanese automakers.[4] While GM's 13 internal parts divisions and Ford's 7 parts divisions produced a broad range of parts in the mid 1980s, Japanese automakers purchased nearly all parts from outside except a few critical components including engines, transmissions, axles, and large pressed parts.

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[3]The term, traditional is used for the sake of convenience. Naturally, established supplier relationships evolved over a period of time both in the United States and Japan, and older patterns even reappear (discussed later). However, since relationships in Japan have recently remained relatively stable, while in the U.S. major changes have initiated since the early 1980s, I use this expression.

[4]For example, see U.S. International Trade Commission (1987), 3-3, Helper (1989a), 24, Mitsubishi Research Institute (1987), 3. Though similar numbers were referred to in several studies, there is no comparable data for the two countries. For an estimation on a comparable basis, see Cusumano (1985), 186-193.

Despite the higher out-sourcing ratio, the number of parts suppliers for Japanese automakers was quite limited as shown in Table 1.1. As of 1986, more than 5,500 suppliers were supplying productive materials (excluding raw materials, tools and plants facilities) to GM, whereas Toyota's direct suppliers consisted of 172 parts manufacturers. Also, at the plant level, Asanuma (1988b) observed a similar contrast: the number of suppliers at the typical GM assembly plant was 800, while Toyota's was 125.[5] He found similar figures for other auto manufacturers in the two countries.

Table 1.1 Number of Suppliers

Automakers	Number of suppliers
GM	5,500 firms supplying 80% of parts (1986)
Ford	2,500 firms (1986) The largest 150 firms supplying over 60% of parts
Chrysler	2,000 firms (1986) 300 firms supplying 90% of parts
Toyota	172 firms supplying over 90% of parts (1986)
Nissan	163 firms supplying 90% of parts (1983)
Mazda	326 firms (1982)

Note: Percentages are all on a dollar basis. Suppliers of raw materials, tools and production facilities are not included in the number of suppliers.
Source: Asanuma (1988b).

One reason for this contrast lies in a Japan's tiered structure. In this system, automakers buy sub-assembled units or system components from the first-tier suppliers who buy constituent parts from subcontractors in the second tier in the hierarchy, and so on. Automakers thus have direct business primarily with a small number of first-tier suppliers. American automakers, by contrast, purchased parts at relatively lower stages of

[5]The difference stands out the more considering that (1) the typical Japanese assembly plant has the capacity to produce twice as many units as the American; and that (2) the typical Japanese plant has the stamping shop inside, whereas the American does not. (Asanuma [1988b], 7).

assembly from a correspondingly larger number of parts manufacturers. Though larger size partsmakers, such as Borg-Warner, Bendix, Dana and TRW, supplied system components, they were exceptional in the United States.[6] Also the number of suppliers for a part differed. In Japan single-sourcing (one supplier for a particular part of a specific model) is the typical practice, but the usual case in America was that automakers had several (not just two) suppliers to insure continuity of supply and to provide leverage on prices.[7] Asanuma (1988b) also pointed to that U.S. automakers retained on the first tier a larger number of marginal suppliers, which received order only intermittently, and that they also had a larger number of local suppliers, which supplied only to one plant or at most to a few plants of a given customer.

Another characteristic of the Japanese structure is that some first-tier suppliers are affiliated with one or more automakers, a feature not observed in America. If one defines an affiliated supplier as one which has more than 20% of its stock owned by an automaker, 10-20% of the first-tier suppliers for each automaker are affiliated. In general, affiliated suppliers take responsibility for technically advanced, proprietary products, while independent suppliers for simpler products and processes. But this distinction is not always clear, nor do affiliated suppliers have exclusive relations with the stock-holding automaker.[8]

Operational practices

Studies of supplier relationships have also captured a variety of different operational practices in conjunction with these structural differences.

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[6]Helper (1988) estimated that this type of suppliers accounted for about 1% by number of firms and about two-thirds by dollar volume of the automakers' outside sourcing.
[7]Asanuma (1988b), 8, Nishiguchi (1989), 196, Mitsubishi Research Institute (1987), 4, Lamming (1989), 12.
[8]Nishiguchi (1989), 187, Mitsubishi Research Institute (1987), 4-9. For instance, each affiliated partsmaker supplies to 4.8 automakers in average. (Mitsubishi Research Institute [1987], 4).

Length and stability of relationships

The relationships between buyers and suppliers in Japan are long-term ones. According to Asanuma (1988a, 1988b), the delivery of a part by a particular supplier endures for the life of the part, that is, four years for those parts to be changed for a complete model change; and two years for parts changed for a minor model change. Though there is no guarantee that a supplier can get a future order for the same type of part for the new model when the life of the previous model comes to an end, Japanese automakers have purchased a dominant portion of parts from the suppliers with long-standing relations, operating continuously beyond the life of any single model. Asanuma claims that it is a remarkable aspect of the Japanese auto industry that the set of suppliers to each automaker is relatively stable in identity. One institution which structures the long-standing relationships with first-tier suppliers is a "kyoryokukai," an association of cooperative partsmakers. Each automaker has kyoryokukai to facilitate communication with suppliers and among suppliers, and their membership is fairly stable. For example, membership in Kyoho Kai, Toyota's kyoryokukai, changed little between the 1950s and the early 1980s.[9]

While maintaining long-standing relations with a limited number of suppliers, Japanese automakers have these suppliers compete through "two-vendor policy" and "grading system." Though the number of suppliers for a part of a specific model is typically one, Japanese automakers have always tried to create plural (typically two to three) sources, sometimes including their own in-house divisions. In selecting suppliers at product development stage, automakers solicit their competition. Throughout long business experience, automakers evaluate suppliers by rating them. The suppliers with better grades can expect to obtain more value-added business and longer-term commitments

[9]Cusumano (1985), 252.

from automakers, while those with lower scores may be demoted to a lower tier.[10] Thus only competent suppliers can enjoy long-standing relations.

In America, on the other hand, the dominant pattern was the annual inquiry process. Buyers set the formal effective period of a contract at one year, at the end of which, each part was subject to competitive bidding to find the cheapest supplier.[11] In a few exceptional cases, large parts manufacturers supplying system components received implicit long-term commitments, but business was still unstable for them. Helper (1989a) showed that it was not unheard of for automakers to "cheat", or renege on these implicit contracts.[12] Traditional American supplier relationships were thus short-term and unstable ones, in comparison with the Japanese.

Product development

The role of suppliers in product development can be categorized into three modes: (1) suppliers develop the parts entirely as standard products (supplier proprietary parts); (2) suppliers conduct detailed engineering based on the functional specification provided by automakers (black-box parts); (3) suppliers only produce the parts entirely developed by automakers (detail-controlled parts).[13] Conducting a study of product development in the world auto industry, Fujimoto (1989) showed another sharp contrast between the two countries, indicating that a larger role is played by suppliers in Japan. As shown in Table 1.2, in Japan, where black-box parts account for 62%, about 50% of product engineering is carried out by suppliers, whereas automakers in the United States undertook 86% of the engineering, using detail-controlled parts for 81%.

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[10]Asanuma (1988a), 4, Asanuma (1988b), 22-24, Nishiguchi (1989), 215-220.
[11]Asanuma (1988b), 10, Lamming (1989), 12.
[12]White (1971) also found a tendency to let suppliers develop a product, purchase it for a while, and then either purchase the plant or build one for in-house production.
[13]Fujimoto (1989), 351. Asanuma (1988a) named them (1) market-good type parts; (2) drawing approved parts; and (3) drawing supplied parts, respectively.

Table 1.2 Role of Suppliers in Product Development

	Japan (12)	USA (6)
Ratio by parts costs		
Supplier proprietary (SP)	8%	3%
Black box (BB)	62%	16%
Detailed-controlled (DC)	30%	81%
Supplier engineering ratio (SP + 0.7*BB)	51%	14%

Note: ( )=sample size of car projects. Supplier engineering ratio is an estimated fraction of engineering hours worked by parts suppliers.
Source: Fujimoto (1989), 351a.

A consequence of the larger supplier role in Japan is their early involvement in product development. Asanuma (1988b) observed that Japanese black-box parts suppliers begin to participate in the development process before the automakers have detailed specifications for the model (about 24 months before starting commercial production of the new model (Job 1)), while for Ford, supplier involvement began 6 to 18 months prior to Job 1. To facilitate coordination it became a common practice for major suppliers to send several "resident" engineers to their customers in Japan.[14]

Along with long-standing relationships and constant competitive pressure, Japanese development practices have pushed suppliers to make a greater commitment to technological improvement,[15] giving automakers more effective product development than the U.S. counterparts. Clark (1988) estimated that supplier involvement in product development and strong supplier relationships account for one-third of the Japanese automakers' advantage in product development hours, and four to five months of their lead time advantage.

Pricing practices

Cole et al. (1984) claimed that perhaps the most striking operational difference between purchasing in the two industries was in the area of part pricing. Traditionally,

[14]Asanuma (1988b), 14-17, Nishiguchi (1989), 210 - 214.
[15]See, for example, Asanuma (1988b),18, Cole et al. (1984), 170, Nishiguchi (1989), 231.

American automakers have relied on direct market forces among suppliers (competitive bidding), while the Japanese have relied on more subtle and indirect forms of competition. In Japan, the so-called "target pricing" method is used. Working on market-price-minus, rather than cost-plus, principles, automakers set a target price for each part based upon the sales price of a new car model determined first, and suppliers are urged to reach the target. By jointly evaluating various possibilities, the part price must be reduced step by step to the target while keeping the required specifications constant. VE (Value engineering), a technique to study product designs, materials, and manufacturing methods to reduce systematically the costs of parts in development, considered a particularly powerful tool.[16]

Another distinction was observed in pricing after starting commercial production. Automakers in Japan have generally pursued incremental reductions on parts prices throughout the life cycle. Through regular semi-annual negotiations between automakers and suppliers, the prices are revised, and suppliers, on the whole, somehow end up meeting customer price demand through perpetual efforts to reduce manufacturing costs. Improving suppliers' manufacturing processes and VA (Value Analysis), a technique to study product designs, materials, and manufacturing methods to systematically reduce the costs of parts after starting production, are major tools for cost/price reductions. In the United States, on the other hand, such continuous price reductions were not found. Though American automakers used price bidding for downward pressure, they allowed suppliers to pass wage increases on through some kind of escalator clauses for as long as the contract continued.[17]

Behind the Japanese practices, several mechanisms are at work. By frequently requesting detailed cost data from suppliers, automakers attempt to pursue price determination on the basis of objective measurements. "Profits" generated from cost reduction through VE, VA and other improvements, are shared between automakers and

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[16]Cole et al. (1984), 156, Nishiguchi (1989), 201.
[17]Asanuma (1988b), 18, Lamming (1989),18.

suppliers. While the initial cost is often higher than the price, suppliers struggle to reduce the cost below the price and eventually retain a certain portion of the "profits" from these efforts. Also, in the long-term, these efforts are rewarded through increased cumulative ratings.[18]

Quality management

A critical contributing factor to the superior quality of Japanese cars is the high quality of parts. A comparison by the Japan Automobile Manufacturers Associations of parts imported from American suppliers and parts made in Japan showed that the defect rates for U.S. imports (0.35 to 2.6%) were much higher than those supplied by Japanese suppliers (0 to 0.01%).[19] Because it is reasonable to assume no defects, Japanese automakers generally need not inspect incoming parts. Similar to cost reductions, continuous quality improvement by suppliers is taken for granted as trading relations continue. If suppliers fail to achieve these gains, customers try to track the source of the problems and urge suppliers to solve them at their origin.[20]

Studying Japanese quality management, Sei (1989) pointed out that the problem-solving orientation is a driving force in continuous quality improvement of parts and materials. In specifications in parts drawings and quality assurance contracts between automakers and suppliers, he found expression assigning to suppliers the responsibility to solve whatever problems arise. He argued that this principle has led to ongoing improvement in the quality of parts in Japan.

Traditional American quality management differed considerably from the Japanese. They relied on the detection of errors after-the-fact rather than prevention of problems at the root, with no effort to learn from their experience with defective parts. Variance by suppliers was also tolerated and responsibility for quality tended to be centralized in the

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[18]Asanuma (1988b), 19-20, Nishiguchi (1989), 201-203.
[19]Mitsubishi Research Institute (1987), 25.
[20]Nishiguchi (1989), 280.

quality control and inspection staff of the automakers and suppliers rather than diffused to all employees. Automakers and suppliers argued over who was to blame for quality problems, and made ad hoc adjustment.[21]

Delivery and flexible manufacturing

Delivery system illustrates another well-known difference. The JIT (just-in-time) delivery system is broadly used in Japan, while U.S. automakers used a sort of "just-in-case" system, treating inventory as "a hedge against the interruption of the long production runs of standardized items mandated by the gospel of scale economies."[22] To illustrate the contrast, the inventory ratio of Japanese automakers (94.8) was five times as large as that of the American (18.7) in 1985.[23]

The JIT system is not simply a delivery system, but rather a manufacturing system, with the goal of eliminating buffer stock of both the automakers and the suppliers. Toward this end, Japanese automakers and suppliers have been pursuing flexible manufacturing systems which allow suppliers to increase product mix and variants, design changes, quick and frequent deliveries, etc.[24] Comparing suppliers globally, Nishiguchi (1989) showed that the degree of flexibility of Japanese suppliers' manufacturing systems exceeds that of American and European suppliers.

Response to problems

Although problem response is not a specific practice, but rather a guiding principle, two studies have found the differences in this area.

Focusing on responses to problems arising in a buyer-supplier relation, Helper (1989a) identified two types of responses, which she termed the exit system and the voice system, which can be measured along with two dimensions, the degree of administrative coordination and the degree of commitment. In the exit system, the buyer's response to

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[21]Temple, Barker & Sloane (1987), 49, Helper (1989a), 29.
[22]Abernathy et al. (1983), 75.
[23]Temple, Barker & Sloane (1987), 42.
[24]Nishiguchi (1989), 313-358.

problems with a supplier is to find a new supplier; this requires low commitment and low administrative coordination. The voice system, wherein the buyer works with the original supplier until the problem is corrected, requires high commitment, high administrative coordination and a rich flow of information. Helper argued that the dual system of vertical integration and exit-based relations with outside suppliers gave American automakers strong bargaining power but did not encourage most types of technical change.

Nishiguchi (1989) claimed that the Japanese approach has a "problem-solving" orientation, as opposed to "bargaining" orientation. Through a range of new inter-firm practices including VE, VA, target cost method, early involvement, black-box parts, grading and resident engineers, the problem-solving principle has encouraged suppliers to strive for continuous cost reduction and quality improvement.

1.2. Changing supplier relationships in the United States

Rationale behind the changes

Finding that a substantial part of the Japanese advantage in cost, quality, and product development derived from their supplier relationships, American automakers began changing the structure and practices of supplier relationships in the early 1980s. Some studies indicate that the increasing importance of technology and consumer market diversification necessitated the reorganization.

According to Helper (1989a), as technology became an important factor in competition, American automakers were urged to build more coordinated relationships to spur more innovation, for which the traditional American approaches were not best fitted.

Sabel et al. (1989) referred to shorter product life cycle and more rapid technological change as important factors stimulating change. The need to reduce rising development costs associated with these two trends has required automakers to seek the collaboration of many specialized suppliers.

Asanuma (1988a, b) claimed that the fundamental driving force for improving supplier relationships is the increasing diversification of car-buyers' needs. As products and correspondingly their components come to require more customization in order to capture these diversified needs, the so-called "relation-specific skill" comes to the fore. The relation-specific skill is the skill required to respond efficiently to buyers' specific needs, and developing the skill requires close inter-firm relations, with due care to incentives and competitive stimuli. He claimed that Japanese supplier relationships have evolved in this way and that similar changes are being examined in the United States.

New supplier relationships

Table 1.3 summarizes the features of Japanese and traditional American relationships discussed earlier, and features of the new relationships being pursued by American automakers. As shown, new American relationships come close to the Japanese.

Structure

Regarding structural aspects, American automakers have begun to reduce the number of suppliers by system sourcing and by limiting the number of suppliers of each part. By dividing the existing suppliers into first tier and second tier, system sourcing has led to a tiered structure.[25] Neither can automakers' internal parts divisions escape the change. Internal divisions' "sheltered" life left some of them unable to compete on quality, technology, or cost, but automakers have begun requiring them to sell their products in the open market as an outside supplier does. A further step was Chrysler's putting all of its "non-core" parts plants into an independent subsidiary called Acuster.[26]

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[25]Helper (1989b), Asanuma (1988b), 12-13, Lamming (1989), 5-6.
[26]Sabel et al. (1989), 14-16, Helper (1989a), 34.

Table 1.3 Features of Supplier Relationships in the Two Countries

Issues	Japanese	Traditional American	New American
Structure			
Vertical Integration	•Low [c,e,i,m,n]	•High [c,e,i,m,n]	•Competition for internal parts divisions [f,k]
# of suppliers	•Small [c]	•Large [c,h]	•Smaller [c,g,k]
Tiered structure	•Hierarchical [c,d,i,m]	•Flat [c,d,h,m]	•More hierarchical [c,k]
Financial affiliation	•Affiliated suppliers [c,e,i,j,m]		
Practices			
Contract length	•Four (or two) years [c,i]	•One year [c,h,m]	•Longer [c,f,g]
Stability	•Stable [c,e]	•Unstable [c,g]	•More stable [c,g]
Competitive pressure	•Two-vendor policy [c] •Ratings [c,j]	•Competitive bidding [c,h]	
Development	•Larger role of suppliers [c,f] •Early involvement of suppliers [c] •Resident engineers [c,j,d]	•Small role of suppliers [c,f] •Late involvement of suppliers [c]	•Larger role of suppliers [a,c,f,k] •Earlier involvement of suppliers [c,j,k]
Pricing	•Target pricing [d,j] •Downward price revision [c] •VE, VA [c,j,e] •"Profit-sharing" incentive [c,j] •Requiring costs data to suppliers [j]	•Competitive bidding [c,d,f,h] •Allowing price increase [c,h]	•Asking price reduction [c,h]
Quality management	•Low defect rate [i] •Continuous quality improvement [c,i,j,l] •No inspection of parts received [c,i] •Problem-solving [l]	•High defect rate [i] •Larger tolerance for quality [m,l] •Centralized to quality control and inspection [m] •Detection rather then prevention [m,j]	•More emphasis on quality [a,f,g,m] •Using SPC data [c,f,g]
Delivery/Flexible Manufacturing	•Just-in-time system [c] •More flexible manufacturing system [c,j]	•Just-in-case system [a,k] •Less flexible manufacturing system [j]	•Using JIT system [a,c,f]
Responses to problems	•Voice system (solving problems together) [f] •High administrative coordination and commitment [f] •Problem-solving oriented [j]	•Exit system (finding a new supplier) [f] •Low administrative coordination and commitment [f] •Bargaining oriented [j]	•Voice system [f] •High administrative coordination and commitment [f]

Source: [a]Abernathy et al. (1983), [b]Asanuma (1988a), [c]Asanuma (1988b), [d]Cole et al. (1984), [e]Cusumano (1985), [f]Helper (1989a), [g]Helper (1989b), [h]Lamming (1989), [i]Mitsubishi Research Institute (1987), [j]Nishiguchi (1989), [k]Sabel et al. (1989), [l]Sei (1989), [m]Temple, Barker & Sloane (1987), [n]U.S. International Trade Commission (1987).

Practices

American automakers have initiated changes in various aspects of operational practices. By making multi-year contracts with fewer suppliers and continuing to procure from them for the life of the parts, automakers have started to build long-term relationships. Selected suppliers are expected to have a larger role in development and to get involved at an earlier stage of the development process. Ford, for instance, has changed the period of supplier involvement from 6-18 months to 2-4 years prior to job 1. In price revision, the usual annual increases have been disappearing. Automakers instead have started asking suppliers to reduce prices each year, and linking this to long-term contracts. In contact with automakers, suppliers are expected to adopt statistical process control (SPC), work on quality problems and practice just-in-time delivery system.[27] Surveying suppliers in America, Helper (1989b) showed that over the last five years the number of suppliers has decreased, the average contract length has almost doubled, information flow is up between buyers and suppliers, and the number of suppliers using SPC data has increased.

Helper (1989a) described these transitions as a significant change from the exit-based system toward a voice-based system, where administrative coordination and automakers' commitment to suppliers are far greater than in the traditional system.

It is noteworthy that American relationships are perceived to be returning to older patterns. Abernathy et al. (1983) described the shift thus: "the new guiding principle is once again what it was during the evolution of the American manufacturing system in the 19th century. The principle was to capitalize on suppliers' technical strengths and on the greater commitment to product quality that comes with enhanced responsibility, a more timely exchange of information, and a long-term relationship." Helper (1989a) attributed the recurrence to the trend making the final-product market structure resemble that at the turn of the century: lots of technology-based competition.

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[27]Asanuma (1988b), 12-14, 17, Helper (1989a), 32, Lamming (1989), 18.

Stumbling blocks

Observing these changes, Asanuma (1988b) pointed out several areas of potential difficulties for American supplier relationships which are transforming along these lines. He noted difficulties in reversing the past tendencies such as the practice of expecting price increases; lack of understanding of incentive schemes and competitive stimuli at work in Japanese supplier relationships; and the philosophy of economies of high volume which are deeply rooted in the United States.

Others have also indicated obstacles to change. To establish new relationships, automakers must alter incentive structures, expectations and capabilities built up over decades. Automakers need new organizations with expensive communication and evaluation systems. These requirements notwithstanding, there is a tendency among purchasing departments, engineers, and internal parts divisions' managers and workforce of the automakers to retain customary ways. There also exists implicit skepticism between automakers and suppliers. Supplier weakness in technology can not remedied overnight. Even establishing new relationships with internal parts divisions has not been easy.[28] Helper saw that American automakers are experimenting with different approaches: "continuing traditional approaches, broadening the criteria to include quality and delivery"; or "overcoming the legacy of mistrust and low technical capability of their outside suppliers and establishing new relationships with them as well as internal parts divisions."[29]

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[28]Helper (1989a), 42-44, Lamming (1989), 10, Sabel et al. (1989), 16-22.
[29]Helper (1989a), 46. According to Helper (1989b), supplier confidence that their customers will treat them fairly is at a low level and has been virtually constant over the last five years.

CHAPTER II Research Methods

Most of the literature I reviewed analyzed supplier relationships largely in an anecdotal and qualitative fashion. A few exceptions providing quantitative data collection and analysis are Fujimoto (1989), Nishiguchi (1989), and Helper (1989b). Fujimoto, however, focused on product development, and the quantitative data of Nishiguchi were primarily for analyzing the flexibility of suppliers' manufacturing systems. Though Helper provided quantitative data on supplier relationships, her work covered only the United States, including neither overseas data nor analysis of Japanese transplants in the United States. Thus we have literally almost no data for examining the supplier relationships in the two countries as observed in the existing literature.

To examine the current situations of supplier relationships of three groups (American automakers, Japanese automakers in Japan, and Japanese transplants in the United States) and attempt to answer the three questions set at the beginning of this thesis, I adopted two methods:

- a questionnaire survey for quantitative data collection to clarify the current supplier relationships (for question (1) and (2));
- field interviews to analyze the applicability of the Japanese approaches to the situation in the United States (for question (3)).

2.1. Questionnaire survey

I carried out a questionnaire survey of auto manufacturers in the United States and Japan from January through March, 1990. Details of the survey are as follows.

Unit of analysis

The data was collected from automakers rather than suppliers, since supplier relationships are primarily determined by the policy of automakers.[30]

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[30]See, for example, Helper (1989a), Nishiguchi (1989).

One difficulty in analyzing supplier relationships is that it is hard to generalize the relationships across the types of parts since a wide variety of parts is involved. Also, relationships may differ for each car model even in the same company. To overcome this complexity and to control the data analysis, I collected data on the four specific parts (discussed below) of a specific passenger car model chosen by each respondent. Thus the primary unit of analysis is a case of the supplier relationships for a part (among the four parts) of a model. Compared with existing studies, this format allows more systematic and controlled comparisons.

For this survey, I chose the following four specific parts:

- shock absorber
- front seat assembly
- gauge assembly
- instrument panel

The selection criteria were: (1) various types of parts should be included (functional parts/interior parts/electric parts/plastic parts, black-box parts/detail-controlled parts); (2) those parts Japanese transplants are importing from Japan should be excluded[31]; and (3) those parts American automakers only produce internally without procuring from outside should be excluded.

Attributes

Table 2.1 lists the data collected. A broad range of attributes was examined to clarify the current situation of supplier relationships in the two countries in terms of structure and practices. Details of the definitions are provided in Chapter 3, along with the results and analysis. The actual questions are reproduced in Appendix 1.

[31]For this reason, engine related parts were excluded. Currently most engines for Japanese transplants are manufactured in Japan and imported.

Table 2.1 Data Collected by the Questionnaire

Category	Attributes (type)	Corresponding Questions
Model chosen	•market segment (subcompact/compact/midsize/fullsize)	Q1.1.
	•production volume	Q1.2.
	•year of market introduction	Q1.3.
Structure	•number of suppliers	Q2
	•types of suppliers (internal division/affiliated supplier/independent supplier)	Q2
	•types of the major suppliers (ditto)	Q2
Practices	•length of contract and business	Q3
	•alternation of suppliers	Q4
	•supplier selection criteria	Q5
	•role of suppliers in product development (supplier proprietary/ black-box/detail-controlled)	Q6.1.
	•stage of supplier involvement in development	Q6.2.
	•target price ratio	Q7.1.
	•price change rate	Q7.2.
	•rationale behind price increase/decrease	Q7.3.
	•defect rate	Q8.1.
	•defect rate change over time	Q8.2.
	•information possessed by automakers	Q9.1.
	•suggestions made by automakers	Q9.2.

Note: See Appendix 1 for the actual questions.

Sample

Three American automakers, the five largest Japanese automakers, and the six largest Japanese transplants in the United States were initially selected. Their managers of purchasing or planning were then identified and asked to participate. Each automaker was asked to report on more than one model.[32] The sample was not random. The leading Japanese companies were intentionally selected by the author, rather than chosen at random, and each respondent was allowed to decide the number of models and which models they wanted to include. From this, one may assume that the managers probably chose projects for which they have detailed data.

The final result of the response is summarized in Table 2.2. Two of the five Japanese firms chose not to respond for competitive reasons, even though confidentiality was promised. Also, since many managers, especially those of American firms, did not collect data covering various aspects of supplier relationships for all the four parts in sufficient detail, the sample size was smaller than initially planned. In particular, there

Table 2.2 Sample Description

Group	Firms (Response Rate)	Models	Parts analyzed Total	SA	GG	ST	IP
USA	2 (66%)	11	22	7	2	7	6
Japanese transplants	5 (83%)	6	24	6	6	6	6
Japan	3 (60%)	7	27	7	7	7	6
Total	10 (71%)	24	73	20	15	20	18

Note: SA: shock absorber; GG: gauge assembly; ST: front seat assembly; IP: instrument panel. Japanese transplants include two joint ventures with American automakers. Profiles of models chosen are shown in Appendix 3.

[32]All the Japanese transplants except one reported only one model for each, since the number of models produced at each Japanese transplant is limited.

are only two examples for gauge assembly in the American sample, though the other three parts are well-balanced across the three groups. Moreover, for some sensitive questions the sample size was limited.[33]

In spite of these limitations, the data should provide unique quantitative information on supplier relationships in a standardized form, collected from leading American and Japanese automobile manufacturers. Although the sample may not be perfectly representative of the three groups' supplier relationships, neither is it sharply exceptional.

2.2. Field interviews

Field interviews were conducted to elicit in qualitative way the reasons that Japanese transplants can not apply Japanese approaches across the board in the United States (for question (3)). The primary focus of the interviews was on pricing practices, an area which illustrates a most distinctive contrast between the two countries and encompasses various issues of supplier relationships: cost management, quality management, product development, and so on.[34]

From January 22 through February 9, 1990, I interviewed 49 managers of four Japanese auto transplants and 23 Japanese parts suppliers' transplants. Among them one auto transplant and nine supplier transplants are joint ventures with American firms. Though I do not identify these sources due to requests for confidentiality, the interviewees are profiled in Appendix 4.

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[33]The sample size for each question is shown in the analysis in Chapter 3. Also, respondents' confidence about their responses is shown in Appendix 2.

[34]Ideally, field interviews should be conducted before carrying out a questionnaire survey to identify critical information to be collected and/or after carrying out a questionnaire survey to supplement it. Due to time constraints, however, I conducted the questionnaire and the field interviews simultaneously, so that feedback and interactions between two information collection activities were limited.

CHAPTER III Current Situation of Supplier Relationships (Results and Analysis of the Survey)

This chapter presents the results and analysis of the survey of supplier relationships in the United States and Japan. The primary comparisons are between three groups: American automakers, Japanese automakers and Japanese automaker transplants in the United States. Additional comparative factors, such as the types of suppliers and the types of parts, are taken into account, as necessary.[35] It should be remembered that the data below covers only the four parts.

3.1. Structure

Number of suppliers

Table 3.1 shows the number of suppliers[36] per part for a model. There is one exceptional case where an automaker procures constituent parts, rather than seats assembled, from 25 parts suppliers. With that exception, all the parts are supplied as system components or assembled parts. Excluding the exceptional case, the average number of suppliers per part is 1.8 for American automakers, 1.2 for Japanese transplants, and 1.3 for Japanese automakers. Though the number for American automakers still exceeds those for the other two groups with statistical significance at the 10% level, cases of procuring from only one supplier account for 59% of the American sample. It suggests that American automakers now limit the number of suppliers per part, a different feature from the traditional approach.

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[35]One concern was possibilities of biased comparisons between the three groups due to unequal cell frequency in terms of the types of parts and models (segments and production volume) across the three groups (see Table 2.2 and Appendix 3). However, statistical tests and additional analysis clarified that, in most of the attributes, supplier relationships do not depend on the types of parts and models, and even the few exceptions do not disprove the comparative analysis between the three groups in this chapter. Thus the following analysis is reasonably robust for the unbalanced observation frequency regarding the types of parts and models. For details of the tests and analysis, see Appendix 6.

[36]"Suppliers" include internal parts divisions in this chapter.

Another interesting finding is that 30% of the Japanese sample uses two suppliers. A typical case may be that one manufacturer supplies the part for the export version of the model, and the other for the domestic version. It suggests that by using two suppliers simultaneously Japanese automakers make suppliers compete each other. Japanese transplants take an approach similar to that in Japan.

Table 3.1 Number of Suppliers per Part

(Frequency distribution and mean)

# of suppliers	USA	Japan / USA	Japan	Total
1	13 (59.1%)	20 (83.3%)	19 (70.2%)	52 (71.23%)
2	3 (13.6%)	4 (16.7%)	8 (29.6%)	15 (20.6%)
3	3 (13.6%)	0 (0%)	0 (0%)	3 (4.1%)
4	1 (4.6%)	0 (0%)	0 (0%)	1 (1.4%)
5	1 (4.6%)	0 (0%)	0 (0%)	1 (1.4%)
more than 5	1# (4.6%)	0 (0%)	0 (0%)	1 (1.4%)
sample total	22 (100%)	24 (100%)	27 (100%)	73 (100%)
mean ab (mean) a**b*	2.8 (1.8)	1.2 (1.2)	1.3 (1.3)	1.7 (1.4)

Note: The number of suppliers per part for a model.
Suppliers include internal parts divisions here and in the following tables and figures in this chapter.
#:For one model an American automaker procures sub-parts of seats (rather than seats assembled) from 25 parts suppliers.
(Mean) = the mean excluding the exceptional case of procuring from 25 suppliers.

Indication of statistical test:
a , a*, a** = the difference between USA and Japan/USA is statistically significant at the 10% level (a*= 5% level, a**= 1% level);
b, b*, b** =the difference between USA and Japan is significant at the 10%, 5%, and 1% levels.
c, c*, c** =the difference between Japan/USA and Japan is significant at the 10%, 5%, and 1% levels.
The test is based on the Fisher's PLSD (Protected Least Significant Difference) test.
For details of the statistical tests related to this table, see Appendix 5.1.
The same indication will be used for the following tables and figures in this chapter.

Types of the major suppliers

Table 3.2 compares the types of the major suppliers in terms of financial affiliation. The major supplier is defined here as the supplier from which the automaker procures the largest value of the part for the model. Fifty percent of the American automakers' major suppliers in this sample are internal parts divisions and the rest are outside American independent suppliers.[37] Japanese automakers' suppliers in this sample consist of in-house (7%), affiliated suppliers (33%) and independent suppliers (60%). The smaller presence of in-house production and a larger role of affiliated suppliers are features of the

Table 3.2 Types of Major Suppliers

(Frequency distribution)

Types of major suppliers / location	USA	Japan / USA	Japan	Total
in-house (incl. internal div.)	10 (50%)	3 (12.5%)	2 (7.4%)	15 (21.1%)
affiliated supplier / Japan	0 (0%)	1 (4.7%)	9 (33.3%)	14 (19.7%)
affiliated supplier / USA	0 (0%)	5 (20.8%)	0 (0%)	1 (1.4%)
independent Japanese supplier / Japan	0 (0%)	2 (8.3%)	16 (59.3%)	18 (25.4%)
independent Japanese supplier / USA	0 (0%)	4 (16.7%)	0 (0%)	4 (5.6%)
independent U.S. supplier / USA	9 (45%)	9 (37.5%)	0 (0%)	18 (25.4%)
other	1* (5%)	0 (0%)	0 (0%)	1 (1.4%)
US supplier	20 (100%)	9 (37.5%)	0 (0%)	29 (40.8%)
Japanese supplier / USA	0 (0%)	12 (50%)	0 (0%)	12 (16.9%)
Japanese supplier	0 (0%)	3 (12.5%)	27 (100%)	30 (42.3%)
Total	20 (100%)	24 (100%)	27 (100%)	71 (100%)

Note: The major supplier is defined here as the supplier from which the automaker purchases the largest value of the parts for the model.
An affiliated supplier is defined here as one which has 20% or more of its stock owned by the automaker.
* "Other" is a supplier in West Germany.

[37] One exception is a case of importing from a West German supplier.

Japanese sample in comparison with the American. In this aspect, the traditional contrast between the two countries still exists. The Japanese transplant sample has frequency distribution similar to the Japanese, except that American suppliers account for 38%.

The following analysis describes supplier relationships between an automaker and its major supplier.

3.2. Length and stability of relationships

Table 3.3 indicates the length and stability of supplier relationships. First, in terms of the average contract length, the American sample is the shortest (1.7 years), followed by the Japanese transplants (2.5 years) and the Japanese (3.2 years). The frequency distribution is shown in Table 3.4. The table reveals that American contracts are divided into two types: one-year contracts and long-term (4 or 5 years) ones, indicating that though the average contract length of American automakers is shorter than that of the Japanese with statistical significance at 1% level, long-term contracts are also being made. On the other hand, the length of Japanese contracts falls into a broad range from six months to 8 years. The 4-year contract, however, is dominant, accounting for 62%. Japanese transplants resemble the American pattern, with one-year contracts and 4-year contracts.[38]

Though contract length differs among the three groups, the actual duration of purchasing a part is quite uniform. Returning to Table 3.3, one can observe that for each group, the average duration of part transaction (the length of time of purchasing a particular part for a specific model from the same major supplier) is almost equivalent to model life (the length of time of producing one model). In other words, for all the three groups, a part transaction continues as long as the model is made. The responses to the question about changing a major supplier are consistent with this finding. No automaker changed

[38]Two Japanese transplants (8 cases) do not define the formal effective period of transactions in their contracts.

Table 3.3 Length of Contract, Part Transaction, and Model Life

(Mean)

length of	USA	Japan / USA	Japan	Total
contract ^{b**}	1.7 yrs (22)	2.5 yrs (16)	3.2 yrs (26)	3.0 yrs (64)
part trans-action ^{a*c**}	3.2 yrs (21)	1.6 yrs (24)	3.5 yrs (27)	2.8 yrs (72)
model life ^{a**c*}	3.6 yrs (20)	1.7 yrs (24)	3.1 yrs (27)	2.7 yrs (71)
changing suppliers	0 time (21)	0 time (24)	0 time (27)	0 time (72)

Note: ( )= sample size.
The length of part transaction is the total length of time of purchasing a particular part for a specific model from the same major supplier.
The length of model life is the length of time of producing one model.
Changing suppliers indicates how many times the automaker changed a major supplier for the part since the market introduction of the model.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1). For details of the statistical tests see Appendix 5.2, 3,4.

Table 3.4 Length of Contract

(Frequency distribution)

length of contract	USA	Japan / USA	Japan	Total
O.5 yr	0 (0%)	0 (0%)	3 (11.5%)	3 (4.7%)
1 yr	18 (81.8%)	8 (50%)	2 (7.7%)	28 (43.8%)
2 yrs	0 (0%)	0 (0%)	4 (15.4%)	4 (6.2%)
4 yrs	1 (4.6%)	8 (50%)	16 (61.5%)	25 (39.1%)
5 yrs	3 (13.6%)	0 (0%)	0 (0%)	3 (4.7%)
8 yrs	0 (0%)	0 (0%)	1 (3.9%)	1 (1.6%)
sample total	22 (100%)	16 (100%)	26 (100%)	64 (100%)
average length ^{b**}	1.7 yrs	2.5 yrs	3.2 yrs	3.0 yrs

Note: Two Japanese transplants (8 cases) do not define the length of transaction period in the contract.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1).

the major supplier for a part after the market introduction.

One could still assume that American automakers conduct competitive bidding every year when the one-year contract ends. However my supplemental survey of the American respondents who use one-year contracts clarified that in 16 of 17 cases they have not carried out any competitive bidding since the market introduction.

These results clearly indicate that though the average contract length in America is still shorter, the actual duration of purchase of a part for a specific model is as long and stable as in Japan.

Another related issue is the total duration of the business relation on the (buyer) company to (supplier) company level, including transactions of any parts for any models between an automaker and the major supplier. The survey shows that all the relations in Japan have lasted more than ten years (Table 3.5). The American cases have all continued more than five years, with 80% of the sample having lasted more than ten years.[39] In terms of the length of company-to-company relations Japan and the United States are

Table 3.5 Length of Company to Company Relations

(Frequency distribution)

length of the firm business	USA	Japan / USA	Japan	Total
less than 2 years	0 (0%)	6 (26.1%)	0 (0%)	6 (8.3%)
3 to 5 years	0 (0%)	6 (26.1%)	0 (0%)	6 (8.3%)
5 to 10 years	4 (18.2%)	6 (26.1%)	0 (0%)	10 (13.9%)
more than 11 years	18 (81.8%)	5 (21.7%)	27 (100%)	50 (69.4%)
sample total	22 (100%)	23 (100%)	27 (100%)	72 (100%)

Note: The length of the period while the automaker has purchased any parts for any models from the same supplier.

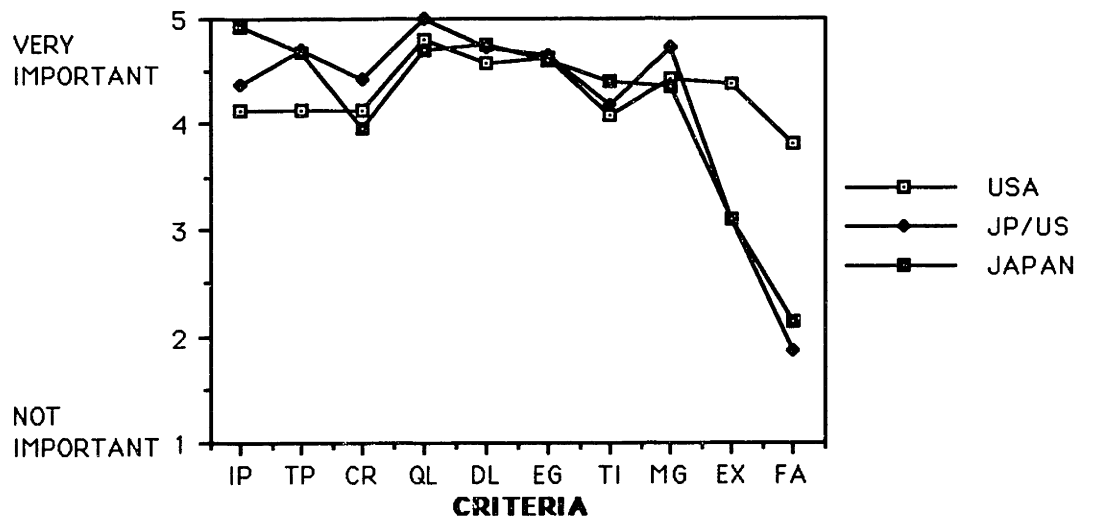
[39]Even if the cases involving internal divisions are excluded, the result for American automakers is little changed: 2 cases (20%) are for 5 - 10 years, and 8 cases (80%) for more than 11 years.

therefore not different.[40] Due to the short history of operation, Japanese transplants do not have long business relations with their suppliers.

3.3. Selection criteria

Figure 3.1 compares the importance of several criteria for automakers in selecting suppliers. Traditionally, American automakers were supposed to put more emphasis on the price /cost criterion than quality and delivery. The result shows just the opposite: American automakers and the Japanese do not differ in importance placed on "quality" and "delivery capability," and Japanese automakers attach more importance to price ("initial price offered" and "target pricing capability in development process").

Figure 3.1. Selection Criteria



Note: IP= initial price offered, TP= target price capability in development process CR= cost reduction capability, QL= quality (conformance to specification) capability, DL= delivery capability, EG= design/engineering capability, TI= technological innovation capability, MG= manufacturing capability, EX= past business experience with your company, FA=financial affiliation (including internal division).
The differences with statistical significance: IP=b**c*, TP=a**b**, CR=c, QL=c*, MG=c EX=a**b**, FA=a**b** (Refer to Table 3.1). For details of the statistical tests see Appendix 5.5.
Sample size: USA = 21, JP/US = 23, JAPAN = 27.

[40]However, whether "cheating" or reneging, one of the traditional American features (see p.12), still exists cannot be determined by this survey.

The largest gaps between American and Japanese automakers are found for "past business experience with your company" and "financial affiliation," on both of which the American firms place more emphasis. The larger role of internal parts divisions for American car producers may offer one explanation why "financial affiliation" is more important for them than for the Japanese.

Other differences with statistical significance are that Japanese transplants consider "quality" and "manufacturing capability" more important than do Japanese automakers. All the respondents of Japanese transplants rated "5" (very important) for "quality." Probably, unsatisfied with the capability of American suppliers (see section 3.6 and Chapter 4), they have to pay more attention to the quality and manufacturing capability of suppliers.

3.4. Development

Role of suppliers

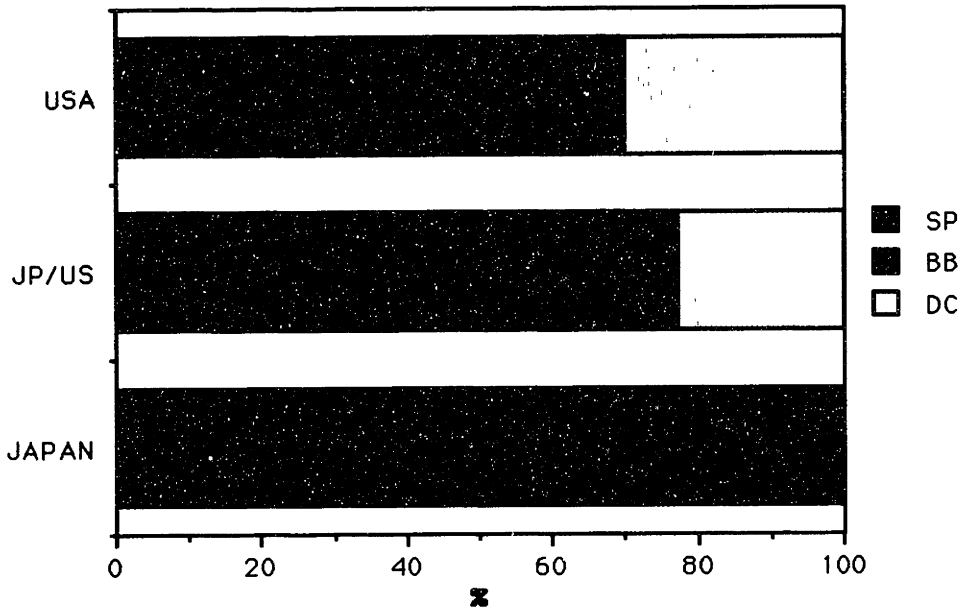
Figure 3.2 depicts the role of suppliers in development. It shows Japanese suppliers play a larger role than the American, but the difference is not so distinct as that found in a survey by Fujimoto (1989), where the ratio of detail-controlled parts for American car producers is far larger (81%).[41] One reason for the discrepancy is that Fujimoto's ratio is based on costs, whereas mine is on the number of cases. Another reason is that my data covers only four parts, while Fujimoto's data includes all parts.[42] One can thus say that as far as my sample is concerned, the role of suppliers in development is not so different in the United States and Japan. Though Japanese

[41] See Table 1.2 (p.13).

[42] Actually, the ratio of detail-controlled parts varies across the four types of parts: 57% for instrument panel, 17% for seat and 0% for shock absorber and gauge. It should be noted that these differences among the four types of parts do not affect the discussion here. See Appendix 6.1.4.

transplants use detail-controlled parts (23%), these are primarily cases of procuring from American suppliers for whom the automakers provided the drawings used in Japan.[43]

Figure 3.2. Role of Suppliers in Development



Note: Frequency distributions of the sample.
SP= supplier proprietary parts, BB= black-box parts, DC= detail-controlled parts.
For definitions see text (p.12).
Sample size: USA= 20, JP/US = 22, JAPAN= 25.

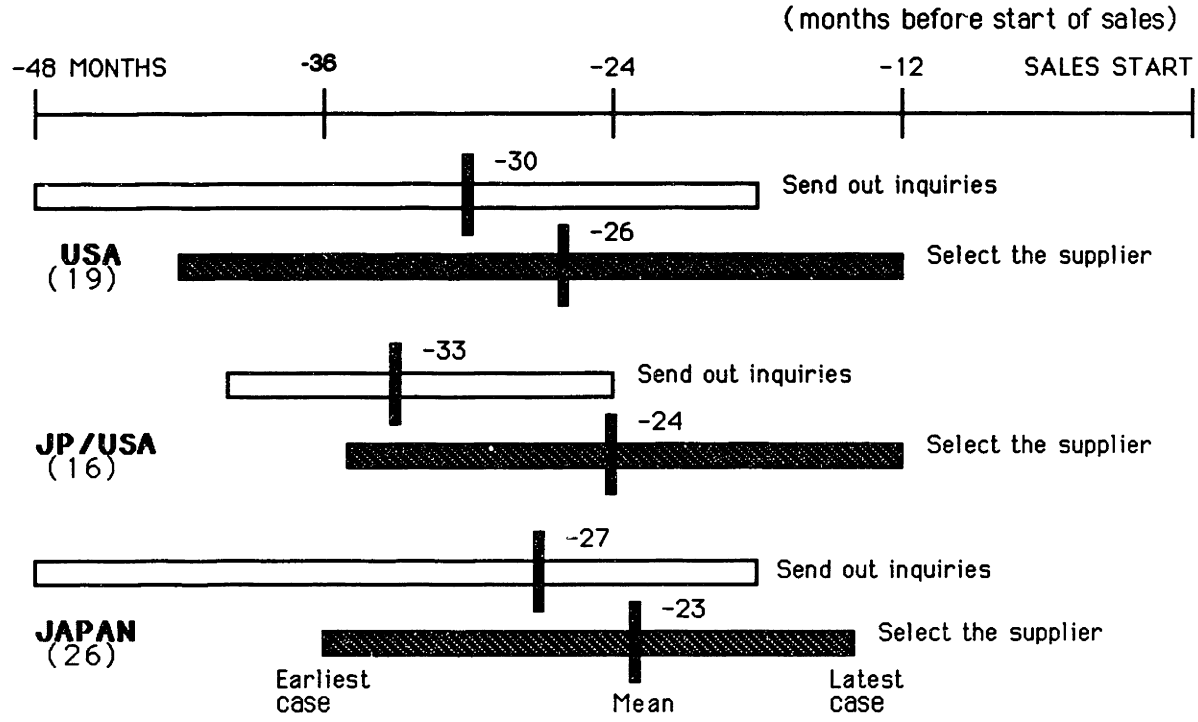
Stage of involvement

Figure 3.3 illustrates supplier involvement in product development, showing how many months prior to the market introduction of a model automakers sent out inquiries to suppliers (white bars) and selected the major supplier (shaded bars). There is no significant difference among the three groups except that Japanese transplants on average

[43]Among the five cases of detail-controlled parts for Japanese transplants, four are those where the major supplier is an American supplier.

sent out inquiries earlier than in Japan. These data indicate America's transition from the traditional approach to a new one of involving suppliers earlier in product development.

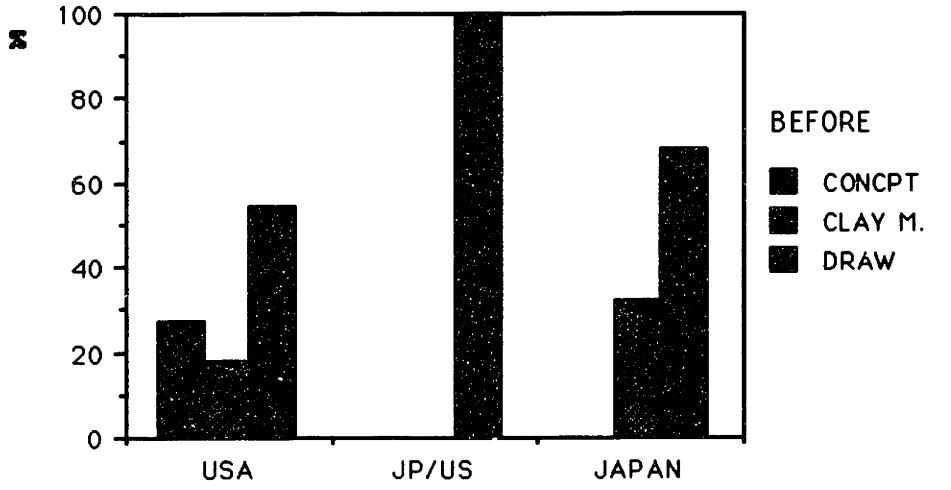
Figure 3.3. Supplier Involvement in Product Development



Note: ( ) = the sample size
The difference between Japan/US and Japan in the stage for sending out inquiries is statistically significant at the 10% level. For details of the statistical tests see Appendix 5.6.

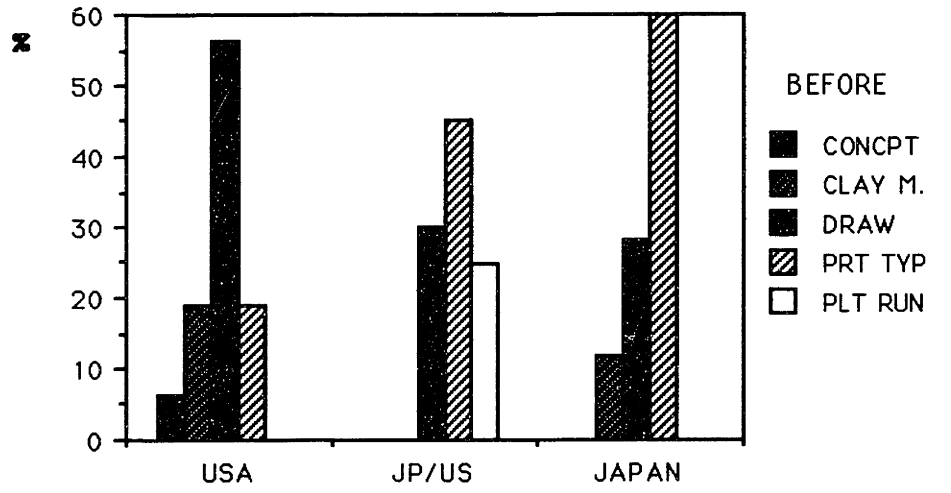
Figure 3.4 and 3.5 examine the same issue from a different angle, showing in which stage of product development suppliers are involved. I chose five milestones of product development: completing concept generation; completing the first clay model; completing the first detailed drawings; completing the first prototype; and starting the pilot run. These figures indicate that American automakers tend to involve suppliers in development at an earlier stage than the Japanese. Compared with Japanese automakers, Japanese transplants involve suppliers at a later stage.

Figure 3.4. Stage for Sending Inquiries



Note: Frequency distribution of the sample.
CONCPT=completing concept generation, CLAY M.= completing the first clay model
DRAW=completing the first detailed drawings
Sample size: USA= 11, JP/US = 20, JAPAN= 25.

Figure 3.5. Stage for Selecting Suppliers



Note: Frequency distribution of the sample.
PRT TYP =completing the first prototype, PLT RUN= starting pilot run
Sample size: USA= 16, JP/US = 20, JAPAN= 25.

In summary, the data indicates that American automakers' supplier policy regarding development have departed from the traditional to new one, with suppliers playing a larger role from an earlier stage in development.

3.5. Pricing practices

Target price ratio and price change rate

I examined pricing practices in terms of "target price ratio" and "price change rate." "Target price ratio" is defined as (actual part price at market introduction of the model)/ (target price the automaker set when it selected the major supplier for the part)*100. It measures how well the target price is achieved. "Price change rate" refers to the average annual price change after market introduction.

Table 3.5 shows the means of target price ratio and price change rate for the three groups; both display a striking contrast. Japanese automakers start purchasing new parts at a price about 2% cheaper than initially targeted and prices drop about 2% annually afterward. American automakers, by contrast, start purchasing new parts at a price about 9% higher than targeted and prices rise about 1% per year after that. Another observation deserving attention is that Japanese transplants do not exhibit performance comparably to the Japanese. Their target price ratio is as high as the American, and their price change rate is between the other two.[44]

Figure 3.6 captures these distinctions vividly. The Japanese cases are concentrated in the lower-left quadrant (low target price ratio and negative price change rate), whereas most of the American cases are positioned in the upper-right area (high target price ratio and positive price change rate). Contrary to the observation of several previous studies that

[44]One reason of the high target price ratio of Japanese transplants lies in the role of suppliers in development. Three out of 18 cases of Japanese transplants are detail-controlled parts and their mean is 128.0, whereas the means of supplier proprietary parts (three cases) and black-box parts (12 cases) are 106.7 and 106.8, respectively. However, even for black-box parts, still the target price ratio of Japanese auto transplants is higher than that of Japanese automakers at the 5% significance level (See Appendix 5.7-6).

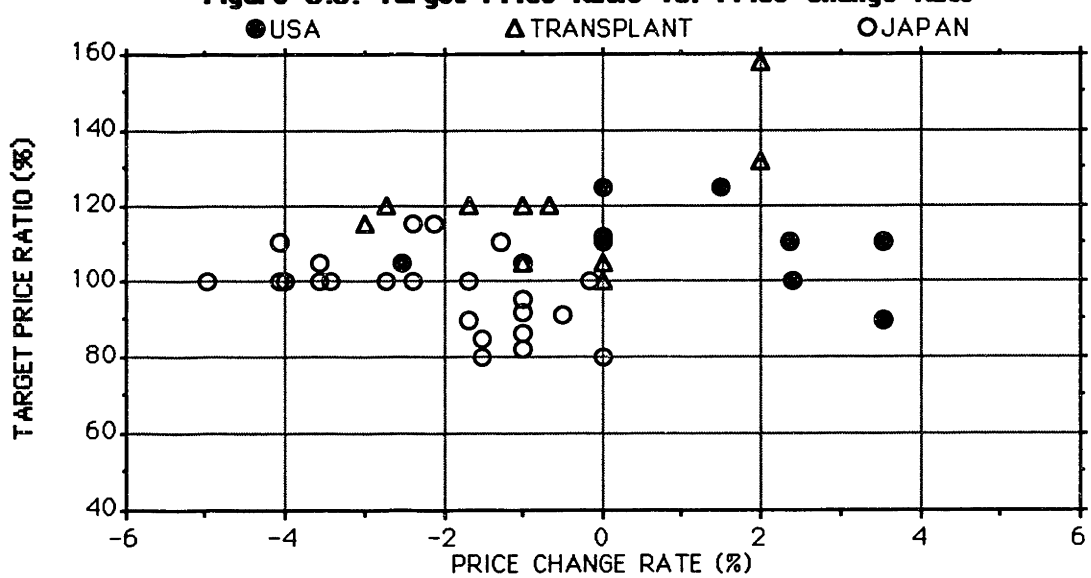
Table 3.5 Pricing Practices

(Mean)

	USA	Japan / USA	Japan	Total
target price ratio b**c**	109.4% (13)	110.7% (19)	97.6% (25)	104.7% (57)
price change rate a*b**c**	0.9% (11)	- 0.4% (16)	-2.1% (26)	-0.9% (53)

Note: ( ) = sample size.
Target price ratio = (actual part price at market introduction)/ (target price the automaker set when it selected the major supplier for the part) * 100 (%).
Price change rate = the average annual rate of price change after the market introduction (excluding the price change when the part's design was changed due to the minor change of the model).
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1). For details of the statistical tests see Appendix 5.7-1, 8-1.

Figure 3.6. Target Price Ratio vs. Price Change Rate



Note: Sample size: USA= 9, TRANSPLANT = 16, JAPAN= 25.

American automakers have recently started asking price reduction of suppliers, the survey shows that for the average as well as for most of the cases of this sample, price has been increasing. The Japanese transplant cases are mostly positioned in the upper-left area: though most of the cases except two achieved a negative price change rate, none had a less-than-100% target price ratio.

Taking into account the types of suppliers, additional findings regarding Japanese transplants surface in Tables 3.6 and 3.7. Both for target price ratio and for price change rate, the cases of procuring from Japanese supplier transplants exhibit the worst performance, the highest target price ratio and positive price change rate, while the cases of procuring from Japanese or American suppliers have lower target price ratio and negative price change rate. Except for that between Japanese suppliers and Japanese supplier transplants regarding price change rate, the differences are not statistically significant in part due to small sample size. At the very least, however, it is an intriguing finding that the combination of Japanese automakers and suppliers, which in Japan shows the best performance, does not exhibit an equivalent performance in the United States. Also it indicates that American suppliers are competitive with Japanese supplier transplants with regard to pricing.

Another difference is that American suppliers have been able to reduce parts price offered to Japanese transplants by about 0.6% annually, while their prices for American automakers have, in contrast, increased by 1% per year. This difference with statistical significance at the 10% level contradicts the assumption that the difference in price change rate between American automakers and Japanese transplants comes only from differences in suppliers. Instead it provides evidence that automakers' approaches may have some bearing on the difference.

Categorizing suppliers by financial affiliation, Table 3.8 highlights additional differences. Both in the American and Japanese samples affiliated suppliers (including internal divisions) offer better price (lower target price ratio) than outside suppliers. But

regarding price change rate, while Japanese affiliated suppliers have reduced price as much as independent suppliers have, American internal parts divisions have raised prices by five times as much as independent suppliers. This is not statistically significant, however.

Table 3.6 Target Price Ratio by Suppliers

(Mean)

	USA	Japan / USA	Japan	Total
with US suppliers	109.4% (13)	107.1% (7)	- (0)	108.6% (20)
w/Japanese suppliers/US	- (0)	114.9% (9)	- (0)	114.9% (9)
w/Japanese suppliers/JP	- (0)	106.7% (3)	97.6% (25)	98.6% (28)
target price ratio b**c**	109.4% (13)	110.7% (19)	97.64% (25)	104.7% (57)

Note: ( ) = sample size.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1). For details of the statistical tests see Appendix 5.7-2,3.

Table 3.7 Price Change Rate by Suppliers

(Mean)

	USA	Japan / USA	Japan	Total
with US suppliers a	0.9% (11)	- 0.6% (7)	- (0)	0.3% (18)
w/Japanese suppliers/US	- (0)	0.4% (6)	- (0)	0.4% (6)
w/Japanese suppliers/JP	- (0)	-1.3% (3)	-2.1% (26)	-2.0% (29)
price change rate a*b**c**	0.9% (11)	- 0.4% (16)	-2.1% (26)	-0.9% (53)

Note: ( ) = the sample size.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1).
The difference between Japanese supplier transplants and Japanese suppliers in Japan for Japanese auto transplants is statistically significant at the 10% level.
For details of the statistical tests see Appendix 5.8-2, 3.

Table 3.8 Pricing Practices with Affiliated Suppliers

(Mean)

attributes	types of suppliers	USA	Japan
target price ratio	internal parts divisions	104.3% (7)	-
	US independent suppliers	117.4% (4)	-
	Japanese affiliated suppliers	-	92.6% (9)
	Jpn independent suppliers	-	100.5% (16)
price change rate	internal parts divisions	1.9% (6)	-
	US independent suppliers	0.4% (4)	-
	Japanese affiliated suppliers	-	- 2.2% (9)
	Jpn independent suppliers	-	- 2.1% (16)

Note: ( ) = sample size.
Due to the limited number of samples in each cell, Japanese transplants are excluded from this analysis.
Regarding target price ratio, the differences between internal part divisions and independent suppliers in the United States, and between affiliated suppliers and independent suppliers in Japan are statistically significant at the 5% level and 10% level, respectively. For details of the statistical tests see Appendix 5.7-4, 5, 5.8-4, 5.

Reasons for price changes

Table 3.9 presents reasons for price increase after market introduction. For American automakers the major reason is material cost, followed by process change and labor cost. Though American suppliers traditionally were allowed to pass on wage increases to price, the result shows labor costs is a cause of price increase in only one out of six cases.

Table 3.10, in turn, indicates reasons for price reduction. The table shows that Japanese automakers exploit a wide variety of means to reduce price/cost. Productivity improvement, design change (VA), die depreciation and defect rate improvement are among

Table 3.9 Reasons for Price Increase

reasons for price increase	USA (6)	Japan / USA (2)	Japan (0)	Total (8)
smaller production volume than expected	0%	0%	-	0%
material cost	83.3%	100%	-	87.5%
machine depreciation	0%	0%	-	0%
die depreciation	0%	0%	-	0%
labor cost	16.7%	0%	-	12.5%
energy cost	0%	0%	-	0%
process change	33.3%	0%	-	25%

Note: ( ) = the sample size.
The ratio is (the number of the respondents who answered the factor is one of the reasons for price increase) / (the number of the respondents whose price increased)*100 (%).

Table 3.10 Sources of Price Reduction

reasons for price decrease	USA (2)	Japan / USA (6)	Japan (25)	Total (32)
larger production volume than expected	0%	0%	4%	3.0%
defect rate improvement	0%	16.7%	64%	51.5%
productivity improvement	50%	100%	100%	97.0%
material cost	0%	66.7%	48%	48.5%
machine depreciation	0%	0%	0%	0%
die depreciation	0%	16.7%	68%	54.6%
labor cost	0%	66.7%	0%	12.1%
energy cost	0%	0%	0%	0%
design change	50%	83.3%	76%	75.8%
process change	0%	83.3%	36%	42.4%
inventory level reduction	0%	0%	28%	21.2%

Note: ( ) = sample size.
The ratio is (the number of the respondents who answered the factor is one of the reasons for price decrease) / (the number of the respondents whose price increased) * 100 (%).

the major mechanisms, followed by material cost, process change and inventory level reduction.

Japanese transplants likewise explore many fronts. In comparison to the Japanese sample, the transplants' ratios of defect rate improvement and die depreciation are lower but those of material cost, labor cost and process change are higher.

In the American sample, the incidence of price reduction is limited (only two cases), as are sources of price reduction, in comparison with the Japanese.[45]

3.6. Quality[46]

Table 3.11 compares the current defect rate ([the number of defective parts[47]] / [the number of parts received] *100), and annual average defect rate changes after market introduction. Again, a marked contrast among the three groups emerges. While enjoying a decrease in the defect rate of about 10% per year, Japanese automakers are receiving parts with the lowest defect rate (0.01%). Defect rates for American automakers have also decreased, but the pace is relatively slow (2%) and the mean defect rate is still high (1.8%). Though the mean rate of Japanese transplants (0.05%) is not yet as low as the Japanese, their improving pace (-30.1%) is fast, indicating their quality level is approaching the Japanese.

Figure 3.7 is a scatter graph of the sample. While there is no American case where defect rate has improved by more than 10% in spite of a relatively higher mean defect rate, in many cases, Japanese transplants and Japanese automakers have improved their defect

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[45]For one American instance of price reduction the reason was "negotiated long-term contract." Though there is only one such case in the survey sample, more than ten of my field interviewees confirmed that recently American automakers are trying to make contracts obliging suppliers to reduce price during the contract period. Japanese automakers do not include this kind of price reduction clause in contract in Japan.

[46]Quality here means quality of conformance.

[47]It should be noted that in defective parts some respondents included those parts delivered in wrong sequence, although physically acceptable. Thus the definition of defective parts is not the same across the respondents. Rather it depends on each respondent's definition of defective parts.

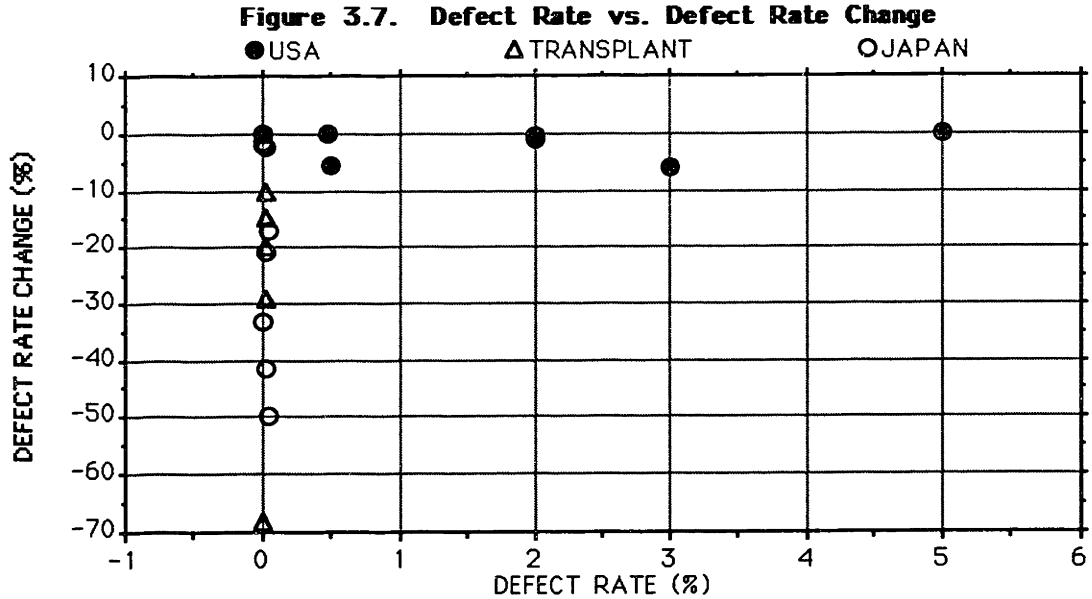
Table 3.11 Defect Rate and Defect Rate Change

(Mean)

	USA	Japan / USA	Japan	Total
defect rate a**b**	1.811% (12)	0.050% (15)	0.010% (25)	0.437% (52)
defect rate change a**c**	- 1.7% (9)	- 30.1% (7)	- 9.5% (25)	- 11.5% (40)

Note: ( ) = sample size.
Defect rate = (the number of defective parts / the number of parts received)*100 (%).
Defect rate change = the average annual rate of defect rate change after market introduction.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1). For details of the statistical tests see Appendix 5.9-1,10-1.

Figure 3.7. Defect Rate vs. Defect Rate Change



Note: Sample size: USA= 7, JP/US = 7, JAPAN= 25.

rates by more than 10% though their defect rates are lower than the American. This means that American automakers still have difficulty catching up with Japan in terms of quality of parts.

Comparing the cases of Japanese transplants in terms of the types of suppliers, Table 3.12 provides a different picture from the previous analysis of pricing practices. In mean defect rate Japanese supplier transplants outperform American suppliers, though still behind Japanese suppliers. American suppliers, however, again show better performance by more than a factor of ten for Japanese transplants than for American automakers with 1% statistical significance. A similar situation may be observed for defect rate change in Table 3.13. This means that some differences between American automakers and Japanese auto transplants in managing supplier relationships have caused the gap in quality. In addition, Table 3.14 shows that American internal parts divisions are poorer in quality than independent suppliers. Their mean defect rate is higher than outside suppliers and their pace of defect rate improvement is slower, though there is no statistical significance, partly due to small sample size.

Table 3.12 Defect Rate by Suppliers

(Mean)

	USA	Japan / USA	Japan	Total
with US suppliers a**	1.811% (12)	0.108% (6)	- (0)	1.247% (18)
with Japanese suppliers/USA	- (0)	0.012% (6)	- (0)	0.021% (6)
with Japanese suppliers/Japan	- (0)	0.007% (3)	0.010% (25)	0.010% (28)
defect rate a**b**	1.811% (12)	0.050% (15)	0.010% (25)	0.437% (52)

Note: ( ) = the sample size.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1). For details of the statistical tests see Appendix 5.9-2, 3.

Table 3.13 Defect Rate Change by Suppliers

(Mean)

	USA	Japan / USA	Japan	Total
with US suppliers a**	-1.7% (8)	-48.8% (2)	- (0)	-11.2% (10)
with Japanese suppliers/USA	- (0)	-31.1% (3)	- (0)	-31.1% (3)
with Japanese suppliers/JP	- (0)	-10.0% (2)	-9.5% (25)	-9.5% (27)
defect rate change a**c**	-1.7% (8)	-30.1% (7)	-9.5% (25)	-11.5% (40)

Note: ( ) = the sample size.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1). For details of the statistical tests see Appendix 5.10-2,3.

Table 3.14 Defect Rate and Defect Rate Change with Affiliated Suppliers

(Mean)

attributes	types of suppliers	USA	Japan
defect rate	internal parts divisions	2.5% (4)	–
	US independent suppliers	1.4% (7)	–
	Japanese affiliated suppliers	–	0.007% (9)
	Jpn independent suppliers	–	0.012% (16)
defect rate change	internal parts divisions	- 1.5% (5)	–
	US independent suppliers	- 2.3% (3)	–
	Japanese affiliated suppliers	–	- 5.6% (9)
	Jpn independent suppliers	–	- 11.7% (16)

Note: ( ) = the sample size.
Due to the limited number of samples in each cell, Japanese transplants are excluded from this analysis.
For details of the statistical tests see Appendix 5.9-4, 5, 10-4, 5.

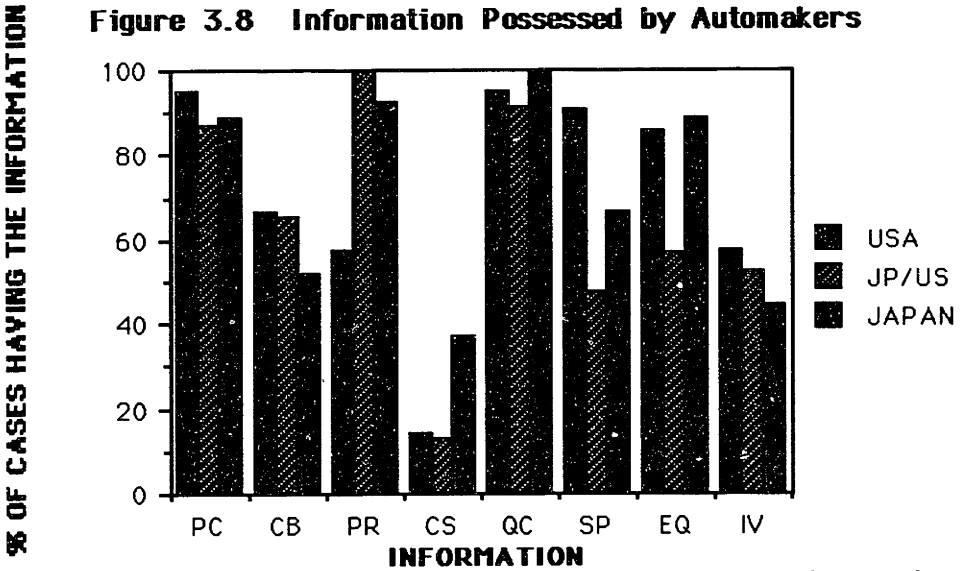
3.7. Information exchange

The final attribute of supplier relationships which I will discuss is information exchange between automakers and suppliers. Figure 3.8 compares the extent to which information about the major supplier is possessed by automakers. There are four major differences among the three groups. First, more Japanese automakers and transplants have information about suppliers' process steps than do American automakers. This may indicate that Japanese automakers pay more attention to suppliers' manufacturing system. The second difference is that more American automakers have statistical process control (SPC) data than the other two groups. Having required suppliers to provide SPC data, American automakers now surpassed Japanese automakers in this aspect. Third, for the cost of each process step, though none of the three has much information, the Japanese automakers have more than the others. Fourth, Japanese transplants' information about equipment used is limited, compared with the other two.

The comparison of suggestions made by automakers brings a more distinct contrast. As shown in Figure 3.9, in every area of suggestion Japanese automakers and transplants exceed the American.. The largest gap is seen for production process changes. More suggestions about inventory level reduction and quality control programs are also made by the Japanese, and American automakers make no suggestions at all about equipment changes. As above, these results hint at the difference between the two countries in automakers' interest or involvement in the suppliers' manufacturing system.

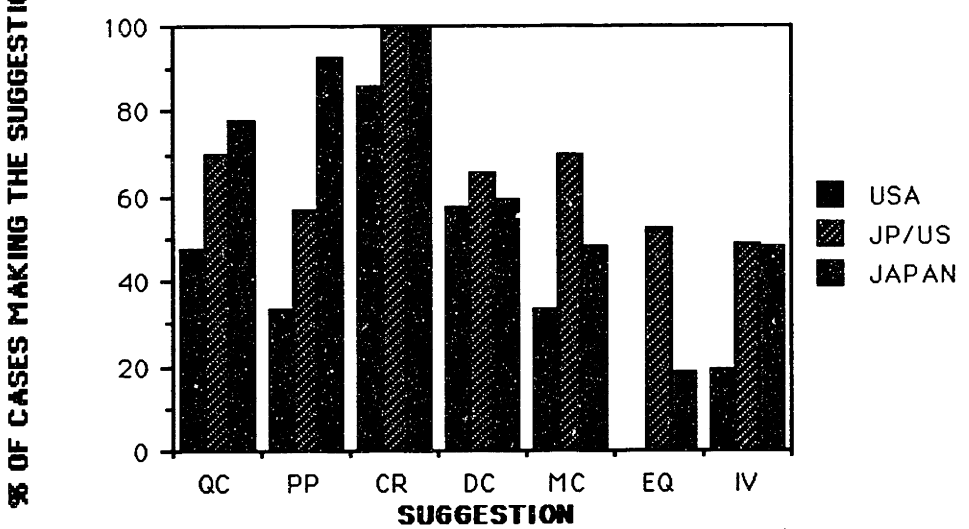
Figure 3.10 presents two indices. One is "information index," which measures how many types of information automakers have about suppliers. The other is "suggestion index," which measures how many types of suggestions automakers provide to suppliers. These indices illustrate that in terms of information possessed no significant difference exists among the three groups but in terms of making suggestions American automakers fall behind the others.

Figure 3.8 Information Possessed by Automakers



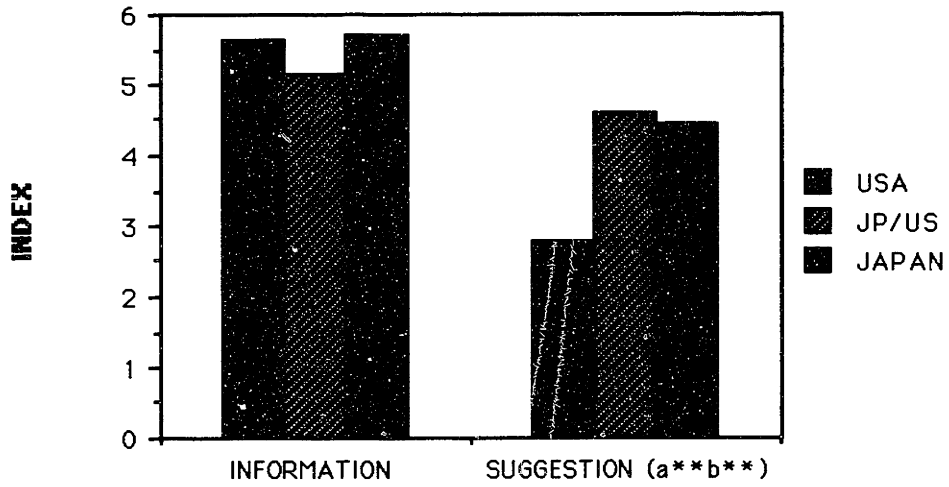
Note: PC=production capacity, CB= cost breakdown into general categories, PR= breakdown of process steps, CS= cost of each process step, QC= quality control program, SP= statistical process control data, EQ= equipment used, IV= inventory level.
Sample size: USA= 21, JP/US = 23, JAPAN= 27.
The chi-square tests show that there is a difference between the three groups with statistical significance for CS (at the 10% level), SP (5%), EQ (5%).
See Appendix 5.11 for details of the statistical tests.

Figure 3.9 Suggestions Made by Automakers



Note: QC=quality control changes, PP= production process changes, CR= cost reduction,DC= design changes, MC= material changes, EQ= equipment changes, IV= inventory control changes
Sample size: USA= 21, JP/US = 23, JAPAN= 27.
The chi-square tests show that there is a difference between the three groups with statistical significance for QC (10%), PP (1%), MC (10%), EQ (1%), IV (10%).
See Appendix 5.12 for details of the statistical tests.

Figure 3.10. Information Exchange Indices



Note: Information index measures how many types of information automakers possess. Thus if an automaker has all the types of information included in Figure 3.8, its information index goes to "8". Suggestion index is calculated in the same way.
Sample size: USA= 21, JP/US = 23, JAPAN= 27.
a, b, c = the statistical significance of the differences between the three groups (refer to Table 3.1). For details of the statistical tests see Appendix 5.13-1,14-1.

Table 3.15 Information Exchange by Suppliers

index	types of suppliers	USA	Japan /US	Japan
information index	internal parts divisions	4.4 (10)	5.0 (2)	6.0 (2)
	US independent suppliers	6.7 (9)	4.9 (9)	–
	Jpn affiliated suppliers	–	5.7 (6)	6.0 (9)
	Jpn independent suppliers	–	5.0 (6)	5.5 (16)
	mean	5.5 (19)	5.1 (23)	5.7 (27)
suggestion index	internal parts divisions	1.3 (10)	6.5 (2)	4.0 (2)
	US independent suppliers	4.1 (9)	5.3 (9)	–
	Jpn affiliated suppliers	–	4.0 (6)	4.1 (9)
	Jpn independent suppliers	–	3.5 (6)	4.6 (16)
	mean	2.6 (19)	4.6 (23)	4.4 (27)

Note: ( ) = sample size.
Both for information index and for suggestion index, the difference between internal suppliers and independent suppliers in the American sample is statistically significant at the 1% level.
For details of the statistical tests see Appendix 5.13-2,14-2.

Comparing information exchange by supplier type, Table 3.15 shows that suggestions made by American automakers for their internal parts divisions are fairly limited. Also the information index of American automakers with internal suppliers is lower than that with independent suppliers, indicating that internal information exchange between assembly divisions and parts divisions is limited, compared with communication with outside suppliers. Another interesting comparison is between American automakers and Japanese transplants. Though Japanese transplants possess less information about American suppliers, they provide more suggestions to their suppliers than American automakers.

3.8. Summary and implications

Table 3.16 summarizes the major findings of the survey analysis. The results indicate that American supplier relationships have changed from the traditional to new ways which resemble Japanese approaches in various attributes.[48] A limited number of suppliers per part; more stable part business without competitive bidding; larger supplier role and earlier involvement in product development; and more emphasis on quality and delivery capability in selecting suppliers are among the areas of similarity.

However, in pricing practices and quality level, the survey revealed a sharp contrast between U.S. and Japanese automakers. Japanese automakers start buying new parts at a price cheaper than initially targeted and prices go down afterward while improving quality at very high level (very low defect rate). To continue price reduction, various ways, such as VA and improvement of manufacturing systems, are utilized. American automakers, in contrast, start buying new parts at a relatively higher price than targeted and prices then increase while the quality improves at a slower pace and with a poorer absolute level.

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[48]No comparable data for the traditional American approaches is available to quantify the transition. But judging from the descriptions of the traditional approaches in existing literature, the results here indicate American approaches have been transformed.

Table 3.16 Major Findings of the Survey

attributes	Japanese	Japanese transplants	USA
Number of suppliers	•small (1.3)	•small (1.2)	•small (1.8)
Types of suppliers	•larger role of affiliated suppliers (33%) •smaller role of in-house production (7%)	•the same as Japanese •purchasing 38% from American suppliers	•larger role of internal parts divisions (50%)
Length of contract	•long (3.2 yrs)	•long and short (2.5 yrs)	•long and short (1.7 yrs)
Length of part transaction	•the same as model life (3.1 yrs)	•the same as model life (1.7 yrs)	•the same as model life (3.6 yrs)
Changing suppliers during model life	•none	•none	•none (no price bidding)
Length of company business	•long (more than 11 yrs)	•short (due to short history)	•long (more than 11 yrs)
Selection criteria	•more emphasis on price	•more emphasis on price and quality	•more emphasis on past business experience and financial affiliation
Development	•DC:0%, BB: 96% SP:4% •early involvement of suppliers (INQ:- 27m,SEL:- 23m)	•DC:23% , BB: 64% SP: 14% •early involvement of suppliers (INQ: - 33m,SEL:- 24m)	•DC:30% , BB: 70% SP: 0% •early involvement of suppliers (INQ: - 30m,SEL:- 26m)
Target price ratio	•below target (98%)	•above target (110%)	•above target (109%)
Price change rate	•decreasing (-2.1%)	•decreasing (-0.4%)	•increasing (+0.9%)
Reasons for price increase			•material cost, process change
Reasons for price decrease	•productivity improvement, VA, die depreciation, defect rate improvement	•productivity improvement, VA, process change, material cost	
Defect rate	•0.01%	•0.05%	•1.811%
Defect rate change	•-9.5%	•-30.1%	•-1.7%
Information exchange with suppliers	•more information of process steps, cost •more suggestions over all •INF: 5.7, SUG: 4.4	•more information of process steps •more suggestions over all •INF: 5.1, SUG: 4.6	•more information on SPC data •less suggestions •INF: 5.6, SUG: 2.8

Note: DC /BB /SP= the ratio of detail-controlled / black-box / supplier proprietary parts in the sample.
INQ / SEL = stage for sending out inquiries to suppliers / selecting the major supplier, in month prior to the market introduction
INF = information index, SUG = suggestion index
See text for details of the definitions.

These differences particularly in dynamic performance (continuous cost reduction and quality improvement at high level) must give extensive competitive advantages to Japanese automakers. The advantages do not lie in only better quality and lower cost of parts at certain moment; such improvement will also be utilized in the next development. For instance, since the price of a part is a critical factor in determining the target price of the part for the next model, price reduction for a part could dictate a correspondingly lower price in the next generation. Most importantly, these quests for dynamic improvement both in costs and quality spur continuous improvement of parts development and manufacturing capabilities.[49] As Dertouzos et al. (1989) claimed, "the cumulative effect of successive incremental improvements and modifications to established products and processes can be very large and may outpace efforts to achieve technological breakthroughs."

What demands attention is the relatively poor performance of American automakers' internal parts divisions in pricing practices and quality. In price change rate, defect rate, and defect rate change, they exhibit worse performance than outside parts suppliers. It seems to indicate American internal parts divisions still live a "sheltered life" and are a source of competitive disadvantage for American automakers, as far as these attributes are concerned.

The survey indicates that suggestions made by automakers have an effect on these differences in performance.[50] Japanese automakers provide suppliers with more suggestions than American automakers, and the gap between them is wide for the suggestions related to manufacturing operation, such as production process changes,

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[49] Price reduction demand by automakers in Japan started as early as the late 1950s. Initially price reductions resulted in poor design quality and high defect rates. But after massive recalls in 1969, Japanese automakers and suppliers started making more efforts to correct defects and improve design quality while continuing cost reductions. (See Cusumano [1985], 245, 335- 340). The long-standing pursuit by Japanese automakers and suppliers since then of cost reductions and improved quality must have made considerable contribution to their gaining the competitive edge in the international market.

[50] Correlation matrix shows that suggestion index is negatively correlated to price change rate and defect rate. See Appendix 5.15.

equipment changes, quality control programs and inventory level improvement. In particular, American automakers make fewer suggestions for, and possess less information about, internal parts divisions than about outside suppliers, indicating a limited flow of internal communication.

Another interesting set of findings concerns the performance of Japanese transplants. They do not exhibit as good a performance as Japanese automakers in target price ratio, price change rate and defect rate, but they outperform the American sample in price change rate, defect rate and defect rate change. On the other hand, American suppliers extend better performance to Japanese auto transplants than to American automakers both in pricing and in quality. With regard to target price ratio and price change rate for Japanese auto transplants, they outperform even Japanese supplier transplants, although lagging behind them in quality. These results indicate, first, that American automakers have some responsibility for their poor performance, rather than American suppliers alone. Second, by their performance for Japanese auto transplants, American suppliers demonstrate their competitiveness with Japanese supplier transplants in pricing, though they need to improve quality further. Third, some areas of Japanese automakers' approaches work effectively in the United States, as shown in better performance of Japanese transplants with American suppliers than American automakers', but other portions are still not viable, as indicated in transplants' worse performance with Japanese supplier transplants than in Japan.

To examine the third argument, the next chapter will analyze obstacles for Japanese transplants in applying Japanese pricing practices in the United States.

CHAPTER IV Pricing Practices of Japanese Transplants

As elaborated in the previous chapter, Japanese auto transplants experience difficulties in applying Japanese pricing practices even with Japanese supplier transplants. This chapter attempts to elucidate the obstacles preventing Japanese transplants from obtaining comparable performance in pricing practices as exist in Japan, and thus to examine the general applicability of Japanese supplier relationships in the United States.[51] The primary information sources for this chapter are my field interviews.[52]

4.1. Target price

In pursuing target pricing, the following are considered obstacles for Japanese automaker and part supplier transplants.

Limited engineering capability

Though some Japanese automakers have begun product development in the United States, most of product and process engineering is still carried out in Japan. As a matter of fact, since usually the same models are produced in Japan, some Japanese transplants set the target price of parts based on the price in Japan. The target price determined in this manner is often difficult to reach in the United States. Two interviewees of Japanese supplier transplants explain,

> The price assigned in Japan assumes that conditions are the same in the United States and Japan. But this is not a correct assumption. (S18)
>
> Without an engineering staff, we can not carry out VE, and it is therefore quite difficult to meet the target price. (S17)

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[51] Pricing practices are deeply related to quality management practices. See Sei (1989) for a detailed analysis of quality management issues of Japanese transplants.

[52] Unless it is deemed necessary, information sources are not referred to in text. Instead, the sources for major findings are shown in Table 4.1 at the end of this chapter (p.64), along with a summary of findings. Sources are all identified by the company code, which is listed in Appendix 4.

The limited engineering capability of Japanese auto and parts transplants thus prevents them from achieving a target price ratio equivalent to that in Japan. It can also plausibly explain why Japanese transplants show lower rank in performance in target price ratio than price change rate. While manufacturing capability, which is the primary source for cost reduction, is substantially transferred to the United States, engineering capability, which is the primary source for achieving the target price, remains across the Pacific.

Regarding American suppliers, their limited engineering capability and unfamiliarity with VE, absent in traditional American practices, make it hard for them to achieve the target price. An engineer of an automaker (A1) particularly pointed to their weakness in process engineering.

> Initially American suppliers present a prototype with a reasonable price. Eventually, however, the price of the product for commercial production often goes up, due to their limited capability in process engineering.

Lack of cost data

In Japan automakers generally have extensive cost analysis database for each type of part, having collected information by requiring suppliers to submit cost data and by their own analysis.[53] However, Japanese transplants have not developed database in part due to their short experiences in America. Another reason is that American suppliers often decline to provide cost data to automakers for competitive and bargaining reasons. This is another hurdle for automakers in setting a feasible target price and thus achieving the target.[54] The same problem faces Japanese suppliers whose American subcontractors refuse to present cost data.

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[53]With a few exceptions, in Japan suppliers provide cost data to automakers in response to automakers' requests. The degree of detail and accuracy of data may vary depending on the case, though.

[54]One questionnaire respondent of a Japanese transplant did not answer the question about target price ratio, saying that "we do not have sufficient data to determine the target prices at this moment."

Higher design quality standard

With regard to design quality, Japanese automakers' requirements for durability and tolerance are often higher than those of American.[55] The driving forces for a higher standard have been the extensive emphasis on quality and the fact that most Japanese cars are designed to be exported around the world facing various driving conditions and consequently requiring more durability and tolerance than cars designed only for a specific country or region. To meet that level of design quality, American suppliers, who have little experience responding to such a requirement, sometimes offer a higher price than Japanese automakers initially assumed.

Even for Japanese parts suppliers it is difficult to reach the target price while meeting the quality requirements because their constituent parts and materials procured from American manufacturers are often expensive for the same reason.[56]

Higher short-term margin rate and product-base business

Another obstacle in target pricing with American suppliers is their higher margin rate requirement. While the typical margin rate (sales, general & administration expenses and profit) assumed in Japan is about 15%, that in the United States is approximately 20-30%. America's higher cost of capital can partly account for the difference. Also Japanese suppliers could accept starting a transaction at low margin, expecting to reduce costs and thus eventually gain higher margin rate in the long term, whereas American suppliers do not accept a short-term lower margin rate. In other words, given a price, Japanese suppliers attempt to reduce the costs over the long term to see a profit, whereas American suppliers set a price based on the currently feasible costs plus an appropriate profit and stick to it.[57]

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[55]For a detailed analysis, see Sei (1989).

[56]Issues regarding second-tier suppliers and material suppliers will be discussed in the next section (pp.61-62).

[57]For similar discussions on differences in pricing in general, see Kaplan et al. (1989), 191, and Hiromoto (1988).

Moreover, Japanese suppliers sometimes comply with low margin rate for a specific part, expecting automakers to allow higher margin rates for other parts. American suppliers, however, tend to put more emphasis on the profitability of each individual product. In other words, business in Japan is carried out on a company-basis, in comparison to a product-basis business in the United States.

American parts suppliers' greater emphasis on short-term product profits seems to be driven in part by pressures from the capital market.[58] Also the volatility of American auto market and production has required suppliers to adhere to short-term profitability and higher risk-adjusted discount rate. On the other hand, in Japan, where both the pressure from the capital market and the volatility of auto production are relatively small, suppliers are somehow able to meet automakers' requirement with less difficulty.

Low volume and short history

Though Japanese transplants have been expanding production, their volume is still small particularly comparing the production volume of individual Japanese transplants with that of U.S. automakers. Due to American manufacturers' favoring mass production, a product with lower volume tends to be charged a higher price, than in Japan.[59]

Lower volume also means limited bargaining power for Japanese transplants. It is difficult for a small customer to require suppliers to offer a favorable price. This is even the case with the business with Japanese supplier transplants, which can not enjoy large production volume and broad product lines as in Japan. Also, the brevity of their operation in the United States makes it difficult for Japanese auto transplants to establish a reputation of long-term mutual benefit, a condition which facilitates pricing practices in Japan.

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[58]The nature of the capital market is not the only cause of America's short time horizons, but is an important factor. For discussions on this issue, see Dertouzos et al. (1989), 53-66.

[59]See, for example, Asanuma (1989b), 32-34, and Dertouzos et al. (1989), 47-49.

4. 2. Price reduction

Japanese transplants encounter a variety of difficulties in trying to reduce costs/prices after starting production.

No tradition in the United States

Though American automakers have recently begun pursuing downward price revisions, the practice is not yet deeply rooted. American suppliers are not familiar with the "profit-sharing" concept, or with VA.

An interesting comment often made by Japanese suppliers in joint ventures with American suppliers is that American suppliers do not have management mechanisms for continuous improvement of manufacturing system. Cost management is a good case in point. American cost accounting measures the variance of actual costs with budgeted cost each month as Japanese suppliers do in Japan, but the use of the data is quite different. American management simply notes the variance and records it, maintaining the target cost constant over a year. The Japanese, in contrast, always makes every effort to reduce actual costs, and revise the target costs downward every month. One American president of a joint venture of American and Japanese suppliers (S21) described the difference:

> Cost management data in American firms is primarily used for accounting purposes, but Japanese firms use it for manufacturing improvement.

A Japanese president of another joint venture (S15) said,

> In Japan, not only the accounting staff but also engineers and quality control staff are involved in cost management. Every month they have a meeting to analyze cost data for the previous month and revise the target cost downward for the following month. This is one of the most serious meetings for our parent company in Japan. Our American partner does not have this kind of meeting. At their company cost management is just handled by accounting staff.

Lack of engineering capability

One critical source of cost reduction in Japan is design changes based on VA. Similar to the situation for target pricing, the lack of engineering capability of Japanese suppliers transplants makes it difficult for them to carry out VA. This is also a problem with American suppliers with limited engineering capability.

Human resources for manufacturing

Another critical source of cost reduction in Japan is continuous improvement of manufacturing system for higher productivity and better quality. Two major areas affecting manufacturing capability for Japanese supplier transplants are workers and maintenance staff.

Some suppliers consider American workers to be less productive than Japanese workers, but others, most of whom have longer operational experiences in the United States, find no substantial difference in workers' capability. Some suppliers say that American workers are good at detecting problems in the process but not at solving them — others disagree with that view, and a few suppliers insist that American workers offer excellent suggestions and are as productive as Japanese. In summary, though the productivity of American workers is an issue for some suppliers, it seems to be a matter of the experience and/or management by suppliers, rather than of the American workers themselves.[60]

In order to secure manufacturing excellence, most of Japanese supplier transplants use state-of-the-art machines.[61] A problem which arises is a shortage of maintenance workers able to keep machine utilization rate at a maximum, a critical requirement for high productivity and cost reduction. One reason for the problem is that the advanced machines

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[60]Studying the human resource utilization system in Japanese auto transplants, Shimada et al. (1986) observed that in most companies the Japanese system operated satisfactorily for routinized production process but whether it can operate in a way that develops a self-generating innovative capacity remained to be seen.

[61]Some Japanese suppliers I visited use newly developed machines which have not even been used in Japan yet.

are usually developed in Japan by suppliers and machine producers so that American workers have no opportunity to learn about the machine.[62] The other root of maintenance difficulties is the paucity of excellent industrial eduction in the United States. Though more sophisticated training in mechanics and electronics is needed to handle new machines, the American vocational education system has failed to respond. The president of a Japanese transplant (A4) claimed,

> The shortage of maintenance workers is a really serious matter for America. America used to have excellent vocational schools, but they have been declining over the past 20 years. We therefore started supporting local vocational education to ensure our survival in the United States.

Higher cost for higher quality

A different notion of the relation between quality (quality of conformance) and cost is another obstacle. In Japan, the basic notion is that better quality reduces cost. However, some American suppliers believe better quality entails higher cost.[63] Because of this notion, Japanese transplants face skepticism when asking suppliers for price reductions while requiring quality improvement at the same time.

Second-tier suppliers and manufacturing infrastructure

Many interviewees pointed to the unsatisfactory level of second-tier subcontractors and manufacturing infrastructure. Though Japanese supplier transplants are attempting to procure more parts in the United States in response to political pressure and to avoid the risk of exchange rate fluctuation, they have encountered difficulties in finding qualified subcontractors in terms of quality and cost. Many Japanese transplants also complain, especially in terms of quality, about the poorer level of basic manufacturing infrastructure such as dies, tools, steels, compound materials for plastics, paints, fasteners and gilding.

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[62]Some companies have started machine development in the United States, and others have started sending American workers to Japan to join machine development.

[63]For Japanese notion, see Ishikawa (1989), 45. For discussions of cost and quality, also see Garvin (1988).

Even big American steel manufacturers, for instance, have barely been able to meet Japanese quality standards.[64]

Two problems result from these limitations. First, it is fairly difficult for Japanese transplants to pursue cost reduction without reliable second-tier suppliers and manufacturing infrastructure. Suppliers in Japan can somehow respond to price reduction requirements of automakers owing to the cooperation of *their* suppliers; as automakers make requests to first-tier suppliers, first-tier suppliers ask second-tier suppliers for price reduction in a similar manner, and so on. As one interviewee (S13) confessed,

> After starting production in the United States, we have come to realize how much we owe our competitiveness to our subcontractors and material suppliers,

without this relationship Japanese supplier transplants can find few sources of cost reductions.

Second, importing parts and materials which can not be procured in the United States often defeats suppliers' efforts at consistent cost reductions due to the fluctuation of exchange rate.

Other difficulties

As is the case in target pricing, weak bargaining power as a consequence of low production volume, and lack of the reputation for long-term mutual benefit also deter Japanese automakers in asking continuous price reductions.

The pressure for short-term profits is again an obstacle. In Japan there is the notion that when automakers face an adverse period, parts suppliers should share the burden by responding to those makers' price reduction requirements. With the expectation of continued business in the future, Japanese suppliers make efforts to meet these pricing requests as much as possible. This practice of "sharing the burden" is fairly difficult for American suppliers to accept under the pressures of the capital market.

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[64]See for detailed discussion Sei (1989).

4.3. Applicability of Japanese approaches

Table 4.1. summarizes the findings discussed above. These obstacles can be classified into two categories: "transitional" and "structural."

Transitional obstacles include limited engineering capability; lack of cost database; low production volume and weak bargaining power; no tradition of price reduction in the United State; and limited productivity of American workers. These obstacles are to a greater or lesser degree controllable by Japanese transplants and are expected to be removed in relatively sooner than the structural obstacles. As more transplants accumulate experience, for example, those claiming that American workers' productivity does not match Japanese will become a minority. Since not only Japanese auto transplants but also American automakers have started requiring continuous price reductions of American suppliers, this may eventually become the accepted practice. Some Japanese automakers and suppliers have already begun partial product development in the United States. Their target price ratio as well as price change rate are consequently expected to improve gradually, although managing engineering staff in the United States poses, for Japanese transplants, a different and even more difficult challenge than that of managing production.

On the other hand, structural obstacles are more difficult to surmount: a higher margin rate requirement; inadequate vocational education; weak second-tier suppliers; and weak manufacturing infrastructure. For Japanese transplants a relatively longer time or much greater effort is required to overcome these obstacles. Developing maintenance workers and capable second-tier suppliers, and shaping the manufacturing infrastructure take time. Some areas have already improved; the American steel industry, for example, has improved its product quality in recent years with support and technical assistance from Japanese automakers and steel manufacturers, but the larger part of the American manufacturing infrastructure is yet to be improved.

Table 4.1. Obstacles for Transplants' Pricing Practices
(A summary of the findings and the sources of information)

Findings	Sources of Information (Company Code)
Obstacles for target pricing	
•Lack of engineering capability of Japanese transplants	A2,S9,11,13,15,17
•Limited engineering capability of American suppliers	A1,S3,16,18,19
•Automakers' limited database for cost analysis	A1,S2
•American suppliers' refusal to provide cost data	S2,9
•Higher design quality requirement from Japanese automakers	A1,2,S2,5,11,13,16, 18,19
•Limited capability of second-tier suppliers	A4,S1,2,5,6,8,10,11, 13,14,16, 20,22,23
•Limited capability of manufacturing infrastructure (dies, fasteners, steels, other materials, tools, gilding)	S1,7,8,9,10,11,13,14, 17,19,23
•Higher profit requirement of American suppliers	A2,S1,6,7,8,9,10,11, 12,13,15,16,17,19,21
•Short-term profit pressure on American suppliers	A4,S6,9,15,16,17,21
•Product-basis business, rather than company-basis business	A4, S7,9,13
•Low production volume and short business history	A4,S4,6,13,18,23
Obstacles for price reduction	
• No tradition of price reduction in the U.S.	A1,S2
•Lack of practice in and mechanism of continuous improvement	A1,S2,3,7,12,13,14, 15,21
•Lack of engineering capability of Japanese transplants	S1,13,15,17
•Limited engineering capability of American suppliers	A1
•(Low productivity of workers)	S2,3,17,19
•(Productivity of workers is the same as that in Japan)	A4,S7,11,13,15
•Shortage of maintenance workers (weak vocational education)	A2,S7,9,17,18
•Higher cost expected for better quality	A1,4,S14,16,20
•Limited capability of second-tier suppliers	A4,S1,2,5,6,8,10,11, 13,14,16, 20,22
•Limited capability of manufacturing infrastructure (dies, fasteners, steels, other materials, tools, gilding)	S1,7,8,9,10,11,13,14, 17,19,23
•No notion of "burden-sharing"	A2,4,S5,6,7,8,10,14
•Low volume and short history	A4,S4,6,13,18,23
•Short-term profit pressure for American suppliers	A4,S6,9,15,16,17,21

Note: For company codes, refer to Appendix 4.

Obstacles like a higher margin rate requirement and product-basis business are more difficult to remove. One may argue that if management assumes a longer-term perspective, American suppliers may be more competitive. To some extent, short-term financial pressure could be reduced by manager commitment to a longer vision, as argued by Dertouzos et al. (1989), but with pressure from the capital market, it seems to remain difficult for American suppliers to make the same decisions as their Japanese counterparts.

As these obstacles reveal, Japanese supplier relationships are built and operated upon a large well-integrated system consisting of not only automakers and first-tier suppliers but also second-tier and third-tier subcontractors, material suppliers and other manufacturing infrastructure, as well as the Japanese capital market. The current poor performance of Japanese transplants will improve, as transitional obstacles are gradually removed, however, lacking some of the favorable structural basis, Japanese supplier relationships will not be fully applicable and Japanese transplants will therefore have to reshape their approaches in the United States.

CHAPTER V Conclusions

5.1. Summary and implications

In an attempt to answer the three questions addressed at the beginning, this thesis has examined supplier relationships in the United States and Japan. Brief answers to the questions are given here.

Question (1) ***What are the features of the current supplier relationships of U.S. automakers, and how are they different from traditional American ones, and from those in Japan?***

•American supplier relationships have changed to include several features similar to Japanese supplier relationships, such as longer-term and more stable purchasing from a limited number of suppliers, larger supplier role and early involvement in development, and more emphasis on quality and delivery capability in selecting suppliers.

•In performance of pricing practices and quality, however, American automakers lag behind the Japanese, where continuous improvement of costs and quality with faster pace at higher level is sought and achieved.

Question (2) ***What are the features of the current supplier relationships of Japanese automaker transplants, and how are they different from American ones, and from those in Japan?***

•Japanese transplants take approaches similar to those in Japan in terms of the number of suppliers, length and stability of business, roles of suppliers in development, selection criteria and information exchange.

•In contrast, their performance in pricing practices and defect rate is inferior to that in Japan, though their performance in price reduction, defect rate and defect rate change exceeds the American.

•American suppliers exhibit better performance in pricing and quality for Japanese auto transplants than for American automakers. Their performance in pricing for Japanese auto

transplants are even better than that of Japanese supplier transplants.

Question (3) ***What are the reasons that Japanese transplants can not fully apply Japanese approaches in the United States?***

•In applying Japanese pricing practices, Japanese transplants face a wide range of obstacles. Some are transitional obstacles which can be overcome, such as limited engineering capability, lack of cost data, no tradition of price reduction and limited productivity of workforce.

•Others are structural obstacles which are difficult to overcome. Weak second-tier suppliers and manufacturing infrastructure, inadequate vocational education and pressure on American suppliers for short-term profits from the American capital market are among them.

These findings contain several implications. First, American automakers still need to improve their supplier relationships to compete with Japanese automakers. A critical strength of Japanese supplier relationships lies in its dynamism towards improvement, as also seen in the Japanese production system. Japanese automakers and suppliers are constantly seeking better quality and lower costs, spurring continuous improvement of manufacturing and development capability. Such dynamism is what American automakers need most to compete with the Japanese.

Better performance in pricing and quality exhibited by Japanese auto transplants with American suppliers demonstrates that automakers' management, rather than country/ cultural factors or supplier capability alone, is a decisive factor for the differences. As discussed in previous studies many stumbling blocks stand in the way of American automakers' seeking more effective supplier relationships. The tendency by internal organizations, if it exists, to retain customary ways should first be overcome. More involvement in supplier operations, especially manufacturing operations, through

suggestion-making , and strengthening internal parts divisions should be key considerations, as indicated by the survey results.

The second implication is that Japanese transplants also need to improve supplier relationships with American suppliers and Japanese supplier transplants. By tackling the transitional obstacles, they can gradually improve performance. For instance, as they bring more engineering capability to the United States, which is essential to pursue lower costs and better quality, their target price ratio and price change rate will improve, though it calls for new challenge of managing engineering staff in the United States. Taking into account structural obstacles, however, they have to cultivate new supplier relationships on "American soil" somewhat different from those in Japan. Careful consideration should be given to the higher margin rate requirement of American suppliers. Insisting on Japanese standard without understanding the difference in the capital markets of the two countries would harm relationships with American suppliers and bring friction.

Third, American suppliers' performance for Japanese auto transplants shows they can be competitive with Japanese supplier transplant in pricing. Their average defect rate is still worse than that of Japanese supplier transplants, but better than that for American automakers. This indicates that joint efforts by Japanese auto transplants and American suppliers could enhance competitiveness in the American parts industry.

Fourth, the weak manufacturing infrastructure frequently pointed to by Japanese transplants is not only a structural obstacle for them but also a serious problem to be remedied for American automakers as well American manufacturing industries in general. As revealed by the analysis of Japanese transplants' obstacles in the United States, Japanese competitive supplier relationships owe much to the well-integrated complex of the manufacturing infrastructure. From the American side, better dies, tools, fasteners, materials, and gilding industries are crucial to competing with Japan. American manufacturing industries need to be more involved in improving the manufacturing

infrastructure, and Japanese transplants can promote the improvement, which would be of benefit to the United States.

5.2. Future research

This thesis is just an initial attempt to explore competitive supplier relationships and the applicability of Japanese approaches. Among a range of research to be done, I mention here the most important points for future research directions.

First, the scope of the survey was somewhat limited. There are many ways to broaden and deepen the scope. This work, for instance, focused on relationships around a limited number of current models. However, the company-to-company relationships rather than transactions for a single product is a promising topic to be analyzed. Covering relationships between a buyer and a supplier as a whole rather than those for a specific model would reveal more of the dynamic aspects of supplier relationships. This survey also did not attempt to measure design quality and technological level of parts. Existing literature ,however, argues the advantage of Japanese approaches in technological competition, and interviewees indicated there are differences in design quality of parts between the two countries. An investigation of these attributes should offer pertinent and intriguing analysis. In another direction, extending the scope to include more types of parts, and to include Europe as well as the United States and Japan will add more diversified perspectives to this thesis.[65]

Second, more studies on the factors behind the differences clarified in this thesis should be carried out. Though I examined factors for Japanese transplants' difficulties in pricing practices in a qualitative fashion, more issues should be analyzed based on a more systematic and controlled data.

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[65]Though it is too late for this thesis, the same questionnaire is being distributed to European automakers.

Third, the primary comparative factors of this thesis were owner nationality and location: American automakers, Japanese automakers and Japanese transplants. Though not discussed in this thesis, I encountered considerable differences *within* the groups, in both the United States and Japan through the survey and the field interviews. As one example, wide variation in purchasing policy has been observed among Japanese transplants. One adopts more Americanized approaches, another attempts to apply Japanese methods, yet another seeks new ways. Likewise, each of the American and Japanese automakers pursues distinct approaches. Comparisons by company rather than owner nationality and location may provide profound and valuable managerial insights.

Finally, this thesis primarily focused on analysis of automakers. Adding analysis from the suppliers standpoint would offer broader and different perspectives.

Taken together, extended research in these directions should allow us to grasp supplier relationships more accurately and thoroughly, contributing to the resources of management and governments, to make more effective decision.

Appendix 1. Questionnaire Sample

Please choose **one of your major passenger car models** which was introduced to market more than one year ago. Please answer the following questions.

Q1. Description of the model you have chosen.

1.1. Market segment (Please check [√])

Subcompact*	[ ]
Compact*	[ ]
Midsize*	[ ]
Fullsize*	[ ]

*Definition:
•Subcompact cars typically have a wheelbase of about 100 inches or less
•Compact cars typically have a wheelbase of over about 101 inches and less than about 105 inches
•Midsize cars typically have a wheelbase of over about 106 inches and less than about 110 inches
•Fullsize cars typically have a wheelbase of over about 111 inches or more

1.2. Production volume of the model per year at your plant (Please check [√])

Less than 100,000	[ ]
100,001 - 200,000	[ ]
200,001 - 300,000	[ ]
300,001 - 400,000	[ ]
More than 400,000	[ ]

1.3. The calendar year of the market introduction

When did you conduct the most recent complete design change (over half the parts were newly designed) for the model? If the current model is a new brand without a predecessor, please write the calender year when you introduced the new model.

(19_____)

For the model you have chosen, please answer these additional questions. We are interested in four parts: **shock absorber (SA); gauge assembly (GG); front seat assembly (ST);** and **instrument panel (plastic injection) (IP).** Please answer the questions **for each of the four parts.**

Q2. Number of parts suppliers

How many parts makers (including internal parts divisions) supply these parts for the model? Please write the number of suppliers in total and the number of each type of suppliers (such as internal parts division, independent parts makers, and affiliated parts makers) among them in ( ) below. If you purchase from more than one supplier, please indicate the type of the **major supplier** for each part by checking [√] corresponding to the type. The major supplier is defined here as the supplier from which you purchase the largest value of the part.

	SA	GG	ST	IP
The number of suppliers in total	( )	( )	( )	( )
Internal parts division(s)	( )[ ]	( )[ ]	( )[ ]	( )[ ]
Affiliated parts maker(s)*	( )[ ]	( )[ ]	( )[ ]	( )[ ]
Independent parts maker(s)*	( )[ ]	( )[ ]	( )[ ]	( )[ ]
American parts maker(s)	( )[ ]	( )[ ]	( )[ ]	( )[ ]
Japanese parts maker(s) in the U.S.	( )[ ]	( )[ ]	( )[ ]	( )[ ]
Others (Please specify)				
_____	( )[ ]	( )[ ]	( )[ ]	( )[ ]

*An affiliated supplier is defined here as a firm in which your company owns a minimum 20% share of its stock.

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q3. Length of contract and business

3.1. The year of starting the purchase

When did you start purchasing the parts for the model from the major suppliers?

SA (19_____) GG (19_____) ST (19_____) IP (19_____)

(How confident are you about these answers (please circle): very , somewhat , not very ?)

3.2. Length of contract

What is the length of the contract (in years) with the major suppliers for the parts?

SA (_____year(s)) GG (_____year(s)) ST (_____year(s)) IP (_____year(s))

(How confident are you about these answers (please circle): very , somewhat , not very ?)

3.3. Length of business

How many years has your company purchased any parts **(including purchases for other models)** from the major suppliers ? Please check [√] below.

	SA	GG	ST	IP
Less than 2 years	[ ]	[ ]	[ ]	[ ]
3 to 5 years	[ ]	[ ]	[ ]	[ ]
5 to 10 years	[ ]	[ ]	[ ]	[ ]
More than 11 years	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q4. Changing the major supplier

If you have changed the major supplier since the market introduction (otherwise please skip this question), please indicate the period when you changed the major supplier by checking [√] below.

	SA	GG	ST	IP
During the 1st year since the introduction	[ ]	[ ]	[ ]	[ ]
During the 2nd year	[ ]	[ ]	[ ]	[ ]
During the 3rd year	[ ]	[ ]	[ ]	[ ]
During the 4th year	[ ]	[ ]	[ ]	[ ]
During the 5th year	[ ]	[ ]	[ ]	[ ]
During the 6th year	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q5. Supplier selection

What degree of importance do you attach to the following criteria in selecting a supplier? Please circle one number. **(5=very important, 1=not important)**

	SA	GG	ST	IP
Initial price offered	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Target cost capability in development process	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Cost reduction capability after market introduction	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Quality (conformity to specification) capability	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Delivery capability	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Design/engineering capability	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Technological Innovation capability	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Manufacturing capability	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Past business experience with your company	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Financial Affiliation (incl. internal division)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Others (Please specify) _____	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q6. Role and involvement of suppliers in design and development

6.1. Role of suppliers

Please categorize the parts in terms of the role of parts suppliers in the parts development by checking [√] below. If you are purchasing from more than one supplier, please answer this question for **the major supplier** (please refer to Q2 for the definition of the major supplier).

	SA	GG	ST	IP
Supplier proprietary parts*	[ ]	[ ]	[ ]	[ ]
Black box parts*	[ ]	[ ]	[ ]	[ ]
Detailed-controlled parts*	[ ]	[ ]	[ ]	[ ]

*Definition:
•Supplier proprietary parts= those parts which are developed entirely by suppliers as standard products.
•Black box parts= those parts whose functional specification is done by your company, while detailed engineering is done by suppliers.
•Detailed-controlled parts= those parts which are developed entirely by your company from functional specification to detailed engineering and produced by suppliers.

(How confident are you about these answers (please circle): very , somewhat , not very ?)

6.2. Stage of involvement

(1) How many months prior to the date of the market introduction did you send out inquiries for the parts to suppliers? And how many months prior to the date of the market introduction did you select the major suppliers?

	SA	GG	ST	IP
Send out inquiries	(months)	(months)	(months)	(months)
Selection of the major supplier	(months)	(months)	(months)	(months)

(How confident are you about these answers (please circle): very , somewhat , not very ?)

(2) At which stage of product development did the major suppliers become involved in the development of the parts? Please indicate the stage at which you sent out inquiries by checking [+], and the stage at which you selected the major suppliers by checking [√] below.

	Example	SA	GG	ST	IP
Before completing concept generation	[ ]	[ ]	[ ]	[ ]	[ ]
Before completing the first clay model	[ ]	[ ]	[ ]	[ ]	[ ]
Before completing the first detailed drawings	[+]	[ ]	[ ]	[ ]	[ ]
Before completing the first prototype	[√]	[ ]	[ ]	[ ]	[ ]
Before starting pilot run	[ ]	[ ]	[ ]	[ ]	[ ]
After starting pilot run	[ ]	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q7. Pricing practices

7.1. Target costing in development stage

To what degree was the targeted cost (which you set when you selected the major suppliers for the parts) achieved at the market introduction of the model?
Please indicate the ratio of **(actual cost at market introduction / targeted cost) *100 (%).**

SA	(%)	GG	(%)
ST	(%)	IP	(%)

(How confident are you about these answers (please circle): very , somewhat , not very ?)

7.2. Pricing revision after starting mass production

How has the price been revised since the market introduction of the model? Please write the changes in procurement price from the major suppliers as an **index (price at the month of market introduction=100).** If you have changed the major supplier for the parts since the market introduction, please write the price changes for the former major suppliers. Also if you have **changed the design of the parts due to a minor change of the model,** please indicate so by checking (√) at the right of the index for the year of the design change of the part. (See example)

	Example	SA	GG	ST	IP
Market Introduction	100	100	100	100	100
After 1 year	[102]( )	[ ]( )	[ ]( )	[ ]( )	[ ]( )
After 2 years	[104](√)	[ ]( )	[ ]( )	[ ]( )	[ ]( )
After 3 years	[105]( )	[ ]( )	[ ]( )	[ ]( )	[ ]( )
After 4 years	[105](√)	[ ]( )	[ ]( )	[ ]( )	[ ]( )
After 5 years	[-]( )	[ ]( )	[ ]( )	[ ]( )	[ ]( )
After 6 years	[-]( )	[ ]( )	[ ]( )	[ ]( )	[ ]( )

(How confident are you about these answers (please circle): very , somewhat , not very ?)

7.3. Rationale behind the revisions

(1) If the price has increased, what were the reasons for that? Please choose the reasons for the recent price increase among the following factors by checking [√] (multiple choice).

	SA	GG	ST	IP
Lower production volume than expected	[ ]	[ ]	[ ]	[ ]
Material cost	[ ]	[ ]	[ ]	[ ]
Machine depreciation	[ ]	[ ]	[ ]	[ ]
Die depreciation	[ ]	[ ]	[ ]	[ ]
Labor cost	[ ]	[ ]	[ ]	[ ]
Energy costs	[ ]	[ ]	[ ]	[ ]
Design change	[ ]	[ ]	[ ]	[ ]
Process changes	[ ]	[ ]	[ ]	[ ]
Others (please specify) _____	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

(2) If the price has decreased, what were the reasons? Please choose the reasons for the recent price decrease among the following factors by checking [√] (multiple choice).

	SA	GG	ST	IP
Higher production volume than expected	[ ]	[ ]	[ ]	[ ]
Defect rate improvement	[ ]	[ ]	[ ]	[ ]
Productivity improvement	[ ]	[ ]	[ ]	[ ]
Material cost	[ ]	[ ]	[ ]	[ ]
Machine depreciation	[ ]	[ ]	[ ]	[ ]
Die depreciation	[ ]	[ ]	[ ]	[ ]
Labor cost	[ ]	[ ]	[ ]	[ ]
Energy costs	[ ]	[ ]	[ ]	[ ]
Design change	[ ]	[ ]	[ ]	[ ]
Process changes	[ ]	[ ]	[ ]	[ ]
Inventory level reduction	[ ]	[ ]	[ ]	[ ]
Others (please specify) _____	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q8. Defect rate

8.1. Defect rate

What is the current defect rate of the parts received from the major suppliers? Please write the current ratio of **(the number of defective parts / the number of parts received) * 100 (%)**.

SA (%) GG (%)
ST (%) IP (%)

(How confident are you about these answers (please circle): very , somewhat , not very ?)

8.2. Defect rate changes over time

How has the defect rate changed since the market introduction? Please indicate the changes, using an **index (defect rate at the month of market introduction=100)**.
(See example)

	Example	SA	GG	ST	IP
Market Introduction	100	100	100	100	100
After 1 year	97	[ ]	[ ]	[ ]	[ ]
After 2 years	96	[ ]	[ ]	[ ]	[ ]
After 3 years	96	[ ]	[ ]	[ ]	[ ]
After 4 years	95	[ ]	[ ]	[ ]	[ ]
After 5 years	-	[ ]	[ ]	[ ]	[ ]
After 6 years	-	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q9. Information exchange

9.1. Information possessed

What type of information do you have about the major suppliers? Please check [√] (multiple choice).

	SA	GG	ST	IP
Production capacity	[ ]	[ ]	[ ]	[ ]
Cost breakdown into general categories (such as overhead, labor, materials)	[ ]	[ ]	[ ]	[ ]
Breakdown of process steps	[ ]	[ ]	[ ]	[ ]
Cost of each process step	[ ]	[ ]	[ ]	[ ]
Quality control program	[ ]	[ ]	[ ]	[ ]
Statistical process control data	[ ]	[ ]	[ ]	[ ]
Equipment used	[ ]	[ ]	[ ]	[ ]
Inventory level	[ ]	[ ]	[ ]	[ ]
Others (Please specify)				
_____	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

9.2. Suggestions for improvement

What type of suggestions for improvement have you given to the major suppliers after the market introduction? Please check [√] (multiple choice).

	SA	GG	ST	IP
Quality control changes	[ ]	[ ]	[ ]	[ ]
Production process changes	[ ]	[ ]	[ ]	[ ]
Cost reduction	[ ]	[ ]	[ ]	[ ]
Design changes	[ ]	[ ]	[ ]	[ ]
Materiel changes	[ ]	[ ]	[ ]	[ ]
Equipment changes	[ ]	[ ]	[ ]	[ ]
Inventory control changes	[ ]	[ ]	[ ]	[ ]
Other (Please specify)				
_____				
_____	[ ]	[ ]	[ ]	[ ]

(How confident are you about these answers (please circle): very , somewhat , not very ?)

Q10. (Optional)
It would be helpful to this study, although not essential, to identify the name of the model you have chosen and the name(s) of the major supplier(s). This is an optional question and the names will be strictly confidential.

Model: [ ]

Name of the major suppliers:

Shock absorber	[	]
Gauge assembly	[	]
Front seat assembly	[	]
Instrument panel	[	]

Thank you very much for your cooperation. We will send you a copy of the survey results. Please give your name and address below.

Name _____

Company _____

Organization _____

_____

Address _____

_____

_____ ZIP_____

Telephone Number (____) _____ – _____

Fax Number (____) _____ – _____

Appendix 2. Confidence of Respondents

•The questionnaire asked each respondent how confident he/she is about his/her answer to each question. Belows are statistical tests of the confidence index for each question.
•The index is calculated by the following rating scale. 1= very confident, 2= somewhat confident, 3= not very confident.
•Refer to Appendix 1 for the actual questions.

Question	Mean (Standard Deviation)				Analysis of Variance				
					F (df)	p	Fisher's PLSD		
	USA	J/US	Jpn	Total			U vs J/U	U vs Jp	J/U vs Jp
Q2	1 (0)	1 (0)	1 (0)	1 (0)	•	•	0	0	0
Q3.1	1.3 (.483)	1 (0)	1 (0)	1.13 (.344)	2.422 (2,20)	.1143	.289*	.275*	.311
Q3.2	1 (0)	1 (0)	1 (0)	1 (0)	•	•	0	0	0
Q3.3	1.222 (.441)	1 (0)	1 (0)	1.095 (.301)	1.496 (2,18)	.2564	.284	.257	.299
Q4	1 (0)	1 (0)	1 (0)	1 (0)	•	•	0	0	0
Q5	1.2 (.422)	1.5 (.548)	1.286 (.488)	1.304 (.47)	.753 (2,20)	.4838	.424	.404	.457
Q6.1	1.222 (.441)	1 (0)	1 (0)	1.091 (.294)	1.604 (2,19)	.2272	.261	.249	.275
Q6.2 (1)	1.375 (.518)	1.833 (.408)	1.667 (1.03)	1.6 (.681)	.802 (2,17)	.4649	.646	.646	.691
Q6.2 (2)	1.667 (.707)	1.5 (.548)	1 (0)	1.409 (.59)	3.14 (2,19)	.0663	.49	.568**	.518
Q7.1	1.857 (.9)	1.833 (.983)	1.8 (1.10)	1.833 (.924)	.0005 (2,15)	.9951	.959	1.009	1.043
Q7.2	1.857 (.9)	2 (1)	1.667 (1.03)	1.833 (.924)	.164 (2,15)	.8506	.998	.946	1.033
Q7.3 (1)	1.25 (.707)	1 (0)	1 (0)	1.111 (.471)	.595 (2,15)	.5639	.573	.438	.584
Q7.3 (2)	1.25 (.463)	1 (0)	1.333 (.516)	1.253 (.437)	.557 (2,14)	.5851	.536	.428	.56
Q8.1	1.875 (.641)	1.833 (.753)	1.167 (.408)	1.65 (.671)	2.61 (2,17)	.1027	.583	.707**	.623*
Q8.2	2.571 (.535)	2.333 (.577)	1.333 (.516)	2.062 (.772)	9.141 (2,13)	.0033	.653	.896***	.817**
Q9.1	1 (0)	1.667 (.516)	1.143 (.378)	1.227 (.429)	7.256 (2,19)	.0046	.512***	.296	.395**
Q9.2	1 (0)	1.6 (.548)	1.143 (.378)	1.19 (.402)	5.167 (2,18)	.0169	.543***	.295	.416**

Note: df = degree of freedom
Fisher's PLSD = Fisher's Protected Least Significant Difference Test (a test to examine a difference between means. See, for instance, Snedecor et al. [1986], 232-236.)
*=significant at the 10% level, **=at the 5% level, ***=at the 1% level.

Appendix 3. Profiles of Sample Models

•Belows are profiles of sample models in terms of segment and production volume.
•As shown, the observation frequency in each cell is not balanced across the three groups. The unbalanced distribution seems to represent the differences in product mix between the three groups. One possible concern nevertheless, was that such unbalanced frequency might have produced some biases in comparisons between the three groups. However, statistical tests and additional analysis clarified that the unequal cell frequency does not disprove the comparative analysis between the three groups in Chapter 3. For details see Appendices 6.2 and 6.3.

profile		USA	Japan / USA	Japan	Total
segment	compact	3 (14.3%)	8 (33.3%)	8 (29.6%)	19 (26.4%)
	subcompact	4 (19.1%)	16 (66.7%)	15 (55.6%)	35 (48.6%)
	midsize	10 (47.6%)	0 (0%)	4 (14.8%)	14 (19.4%)
	fullsize	4 (19.1%)	0 (0%)	0 (0%)	4 (5.6%)
production volume / year	less than 100,000	4 (19.1%)	4 (16.7%)	4 (14.8%)	12 (16.7%)
	100,001 -200,000	3 (14.3%)	16 (66.7%)	11 (40.7%)	30 (41.7%)
	200,001 - 300,000	12 (57.1%)	4 (16.7%)	4 (14.8%)	20 (27.8%)
	300,001 - 400,000	2 (9.5%)	0 (0%)	8 (29.6%)	10 (1.4%)
total sample		21 (100%)	24 (100%)	27 (100%)	72 (100%)

Note: Numbers here show the number of cases included in the category, not the number of car models chosen.
Segmentation is here defined as follows: Subcompact cars typically have a wheelbase of about 100 inches or less. Compact cars typically have a wheelbase of over about 101 inches and less than about 105 inches. Midsize cars typically have a wheelbase of over about 106 inches and less than about 110 inches. Fullsize cars typically have a wheelbase of about 111 inches or more.

Appendix 4. List of Interviewees

	Company Code (Product)	# of interviewees	Position of the interviewee
Automakers	A1 (passenger car)	2	Executive Vice President
			Senior Engineer, Product Eng. & Development
	A2 (passenger car)	4	Purchasing Senior Adviser
			Vice President and Senior Manager, Administration
			Administrator, Corporate Communications
			Administrator, Administration Department
	A3 (passenger car)	1	Purchasing Adviser
	A4 (passenger car)*	4	President
			General Manager, Purchasing
			Coordinator, Purchasing
			Coordinator, General Affairs
Suppliers	S1 (seat)	3	Executive Vice president
			Representative, Sales and Marketing
			Executive Advisor
	S2 (glass)*	2	Manufacturing Manager
			Administration manager
	S3 (electric)	3	President
			Assistant Director
			Assistant General Manager, Marketing and Planning
	S4 (brake)*	1	Account Representative
	S5 (electric)	1	Senior Manager, Application Development Depart.
	S6 (electric)	1	Vice President
	S7 (plastic)*	1	Chairman
	S8 (suspension)	2	President
			Officer Secretary
	S9 (seat)	2	President
			Staff Coordinator, Purchasing
	S10 (fastener)*	1	General Manager, Sales
	S11 (electric)	2	President
			Executive Vice President
	S12 (plastic)*	1	Vice President
	S13 (electric)	1	Vice President
	S14 (seat)*	1	President
	S15 (rubber)*	3	President
			Vice President, Production & Sales
			Administration Manager & Purchasing Manager
	S16 (brake)	1	President
	S17 (electric)	2	President
			Director Business Plan/ Control and Purchasing
	S18 (suspension)*	2	President
			Assistant to President, Sales and Marketing
	S19 (fastener)	1	Vice President
	S20 (rubber)	2	Vice President, Secretary-Treasurer
			Management Staff, General Affairs
	S21 (brake)*	2	President
			Executive Vice President
	S22 (plastic)	1	Executive Vice President
	S23 (radiator)	2	Vice President, Purchasing
			Sr. Advisor of Plant Operations, Dir.of Material Mgmt

Note: Due to requests for confidentiality, the name of companies and persons interviewed can not be identified. The company with "*" is a joint venture of Japanese and American companies. The interviews were jointly conducted by Professor Sei and the author from January 22 through February 9, 1990.

Appendix 5. Results of Statistical Tests

•For the analysis in Chapter 3, three types of statistical tests were performed: analysis of variance (ANOVA) to examine differences of means; chi-square tests for cross-tabulation to examine the independence assumption of two variables of cross-tabs; and correlation matrix analysis to see the correlation coefficient between variables.
•It should be noted that chi-square tests were not conducted for cross-tabs without sufficient expected cell size (when the expected sample size per cell is less than five, the chi-square value becomes unreliable).

•Belows are the results of the statistical tests of the survey.

•Abbreviation:
N=sample size
Std.Dv.=standard deviation
M.Dif.=mean difference
Fisher's PLSD=Fisher's Protected Least Significant Difference Test (see the note for Appendix 2)
*=significant at the 10% level, **=at the 5% level, ***=at the 1% level
DF= degree of freedom

5.1-1. ANOVA (Analysis of variance) of number of suppliers

Category: The three groups **Attribute analyzed:** Number of suppliers

F-test: DF = 2, 70 F = 2.454, p=.0923

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	22	2.818	5.086	US vs JP/US	1.652	1.654*
JP/US	24	1.167	.381	US vs JP	1.522	1.609*
JP	27	1.296	.465	JP/US vs JP	-.13	1.314

5.1-2. ANOVA of number of suppliers (excluding one exceptional case)

Category: The three groups **Attribute analyzed:** Number of suppliers
Sample range: Excluding one exceptional case of procuring from 25 suppliers in the American sample

F-test: DF = 2, 69 F = 4.071, p=.0213

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	1.762	1.179	US vs JP/US	.595	.578***
JP/US	24	1.167	.381	US vs JP	.466	.424**
JP	27	1.296	.465	JP/US vs JP	-.13	.341

5.2. ANOVA of contract length

Category: The three groups **Attribute analyzed:** Contract length

F-test: DF = 2, 61 F = 5.546, p=.0.61

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	22	1.682	1.492	US vs JP/US	-.818	.87
JP/US	16	2.5	1.549	US vs JP	-1.53	1.221***
JP	26	3.212	1.68	JP/US vs JP	-.712	.842

5.3. ANOVA of part transaction length

Category: The three groups **Attribute analyzed:** Part transaction length

F-test: DF = 2, 69 F = 6.103, p=.0036

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	3.238	2.528	US vs JP/US	1.655	1.248**
JP/US	24	1.583	.584	US vs JP	-.28	1.016
JP	27	3.519	2.532	JP/US vs JP	-1.935	1.556***

5.4. ANOVA of model life

Category: The three groups **Attribute analyzed:** Model life

F-test: DF = 2, 68 F = 5.666, p=.0053

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	20	3.55	2.892	US vs JP/US	1.883	1.59***
JP/US	24	1.667	.482	US vs JP	.439	.975
JP	27	3.111	1.987	JP/US vs JP	-1.444	1.109**

5.5-1. ANOVA of selection criteria (initial price offered)

Category: The three groups **Attribute analyzed:** Importance of initial price offered

F-test: DF = 2, 68 F = 7.012, p=.0017

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.143	1.014	US vs JP/US	-.248	.367
JP/US	23	4.391	.839	US vs JP	-.783	.576***
JP	27	4.926	.267	JP/US vs JP	-.535	.423**

5.5-2. ANOVA of selection criteria (target price)

Category: The three groups **Attribute analyzed:** Importance of target price capability

F-test: DF = 2, 68 F = 6.204, p=.0034

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.143	.793	US vs JP/US	-.553	.47***
JP/US	23	4.696	.47	US vs JP	-.524	.453***
JP	27	4.667	.48	JP/US vs JP	.029	.278

5.5-3. ANOVA of importance of selection criteria (cost reduction)

Category: The three groups **Attribute analyzed:** Importance of cost reduction capability

F-test: DF = 2, 68 F = 1.925, p=.1537

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.143	.964	US vs JP/US	-.292	.428
JP/US	23	4.435	.728	US vs JP	.18	.413
JP	27	3.963	.854	JP/US vs JP	.472	.402*

5.5-4. ANOVA of selection criteria (quality)

Category: The three groups **Attribute analyzed:** Importance of quality capability

F-test: DF = 2, 68 F = 3.545, p=.0373

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.81	.402	US vs JP/US	-.19	.201
JP/US	23	5	0	US vs JP	.106	.194
JP	27	4.704	.542	JP/US vs JP	.296	.226**

5.5-5. ANOVA of selection criteria (delivery capability)

Category: The three groups **Attribute analyzed:** Importance of delivery capability

F-test: DF = 2, 68 F = .436, p=.6483

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.571	.978	US vs JP/US	-.168	.349
JP/US	23	4.739	.449	US vs JP	-.169	.337
JP	27	4.741	.594	JP/US vs JP	-.002	.328

5.5-6. ANOVA of selection criteria (design/eng. capability)

Category: The three groups **Attribute analyzed:** Importance of design/engineering capability

F-test: DF = 2, 68 F = .052, p=.9491

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.619	.498	US vs JP/US	-.033	.327
JP/US	23	4.652	.714	US vs JP	.026	.315
JP	27	4.593	.694	JP/US vs JP	.06	.307

5.5-7. ANOVA of selection criteria (technological capability)

Category: The three groups **Attribute analyzed:** Importance of technological innovation capability

F-test: DF = 2, 68 F = .822, p=.4437

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.095	.831	US vs JP/US	-.079	.447
JP/US	23	4.174	.984	US vs JP	-.312	.431
JP	27	4.407	.844	JP/US vs JP	-.233	.42

5.5-8. ANOVA of selection criteria (manufacturing capability)

Category: The three groups **Attribute analyzed:** Importance of manufacturing capability

F-test: DF = 2, 68 F = 1.997, p=.1436

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.429	.598	US vs JP/US	-.311	.345
JP/US	23	4.739	.541	US vs JP	.058	.332
JP	27	4.37	.839	JP/US vs JP	.369	.324*

5.5-9. ANOVA of selection criteria (past experience)

Category: The three groups **Attribute analyzed:** Importance of past business experience

F-test: DF = 2, 68 F = 10.388, p=.0001

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	4.381	.805	US vs JP/US	1.294	.865***
JP/US	23	3.087	1.311	US vs JP	1.27	.833***
JP	27	3.111	1.05	JP/US vs JP	-.024	.511

5.5-10. ANOVA of selection criteria (financial affiliation)

Category: The three groups **Attribute analyzed:** Importance of financial affiliation

F-test: DF = 2, 68 F = 18.408, p=.0001

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	3.81	1.209	US vs JP/US	1.94	.916***
JP/US	23	1.87	1.217	US vs JP	1.661	.883***
JP	27	2.148	1.027	JP/US vs JP	-.279	.542

5.6-1. ANOVA of suppliers involvement stage (sending inquiries)

Category: The three groups **Attribute analyzed:** Stage of sending inquiries to suppliers in months prior to the market introduction

F-test: DF = 2, 58 F = 2.064, p=.1362

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	19	30.16	10.128	US vs JP/US	-2.342	5.104
JP/US	16	32.5	7.043	US vs JP	3.312	4.54
JP	26	26.85	9.177	JP/US vs JP	5.654	4.78*

5.6-2. ANOVA of suppliers involvement stage (selecting suppliers)

Category: The three groups **Attribute analyzed:** Stage of selecting the major supplier in months prior to the market introduction

F-test: DF = 2, 62 F = .772, p=.4664

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	19	25.53	10.803	US vs JP/US	1.726	4.317
JP/US	16	23.8	6.031	US vs JP	3.026	4.067
JP	26	22.5	7.055	JP/US vs JP	1.3	4.008

5.7-1. ANOVA of target pricing

Category: The three groups **Attribute analyzed:** Target price ratio

F-test: DF = 2, 54 F = 7.522, p=.0013

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	13	109.4	11.177	US vs JP/US	-1.352	7.325
JP/US	19	110.7	15.106	US vs JP	11.745	11.101***
JP	25	97.64	9.979	JP/US vs JP	13.097	9.881***

5.7-2. ANOVA of target pricing (for Japanese transplants)

Category: Types of suppliers in terms of owner nationality
Attribute analyzed: Target price ratio
Sample range: The Japanese transplant sample

F-test: DF = 2, 16 F = .062, p=.5506

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US supplier	7	107.1	7.638	US vs JP/US	7.746	17.968
J/U supplier	9	114.9	20.009	US vs JP	-.476	18.599
JP supplier	3	106.7	9.063	JP/US vs JP	-8.222	13.583

5.7-3. ANOVA of target pricing (for American suppliers)

Category: American automakers, Japanese auto transplants
Attribute analyzed: Target price ratio
Sample range: The cases of procuring from American suppliers

F-test: DF = 1, 18 F = .207, p=.6549

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US automakers	13	109.4	11.177	US vs JP/US	2.242	8.553
J/U automakers	7	107.1	9.063			

5.7-4. ANOVA of target pricing (for American automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Target price ratio
Sample range: The American automaker sample

F-test: DF = 1, 8 F = 5.136, p=.0469

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
INT supplier	7	104.3	11.701	INT vs IND	-13.114	12.895**
IND supplier	9	117.4	6.229			

5.7-5. ANOVA of target pricing (for Japanese automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Target price ratio
Sample range: The Japanese automaker sample

F-test: DF = 1, 23 F = 4.155, p=.0532

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
AFD supplier	9	92.6	8.988	AFD vs IND	-7.944	6.68*
IND supplier	16	100.5	9.543			

5.7-6. ANOVA of target pricing (black-box parts)

Category: The three groups **Attribute analyzed:** Target price ratio
Sample range: The cases of black-box parts

F-test: DF = 2, 41 F = 5.291, p=.009

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	8	110	12.817	US vs JP/US	3.25	8.208
JP/US	12	106.8	10.279	US vs JP	12.25	11.783***
JP	24	97.75	10.148	JP/US vs JP	9	7.63**

5.8-1. ANOVA of price change rate

Category: The three groups **Attribute analyzed:** Price change rate

F-test: DF = 2, 50 F = 16.979, p=.0001

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	11	.917	1.926	US vs JP/US	1.299	1.18**
JP/US	16	-.382	1.354	US vs JP	2.992	1.445***
JP	26	-2.075	1.383	JP/US vs JP	1.692	1.276***

5.8-2. ANOVA of price change rate (for Japanese transplants)

Category: Types of supplier in terms of owner nationality
Attribute analyzed: Price change rate
Sample range: The Japanese transplant sample

F-test: DF = 2, 13 F = 2.093, p=.1629

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US supplier	7	-.634	1.124	US vs JP/US	1.02	1.247
J/U supplier	6	.386	1.31	US vs JP	-.7	1.547
JP supplier	3	-1.333	1.528	JP/US vs JP	-1.72	1.585*

5.8-3. ANOVA of price change rate (for American suppliers)

Category: American automakers, Japanese auto transplants
Attribute analyzed: Price change rate
Sample range: The cases of procuring from American suppliers

F-test: DF = 1, 16 F =3.683, p=.073

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US automakers	11	.917	1.926	US vs JP/US	1.551	1.411*
J/U automakers	7	-.634	1.124			

5.8-4. ANOVA of price change rate (for American automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Price change rate
Sample range: The American automaker sample

F-test: DF = 1, 8 F = 2.474, p=.1544

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
INT supplier	6	1.877	1.565	INT vs IND	1.537	1.818
IND supplier	4	.339	1.425			

5.8-5. ANOVA of price change rate (for Japanese automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Price change rate
Sample range: The Japanese automaker sample

F-test: DF = 1, 23 F = .133, p=.7186

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
AFD supplier	9	-2.274	1.088	AFD vs IND	-.213	.999
IND supplier	16	-2.061	1.539			

5.9-1. ANOVA of defect rate

Category: The three groups **Attribute analyzed:** Defect rate

F-test: DF = 2, 49 F = 37.224, p=.0001

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	12	1.811	1.322	US vs JP/US	1.762	.653***
JP/US	15	.050	.109	US vs JP	1.801	.592***
JP	25	.010	.014	JP/US vs JP	.039	.345

5.9-2. ANOVA of defect rate (for Japanese transplants)

Category: Types of supplier in terms of owner nationality
Attribute analyzed: Defect rate
Sample Range: The Japanese transplant sample

F-test: DF = 2, 12 F = 1.58, p=.246

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US supplier	6	.108	.162	US vs JP/US	-.006	.108
J/U supplier	6	.012	.009	US vs JP	-.102	.132
JP supplier	3	.007	.012	JP/US	-.096	.132

5.9-3. ANOVA of defect rate (for American suppliers)

Category: American automakers, Japanese auto transplants
Attribute analyzed: Defect rate
Sample Range: The cases of procuring from American suppliers

F-test: DF = 1, 16 F =9.59, p=.0069

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US automakers	12	1.811	1.926	US vs JP/US	1.703	1.606***
J/U automakers	6	.108	1.124			

5.9-4. ANOVA of defect rate (for American automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Defect rate
Sample Range: The American automaker sample

F-test: DF = 1, 9 F = 1.755, p=.2179

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
INT supplier	4	2.5	2.082	INT vs IND	1.109	1.535
IND supplier	7	1.391	.714			

5.9-5. ANOVA of defect rate (for Japanese automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Defect rate
Sample Range: The Japanese automaker sample

F-test: DF = 1, 23 F = .705, p=.4097

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
AFD supplier	9	.007	.01	AFD vs IND	-.005	.01
IND supplier	16	.012	.016			

5.10-1. ANOVA of defect rate change

Category: The three groups **Attribute analyzed:** Defect rate change

F-test: DF = 2, 38 F = 6.103, p=.005

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	9	-1.672	2.383	US vs JP/US	28.442	22.297***
JP/US	7	-30.11	27.566	US vs JP	7.791	10.934
JP	25	-9.463	15.772	JP/US vs JP	14.442	19.344***

5.10-2. ANOVA of defect rate change (for Japanese transplants)

Category: Types of supplier in terms of owner nationality
Attribute analyzed: Defect rate change
Sample Range: The Japanese transplant sample

F-test: DF = 2, 4 F = .987, p=.4483

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US supplier	2	-48.75	14.142	US vs JP/US	17.65	53.769
J/U supplier	3	-31.1	32.313	US vs JP	38.75	58.901
JP supplier	2	-10	27.648	JP/US vs JP	17.65	53.769

5.10-3. ANOVA of defect rate change (for American suppliers)

Category: American automakers, Japanese auto transplants
Attribute analyzed: Defect rate change
Sample Range: The cases of procuring from American suppliers

F-test: DF = 1, 8 F =34.902, p=.0004

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
US automakers	8	-1.786	2.521	US vs JP/US	46.969	26.675***
J/U automakers	2	-48.75	27.648			

5.10-4. ANOVA of defect rate change (for American automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Defect rate change
Sample Range: The American automaker sample

F-test: DF = 1, 6 F = .211, p=.6622

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
INT supplier	5	-1.45	2.505	INT vs IND	.898	3.798
IND supplier	3	-2.347	2.99			

5.10-5. ANOVA of defect rate change (for Japanese automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Defect rate change
Sample Range: The Japanese automaker sample

F-test: DF = 1, 23 F = .852, p=.3655

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
AFD supplier	9	-5.568	13.525	AFD vs IND	6.085	11.299
IND supplier	16	-11.65	16.918			

5.11-1. Chi-square test for cross-tabulation of information possessed (cost breakdown)

Attributes analyzed: The three groups vs. Whether it possesses information about cost breakdown into general categories or not

DF = 2 **Total Chi-Square** = 1.394, p=.4981

5.11-2. Chi-square test for cross-tabulation of information possessed (cost of each process)

Attributes analyzed: The three groups vs. Whether it possesses information about cost of each process step or not

DF = 2 **Total Chi-Square** = 5.258, p=.0721

5.11-3. Chi-square test for cross-tabulation of information possessed (SPC data)

Attributes analyzed: The three groups vs. Whether it possesses SPC data or not

DF = 2 **Total Chi-Square** = 9.135, p=.0104

5.11-4. Chi-square test for cross-tabulation of information possessed (equipment used)

Attributes analyzed: The three groups vs. Whether it possesses information about equipment used or not

DF = 2 **Total Chi-Square** = 8.616, p=.0135

5.11-5. Chi-square test for cross-tabulation of information possessed (inventory level)

Attributes analyzed: The three groups vs. Whether it possesses information about inventory level or not

DF = 2 **Total Chi-Square** = .791, p=.6732

5.12-1. Chi-square test for cross-tabulation of suggestions made (quality control)

Attributes analyzed: The three groups vs. Whether it made suggestions about quality control or not

DF = 2 **Total Chi-Square = 4.974, p=.0832**

5.12-2. Chi-square test for cross-tabulation of suggestions made (production process)

Attributes analyzed: The three groups vs. Whether it made suggestions about production process changes or not

DF = 2 **Total Chi-Square = 18.562, p=.0001**

5.12-3. Chi-square test for cross-tabulation of suggestions made (design change)

Attributes analyzed: The three groups vs. Whether it made suggestions about design change or not

DF = 2 **Total Chi-Square = .331, p=.8476**

5.12-4. Chi-square test for cross-tabulation of suggestions made (material change)

Attributes analyzed: The three groups vs. Whether it made suggestions about material changes or not

DF = 2 **Total Chi-Square = 5.879, p=.0529**

5.12-5. Chi-square test for cross-tabulation of suggestions made (equipment changes)

Attributes analyzed: The three groups vs. Whether it made suggestions about equipment changes or not

DF = 2 **Total Chi-Square =17.113, p=.0002**

5.12-6. Chi-square test for cross-tabulation of suggestions made (inventory control)

Attributes analyzed: The three groups vs. Whether it made suggestions about inventory control changes or not

DF = 2 **Total Chi-Square = 5.191, p=.0746**

5.13-1. ANOVA of information index

Category: The three groups **Attribute analyzed:** Information index

F-test: DF = 2, 68 F = 6.973, p=.3831

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	5.619	1.802	US vs JP/US	.489	.77
JP/US	23	5.13	1.456	US vs JP	-.085	.742
JP	27	5.704	1.353	JP/US vs JP	-.573	.724

5.13-2. ANOVA of information index (for American automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Information index
Sample Range: The American automaker sample

F-test: DF = 1, 17 F = 11.366, p=.0036

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
INT supplier	10	4.4	1.713	INT vs IND	-2.267	1.949***
IND supplier	9	6.667	1.118			

5.14-1. ANOVA of suggestion index

Category: The three groups **Attribute analyzed:** Suggestion index

F-test: DF = 2, 68 F = 7.989, p=.0008

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	21	2.762	1.947	US vs JP/US	-1.847	1.358***
JP/US	23	4.609	1.901	US vs JP	-1.683	1.309***
JP	27	4.444	1.251	JP/US vs JP	.164	.803

5.14-2. ANOVA of suggestion index (for American automakers)

Category: Types of suppliers in terms of financial affiliation
Attribute analyzed: Suggestion index
Sample Range: The American automaker sample

F-test: DF = 1, 17 F = 18.187, p=.0005

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
INT supplier	10	1.3	.823	INT vs IND	-2.811	1.911***
IND supplier	9	4.111	1.9			

5.15. Correlation Matrix

(Correlation coefficient)

	TPR	PCR	DR	DRC	#SUP	CL	INQ	SEL	INF	SUG
TPR	1									
PCR	-.155	1								
DR	-.022	.712	1							
DRC	-.391	-.051	.18	1						
#SUP	-.237	.339	.04	.146	1					
CL	-.03	-.42	-.366	.222	-.007	1				
INQ	.529	-.16	-.183	-.538	-.088	-.158	1			
SEL	.476	-.274	-.062	-.215	-.222	-.193	.858	1		
INF	.02	-.175	-.072	-.318	-.03	-.212	.165	.293	1	
SUG	.335	-.456	-.354	.151	.066	.244	.47	.471	.539	1

Note:TPR = target price ratio, PCR = price change rate, DR = defect rate, DRC= defect rate change, #SUP = # of suppliers, CL=contract length, INQ = stage of sending inquiries to suppliers in month prior to the market introduction, SEL = stage of selecting the major supplier in month prior to the market introduction, INF = information index, SUG = suggestion index.

Appendix 6. Comparisons by Types of Parts and Models

•As shown in Table 2.2 and Appendix 3, the sample size for each type of part and model (segments and production volume) differs across the three groups. The primary concern was whether such unequal cell frequency might have produced some biases in comparative analysis between the three groups. For instance, the small sample size of gauge in the American sample (two cases, see Table 2.2) might have resulted in a biased observation of differences between the three groups.
•To evaluate the robustness of the analysis in Chapter 3 for such possible errors, statistical tests (ANOVA and chi-square test for cross-tabulation) were performed. The results show that in most of the attributes, supplier relationships do not depend on the types of parts and models, with few exceptions. Even for the few exceptional attributes, it was found that differences affected by the types of parts and models do not disprove the analysis in Chapter 3.
•It should be noted that the effect of the model segments on price change rate and defect rate could not be tested since a few cells have no observation. But additional analysis shows that it is unlikely the differences caused by the model segments would invalidate the analysis of these two attributes in Chapter 3. The tests result that production volume of models does not affect the analysis may also indicate that types of models is not a decisive factor for supplier relationships.
•Overall, one can thus conclude that the comparative analysis between the three groups in Chapter 3 is reasonably robust for the unequal cell frequency with regard to the types of parts and models.
•Details of the statistical tests and analysis are presented below.

6.1. Comparisons by types of parts

•To examine whether supplier relationships depend on the types of parts, statistical tests (ANOVA and chi-square test for cross-tabulation) were conducted.
•It turned out that there are few attributes showing differences between the four types of parts with statistical significance, and none of the differences affecting these attributes disproves the analysis in Chapter 3.

•Belows are the results of the statistical tests for the attributes showing statistically significant differences ($p < .10$), and discussions of the robustness of the comparisons between the three groups in these attributes.

•Abbreviation:
SA= shock absorber, GG= gauge assembly,
ST= front seat assembly, IP= instrument panel
df= degree of freedom

6.1.1. Two-way ANOVA for defect rate

(1)Results

Source	df	F-test	Pvalue
Three groups (A)	2	34.866	.0004
Types of parts (B)	3	2.453	.0773
(AB)	6	2.006	.0876
Error	40		

	SA	GG	ST	IP	Total
USA	1.167 (3)	1.233 (2)	2.75 (4)	1.59 (3)	1.811 (12)
JP/USA	.012 (4)	.0025 (4)	.066 (4)	.14 (3)	.050 (15)
JAPAN	.01 (7)	.0076 (7)	.019 (7)	.0003 (4)	.010 (25)
Total	.258 (14)	.195 (13)	.76 (15)	.519 (10)	.437 (52)

Note: mean, with sample size in parenthesis.

(2) Robustness of the comparisons
•As the table above shows, defect rate differs by the owner nationality (the three groups), the types of parts, and their interaction.
•However, the observation in Chapter 3 that in defect rate the Japanese sample is the lowest, followed by the Japanese transplant sample and then the American, is still valid across the four types of parts except gauge assembly, where the Japanese transplant sample outperforms the Japanese.

6.1.2. Two-way ANOVA for selection criteria (target price capability)

(1)Results

Source	df	F-test	Pvalue
Three groups (A)	2	10.869	.0001
Types of parts (B)	3	4.287	.0084
(AB)	6	1.547	.179
Error	59		

	SA	GG	ST	IP	Total
USA	4.167 (6)	3 (2)	4.143 (7)	4.5 (6)	4.143 (21)
JP/USA	4.5 (6)	4.667 (6)	4.833 (6)	4.8 (5)	4.696 (23)
JAPAN	4.714 (7)	4.286 (7)	5 (7)	4.667 (6)	4.667 (27)
Total	4.474 (19)	4.267 (15)	4.65 (20)	4.647 (17)	4.521 (71)

Note: mean, with sample size in parenthesis.

(2) Robustness of the comparisons
•As the table above shows, the importance of target price capability as a selection criterion differs by the owner nationality (the three groups) and the types of parts.
•However, the observation in Chapter 3 that Japanese automakers and Japanese transplants put more emphasis on this criterion than do American, is still valid across the four types of parts.

6.1.3. Two-way ANOVA for selection criteria (manufacturing capability)

(1)Results

Source	df	F-test	Pvalue
Three groups (A)	2	2.698	.0756
Types of parts (B)	3	2.402	.0766
(AB)	6	1.272	.284
Error	59		

	SA	GG	ST	IP	Total
USA	4.5 (6)	4 (2)	4.286 (7)	4.667 (6)	4.429 (21)
JP/USA	4.833 (6)	4.5 (6)	4.667 (6)	5 (5)	4.739 (23)
JAPAN	4.714 (7)	3.714 (7)	4.857 (7)	4.167 (6)	4.37 (27)
Total	4.684 (19)	4.067 (15)	4.6 (20)	4.588 (17)	4.521 (71)

Note: mean, with sample size in parenthesis.

(2) Robustness of the comparisons

•As the table above shows, the importance of manufacturing capability as a selection criterion differs by the ownerships nationality (the three groups) and the types of parts.

•However, the observation in Chapter 3 that Japanese transplants put more emphasis on this criterion than do Japanese automakers, is still valid across the four types of parts except seat assembly.

6.1.4. Cross-tabulation for the role of suppliers in development

(1) Results

	SA	GG	ST	IP	Total
supplier proprietary	1 (5%)	2 (13.3%)	1 (5.56%)	0 (0%)	4 (5.97%)
black-box	19 (95%)	13 (86.7%)	14 (77.78%)	6 (42.86%)	52 (77.61%)
detail-controlled	0 (0%)	0 (0%)	3 (16.7%)	8 (57.14%)	11 (16.42%)
Total	20 (100%)	15 (100%)	18 (100%)	14 (100%)	67 (100%)

Note: Frequency distribution

Due to small expected size (less than five) of several cells, the chi-square test was not performed.

(2) Robustness of the comparisons

•As the table above shows, the role of suppliers in development differs by the types of parts.

•Since the ratio of detail-controlled parts for gauge (0%) is smaller than those for instrument panel and seat assembly, small sample size (two cases, see Table 2.2) of gauge in the American sample may make its average ratio of detail-controlled parts larger. Thus if the sample size of gauge is more balanced across the three groups, the difference between the American sample and the other two groups would be smaller. But this "adjustment" would not invalidate the observation in Chapter 3 that the role of suppliers is not so

different between the three groups as observed in the comparison between the traditional American and Japanese supplier relationships, rather it supports that observation.

6.1.5. Cross-tabulation for information possessed (cost breakdown)

(1) Results

df = 3 Total chi-square = 16.106 p = .0011

	SA	GG	ST	IP	Total
not possessed	8 (42.11%)	12 (80%)	3 (15%)	5 (29.41%)	28 (39.44%)
possessed	11 (57.89%)	3 (20%)	17 (85%)	12 (85%)	43 (70.5%)
Total	19 (100%)	15 (100%)	20 (100%)	17 (100%)	71 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons

•As shown above, the ratio of possessing information about cost breakdown into general categories differs by the types of parts. However, the small sample size of gauge in the American sample does not affect the observation in Chapter 3. The table below indicates that even excluding the gauge sample the frequency distribution across the three groups is similar to the original including the gauge sample.

	USA	Japan/USA	Japan	Total
not possessed	33.33% (26.32%)	34.78% (23.53%)	48.15% (35%)	39.44% (28.57%)
possessed	66.67% (73.68%)	65.22% (76.47%)	51.85% (65%)	60.56% (71.43%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the gauge sample in parenthesis.
Total chi-square value for the original cross-tabulation = 1.394 (p=.4981)
Total chi-square value for the adjusted cross-tabulation = .664 (p=.7174)

6.2. Comparisons by types of models (segment)

•To examine whether supplier relationships depend on the types of model segments (subcompact, compact, midsize, and fullsize), statistical tests (ANOVA and chi-square test for cross-tabulation) were conducted. In conducting chi-square tests for cross-tabulation, midsize and fullsize were collapsed together to get sufficient cell size (at least five expected observations in each cell). Similarly, some segments were combined in performing two-way ANOVA to eliminate missing cells, depending on necessity. Considering that segmentation is somewhat arbitrary, such adjustment can be allowed.
•It turned out that there are few attributes showing differences between the model segments with statistical significance, and none of the differences affecting these attributes disproves the analysis in Chapter 3.

•It should be noted that regarding price change rate and defect rate, statistical test (two-way ANOVA) could not be conducted since several cells have no observation ("fullsize" and "midsize" in the Japanese transplants sample, "fullsize" in the Japanese sample, and "subcompact" in the American sample). However, additional analysis indicates that it is unlikely that the comparisons between the three groups for these two attributes in Chapter 3 are invalidated due to the unequal cell frequency in terms of model segments across the three groups.

•Belows are the results of the statistical tests for the attributes showing statistically significant differences ($p < .10$), and discussions of the robustness of the comparisons between the three groups in these attributes.

•Abbreviation:
SUB= subcompact, COM= compact, MID= midsize, FUL= fullsize

6.2.1. Cross-tabulation for information possessed (inventory level)

(1) Results

df =2 Total chi-square = 12.238 p = .0022

	SUB	COM	MID+FUL	Total
not possessed	3 (15.76%)	21 (63.64%)	11 (61.11%)	35 (39.44%)
possessed	16 (84.21%)	12 (36.36%)	7 (35.89%)	35 (70.5%)
Total	19 (100%)	33 (100%)	18 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons
•As shown above, the ratio of possessing information about inventory level differs by the model segments. However, as the table below indicates, even if excluding the subcompact sample, which has a higher ratio than the other two categories, the difference between the three groups is similar to that in the original sample (no statistical significance).

	USA	Japan/USA	Japan	Total
not possessed	42.86% (50%)	47.83% (66.67%)	55.56% (68.42%)	39.44% (61.54%)
possessed	57.14% (50%)	52.17% (33.33%)	44.44% (31.58%)	50.7% (38.46%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the subcompact model sample in parenthesis.
Total chi-square value for the original cross-tabulation = .791 (p=.6732)
Total chi-square value for the adjusted cross-tabulation = 1.559 (p=.4585)

6.2.2. Cross-tabulation for suggestions made (quality control change)

(1) Results

df =2 Total chi-square = 6.173 p = .0457

	SUB	COM	MID+FUL	Total
not made	7 (36.84%)	7 (21.21%)	10 (55.56%)	24 (34.29%)
made	12 (63.16%)	26 (78.79%)	8 (44.44%)	46 (65.71%)
Total	19 (100%)	33 (100%)	18 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons

•As shown above, the ratio of making suggestions about quality control change differs by the model segments. However, as the table below indicates, even if excluding the midsize plus fullsize sample, which has a lower ratio of making suggestions than the other two categories, the difference between the three groups is similar to that in the original sample (the ratio of the American sample is lower than the others with statistical significance).

	USA	Japan/USA	Japan	Total
not made	52.38% (83.33%)	30.43% (30.43%)	22.22% (8.7%)	33.8% (26.92%)
made	47.62% (16.67%)	69.57% (69.57%)	77.78% (91.3%)	66.2% (73.08%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the midsize and fullsize model samples in parenthesis.
Total chi-square value for the original cross-tabulation = 4.974 (p=.0832)
Total chi-square value for the adjusted cross-tabulation = 13.732 (p=.001)

6.2.3. Cross-tabulation for suggestions made (design change)

(1) Results

df =2 Total chi-square = 8.808 p = .0122

	SUB	COM	MID+FUL	Total
not made	13 (68.42%)	10 (30.3%)	5 (27.78%)	28 (40%)
made	6 (31.58%)	23 (69.7%)	13 (72.22%)	42 (60%)
Total	19 (100%)	33 (100%)	18 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons

•As shown above, the ratio of making suggestions about design change differs by model segments. However, as the table below indicates, even if excluding the subcompact

sample, which has a lower ratio of making suggestions than the other two categories, the difference between the three groups is similar to that in the original sample (no significance).

	USA	Japan/USA	Japan	Total
not made	42.86% (38.89%)	34.78% (13.33%)	40.47% (31.58%)	39.44% (28.85%)
made	57.14% (61.11%)	65.22% (86.67%)	59.26% (68.42%)	60.56% (71.15%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the subcompact model sample in parenthesis.
Total chi-square value for the original cross-tabulation = .331(p=.8476)
Total chi-square value for the adjusted cross-tabulation = 2.712 (p=.2577)

6.2.4. Cross-tabulation for suggestions made (inventory control change)

(1) Results

df =2 Total chi-square = 8.334 p = .0155

	SUB	COM	MID+FUL	Total
not made	7 (36.84%)	20 (60.61%)	15 (83.33%)	42 (60%)
made	12 (63.16%)	13 (39.39%)	3 (16.67%)	28 (40%)
Total	19 (100%)	33 (100%)	18 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons
•As shown above, the ratio of making suggestions about inventory control change differs by model segments. However, as the table below indicates, even if excluding the subcompact sample, which has a higher ratio of making suggestions than the other two categories, the difference between the three groups is similar to that in the original sample: low in the American sample and high in the other two. But while the difference in the original sample is significant, that in the adjusted sample is not.

	USA	Japan/USA	Japan	Total
not made	80.95% (77.78%)	52.17% (60%)	51.85% (63.16%)	60.56% (67.31%)
made	19.05% (22.22%)	47.83% (40%)	48.15% (36.84%)	39.44% (32.69%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the subcompact model sample in parenthesis.
Total chi-square value for the original cross-tabulation = .5.191(p=.0746)
Total chi-square value for the adjusted cross-tabulation = 1.409 (p=.4942)

6.2.5. Analysis for price change rate and defect rate

•Since there are a few missing cells, two-way ANOVA could not be performed for price change rate and defect rate.

Price change rate

	USA	Japan/USA	Japan	Total
SUB	- (0)	0 (8)	-2.045 (7)	-.954 (15)
COM	-.376 (2)	-.765 (8)	-2.05 (15)	-1.505 (25)
MID	.769 (5)	- (0)	-2.218 (4)	-.558 (9)
FUL	3.174 (3)	- (0)	- (0)	3.174 (3)
Total	1.262 (10)	-.382 (16)	-2.075 (26)	-.912 (52)

Note: mean, with sample size in parenthesis.

Defect rate

	USA	Japan/USA	Japan	Total
SUB	- (0)	.086 (8)	.01 (7)	.05 (15)
COM	.467 (1)	.008 (7)	.01 (14)	.03 (22)
MID	1.586 (9)	- (0)	.013 (4)	1.102 (13)
FUL	3.5 (2)	- (0)	- (0)	3.5 (2)
Total	1.811 (12)	.05 (15)	.01 (25)	.437 (52)

Note: mean, with sample size in parenthesis.

•Tables above show that both in price change rate and defect rate the performance for fullsize models in the American sample is mediocre. It may reflect the fact that American automakers face less competitive pressure from Japanese and European automakers in that segment than in the other segments.
•To see the effect of this difference, excluding the fullsize model cases from the sample, ANOVA was performed to examine the differences between the three groups.

ANOVA of price change rate (original vs. adjusted)
Category: The three groups **Attribute analyzed:** Price change rate

F-test: DF = 2, 50 (2,46) F = 16.979, (13.717) p=.0001 (.0001)

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	11	.917	1.926	US vs JP/US	1.299	1.18**
	(8)	(.442)	(1.116)		(.824)	(1.021)
JP/US	16	-.382	1.354	US vs JP	2.992	1.445***
	(16)	(-.382)	(1.354)		(2.517)	(1.15***)
JP	26	-2.075	1.383	JP/US vs JP	1.692	1.276***
	(26)	(-2.075)	(1.383)		(1.692)	(.858***)

Note: ( ) = results for the adjusted sample excluding the fullsize sample.

ANOVA of defect rate (original vs. adjusted)
Category: The three groups **Attribute analyzed:** Defect rate

F-test:	DF = 2, 49 (2,47)	F = 37.224, p=.0001 (49.029) (.0001)

Group	N	Mean	Std.Dv.	Comparison	M.Dif.	Fisher's PLSD
USA	12	1.811	1.322	US vs JP/US	1.762	.653***
	(10)	(1.474)	(.936)		(1.424)	(.34***)
JP/US	15	.050	.109	US vs JP	1.801	.592***
	(15)	(.05)	(.109)		(1.463)	(.312***)
JP	25	.010	.014	JP/US vs JP	.039	.345
	(25)	(.01)	(.014)		(.039)	(.227)

Note: ( ) = results for the adjusted sample excluding the fullsize sample.

•The tests shows that the results in the adjusted sample are the same as those in the original sample except that the statistical significance of the difference in price change rate between the American and Japanese transplant samples disappears. But still the latter shows the better performance, as observed in the original sample. Thus one may conclude that the unequal cell frequency in terms of model segments is unlikely to disprove the analysis of price change rate and defect rate in Chapter 3.

6.3. Comparisons by types of models (production volume)

•To examine whether supplier relationships depend on production volume of the model, statistical tests (ANOVA and chi-square test for cross-tabulation) were conducted. In conducting chi-square tests for cross-tabulation, "less than 100,000" and "100,001 - 200,000," as well as "200,001 - 300,000" and "300,001 - 400,000" were collapsed together to get sufficient cell size (at least five expected observations in each cell). The same adjustment was made in performing two-way ANOVA to eliminate missing cells, depending on necessity. Considering that the way of categorizing production volume is somewhat arbitrary, such adjustment can be allowed.
•It turned out that there are few attributes showing differences between model segments with statistical significance, and none of the differences affecting these attributes disproves the analysis in Chapter 3.

•Belows are the results of the statistical tests for the attributes showing statistical significance ($p < .10$), and discussions of the robustness of the comparisons between the three groups in these attributes.

•Abbreviation:
V0 = less than 100,000, V1 = 100,001 - 200,000,
V2 = 200,001 - 300,000, V3 = 300,001 - 400,000

6.3.1. Two-way ANOVA for selection criteria (initial price offered)

(1)Results

Source	df	F-test	Pvalue
Three groups (A)	2	8.285	.0007
Volume (B)	3	3.047	.0356
(AB)	6	.468	.8295
Error	59		

	V0	V1	V2	V3	Total
USA	4.333 (3)	4 (3)	3.917 (12)	5 (2)	4.1 (20)
JP/USA	5 (4)	4.5 (16)	3 (3)	- (0)	4.391 (23)
JAPAN	5 (4)	5 (11)	5 (4)	4.75 (8)	4.926 (27)
Total	4.818 (11)	4.633 (30)	4 (19)	4.8 (10)	4.514 (70)

Note: mean and sample size in parenthesis.

(2) Robustness of the comparisons

•As the table above shows, the importance of initial price offered as a selection criterion differs by the owner nationality (the three groups) and the production volume.

•However, the observation in Chapter 3 that Japanese automakers put more emphasis on this criterion than American automakers and Japanese transplants, is still valid except for V3.

6.3.2. Two-way ANOVA for selection criteria (manufacturing capability)

(1)Results

Source	df	F-test	Pvalue
Three groups (A)	2	.597	.554
Volume (B)	3	2.449	.0725
(AB)	6	1.011	.4269
Error	59		

	V0	V1	V2	V3	Total
USA	4.667 (3)	5 (3)	4.333 (12)	4 (2)	4.45 (20)
JP/USA	5 (4)	4.812 (16)	4 (3)	- (0)	4.739 (23)
JAPAN	4 (4)	4.455 (11)	4 (4)	4.625 (8)	4.37 (27)
Total	4.545 (11)	4.7 (30)	4.211 (19)	4.5 (10)	4.514 (70)

Note: mean and sample size in parenthesis.

(2) Robustness of the comparisons

•As the table above shows, the importance of initial price offered as a selection criterion differs by the production volume.

•However, the observation in Chapter 3 that Japanese transplants put more emphasis on this criterion than Japanese automakers, is still valid except for V2.

6.3.3. Cross-tabulation for information possessed (SPC data)

(1) Results

df =1 Total chi-square = 5.473 p = .0193

	V0 + V1	V2 + V3	Total
not possessed	18 (43.9%)	5 (17.24%)	23 (32.86%)
possessed	23 (56.1%)	24 (82.76%)	47 (67.14%)
Total	41 (100%)	29 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons

•As shown above, the ratio of possessing SPC data differs by production volume. However, as the table below indicates, even if excluding the "V2 + V3" sample, which has a higher ratio of information possession than the other two categories and is limited in number of cases in the Japanese transplants sample, the difference between the three groups is similar to that in the original sample: high in the American sample and low in the other two. But while the difference in the original sample is significant, that in the adjusted sample is not.

	USA	Japan/USA	Japan	Total
not possessed	9.52% (16.67%)	52.17% (60%)	33.33% (33.33%)	32.39% (43.9%)
possessed	90.48% (83.33%)	47.83% (40%)	66.67% (66.67%)	67.61% (56.1%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the subcompact model sample in parenthesis.
Total chi-square value for the original cross-tabulation = 9.135(p=.0104)
Total chi-square value for the adjusted cross-tabulation = 4.592 (p=.1007)

6.3.4. Cross-tabulation for suggestions made (material change)

(1) Results

df =1 Total chi-square = 4.769 p = .029

	V0 + V1	V2 + V3	Total
not made	16 (43.9%)	19 (17.24%)	35 (32.86%)
made	25 (56.1%)	10 (82.76%)	35 (67.14%)
Total	41 (100%)	29 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons
•As shown above, the ratio of making suggestions about material change differs by production volume. However, as the table below indicates, even if excluding the "V2 + V3" sample, which has a higher ratio of making suggestions than the other two categories and is limited in number of cases in the Japanese transplant sample, the difference between the three groups is similar to that in the original sample: the Japanese transplant sample is the highest, the Japanese second, and the American third. But while the difference in the original sample is significant, that in the adjusted sample is not.

	USA	Japan/USA	Japan	Total
not made	66.67% (66.67%)	30.43% (25%)	51.85% (46.67%)	49.3% (39.02%)
made	33.33% (33.33%)	69.57% (75%)	48.15% (53.33%)	50.7% (60.98%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the subcompact model sample in parenthesis.
Total chi-square value for the original cross-tabulation = 5.879(p=.0104)
Total chi-square value for the adjusted cross-tabulation = 3.948(p=.1389)

6.3.5. Cross-tabulation for suggestions made (equipment change)

(1) Results

df = 1 Total chi-square = 2.954 p = .0851

	V0 + V1	V2 + V3	Total
not made	28 (68.29%)	25 (86.21%)	53 (75.71%)
made	13 (31.71%)	4 (13.79%)	17 (24.29%)
Total	41 (100%)	29 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons
•As shown above, the ratio of making suggestions about equipment change differs by production volume. However, as the table below indicates, even if excluding the "V2 + V3" sample, which has a lower ratio of making suggestions than the other two categories and is limited in number of cases in the Japanese transplants sample, the difference between the three groups is similar to that in the original sample: the Japanese transplant sample is the highest, the Japanese second, and the American third (no suggestion made).

	USA	Japan/USA	Japan	Total
not made	100% (100%)	47.83% (25%)	81.48% (46.67%)	76.06% (39.02%)
made	0% (0%)	52.17% (75%)	18.52% (53.33%)	23.94% (60.98%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the subcompact model sample in parenthesis.
Total chi-square value for the original cross-tabulation =17.113(p=.0002)
Total chi-square value for the adjusted cross-tabulation = 10.135(p=.0063)

6.3.6. Cross-tabulation for suggestions made (inventory control change)

(1) Results

df =1 Total chi-square = 3.179 p = .0746

	V0 + V1	V2 + V3	Total
not made	21 (51.22%)	21 (72.41%)	42 (60%)
made	20 (48.78%)	8 (27.59%)	28 (40%)
Total	41 (100%)	29 (100%)	70 (100%)

Note: Frequency distribution

(2) Robustness of the comparisons
•As shown above, the ratio of making suggestions about inventory control change differs by production volume. However, as the table below indicates, even if excluding the "V2 + V3" sample, which has a lower ratio of making suggestions than the other two categories and is limited in number of cases in the Japanese transplants sample, the difference between the three groups is similar to that in the original sample: the Japanese transplants sample is the highest, the Japanese the second, and the American the third. But while the difference in the original sample is significant, that in the adjusted sample is not.

	USA	Japan/USA	Japan	Total
not made	80.95% (66.67%)	52.17% (45%)	51.85% (53.33%)	60.56% (51.22%)
made	19.05% (33.33%)	47.83% (55%)	48.15% (46.67%)	39.44% (48.78%)
Total	100% (100%)	100% (100%)	100% (100%)	100% (100%)

Note: Frequency distribution for the original sample, with that for the sample excluding the subcompact model sample in parenthesis.
Total chi-square value for the original cross-tabulation = 5.191(p=.0746)
Total chi-square value for the adjusted cross-tabulation = 1.909(p=.6346)

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