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The Locational and Functional Behavior of U.S. Autoparts Suppliers

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ABSTRACT. The free trade agreement with Mexico was expected to help U.S. autoparts suppliers move southward to take advantage of low labor cost, but this has not yet happened. We can find explanations for this rather perplexing phenomenon through analyzing the outcome of a postal survey conducted just before the North American Free Trade Agreement (NAFTA) went into effect. The responses from the suppliers highlight the apparent hierarchy in the lean production system and its impact on the location choices of the parts-manufacturing firms. Despite advances in transportation and telecommunication technologies, the need to maintain short distance with respect to customers is still the single most important consideration in their decision-making. Given the reluctance on the part of the vehicle assemblers, a mass migration of suppliers to Mexico seems unlikely, although it is true that they are quite attracted to the low wages offered south of the border.

1. Introduction

During the lengthy negotiation process for the North American Free Trade Agreement (NAFTA), many rounds of heated debate were generated regarding the fate of the automobile industry in the continent. A number of researchers presented possible scenarios for the vehicle assembly industry from various perspectives.[1] As for parts suppliers in the U.S., the central theme has been whether Mexico's low wages could outweigh the need to maintain proximity to the assembly plants. Scrutiny of the autoparts sector in this regard has been neglected, however, despite the fact that it employs more workers than the assembly industry proper, and this was partly due to difficulties associated with probing into their complex hierarchical structure. The main objective of this study is to fill this gap by investigating the suppliers' intra-industry structure and their attitude toward a possible Mexican operation.

Contrary to popular belief, ongoing globalization tends to strengthen regional clustering of assemblers and suppliers. Amiti (1998) suggests that comparative advantage does not always determine the production and trade patterns following trade liberalization, especially when the industry is characterized as being vertically integrated, as is the case with the automobile sector. Because of the industry's hierarchical structure, relocation of an assembly plant will likely cause a secondary wave of upstream parts suppliers. As demonstrated by the development of the Japanese transplants network in the U.S., relocation of the auto industry usually takes the form of circular causation, in which an assembler initiates the move. After the suppliers are brought in, other assemblers are lured to the area. New Japanese transplants, seeking non-union labor, chose southern states. Then, Japanese suppliers came in to serve not only the transplants, but the U.S. assembly plants as well.

The causality can run in the other direction, which poses an interesting question for the government of host country. If attracting an assembly plant guarantees that suppliers will seek to be close by it, it would be rational to give a subsidy to lure the hub facility. On the other hand, if suppliers pursue low wages rather than customers, a case can be made for developing an optimal policy mix in that direction. This aspect is intriguing because it is an empirical question, and with little sign of large-scale relocation so far, it is especially meaningful to look back and find out what suppliers were actually making of the impending changes just on the brink of entering NAFTA.

Most of the previous studies on the autoparts suppliers treat them as one homogeneous group,

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focusing rather on technological changes in the automobile industry as a whole and their impact on the spatial organization of the suppliers. For instance, Bingham and Sunmonu (1992) compare Fordist (U.S.) and post-Fordist (Japanese) production systems in terms of locational structure. They predict a continued transition to flexible and lean production that would result in a tighter geographical clustering of suppliers around assembly plants. Glasmeier and McCluskey (1987) found that labor-intensive parts-making activities had continued to expand to the Southeast in pursuit of cheap labor, while the headquarters of large suppliers had been agglomerating in the Detroit area.

To study the location of suppliers, one might make the strong assumption that each supplier serves the closest customer, which may well be true for most manufacturing industries. However, in the case of the automobile sector, not all suppliers are functionally identical. It would be misleading, for example, to presuppose that direct linkages exist between an assembly plant and all the parts-manufacturers located within a 50-mile radius.[2] Therefore, an appropriate survey is essential if a more systematic analysis is desired. Although there do exist quite comprehensive studies based on surveys, notably by Helper (1991) and Miller (1988), they either focus on the large first-tier suppliers or make no effort to dissect the supplier groups and compare their functional behavior. To address these shortcomings, another survey was conducted, which is discussed in this paper. As the first of its kind, the findings shed light on the factors affecting the location of the suppliers, relationships among firms at different stages of production, and, more importantly, their views on Mexico as a potential manufacturing base. In the following sections, the survey procedure and major findings are presented.

2. Methodology

In designing the questionnaire, a high level of detail was sacrificed for the sake of a simple and inviting appearance. Most questions had a multiple- or binary-choice nature. Anonymity was assured by including an unmarked postage-paid reply form. In addition, interested respondents were promised a copy of the research findings. The bulk of the mailing list was built from the *PhoneDisc USA Business Directory*, using the Standard Industry Classification codes as keywords (Table I). Complications arose because SIC 3714 is not the only group selling parts to the assemblers. Likewise, not all firms listed in those groups are necessarily in the automotive business. To supplement the list, more businesses were selected from the *Automotive News Market Data Book* (345 firms) and *Ward's Automotive Yearbook* (175 firms). In addition, 240 Japanese suppliers were obtained from the *Directory of Japanese-affiliated Companies in the USA & Canada*. This brought the total number of businesses to 2,213. After eliminating duplicates and businesses with incomplete addresses, the total number of firms in the mailing list came to 1,860.

The questionnaires were mailed out during the first week of June 1994. Within the following two months, 54 envelopes were returned unopened because the addressees had moved with no forwarding address. The locations of the 1,806 survey recipients are shown in Figure 1. More than half (957) the recipients are located in the inset which represents the Midwest and the so-called transplant corridor, showing a heavy concentration of parts-manufacturing activities in these regions. Eventually, 201 usable responses were generated out of the pool of 1,753 eligible firms, showing an effective response rate of 11.5%. This rather low response rate is understandable, given that firms are generally reluctant to share their sensitive business information. Nonetheless, this exercise seems to have been a success, considering that occasional surveys conducted by trade magazines usually generate less than 150 replies.[3]

TABLE I
Composition of the primary mailing list

SIC	Title	Size
3011	Tires and inner tubes	181
3465	Automotive stampings	228
3592	Carburetors, pistons, rings, and valves	127
3647	Vehicular lighting equipment	75
3691	Storage batteries	180
3694	Engine and electrical equipment	434
3714	Motor vehicle parts and accessories	228

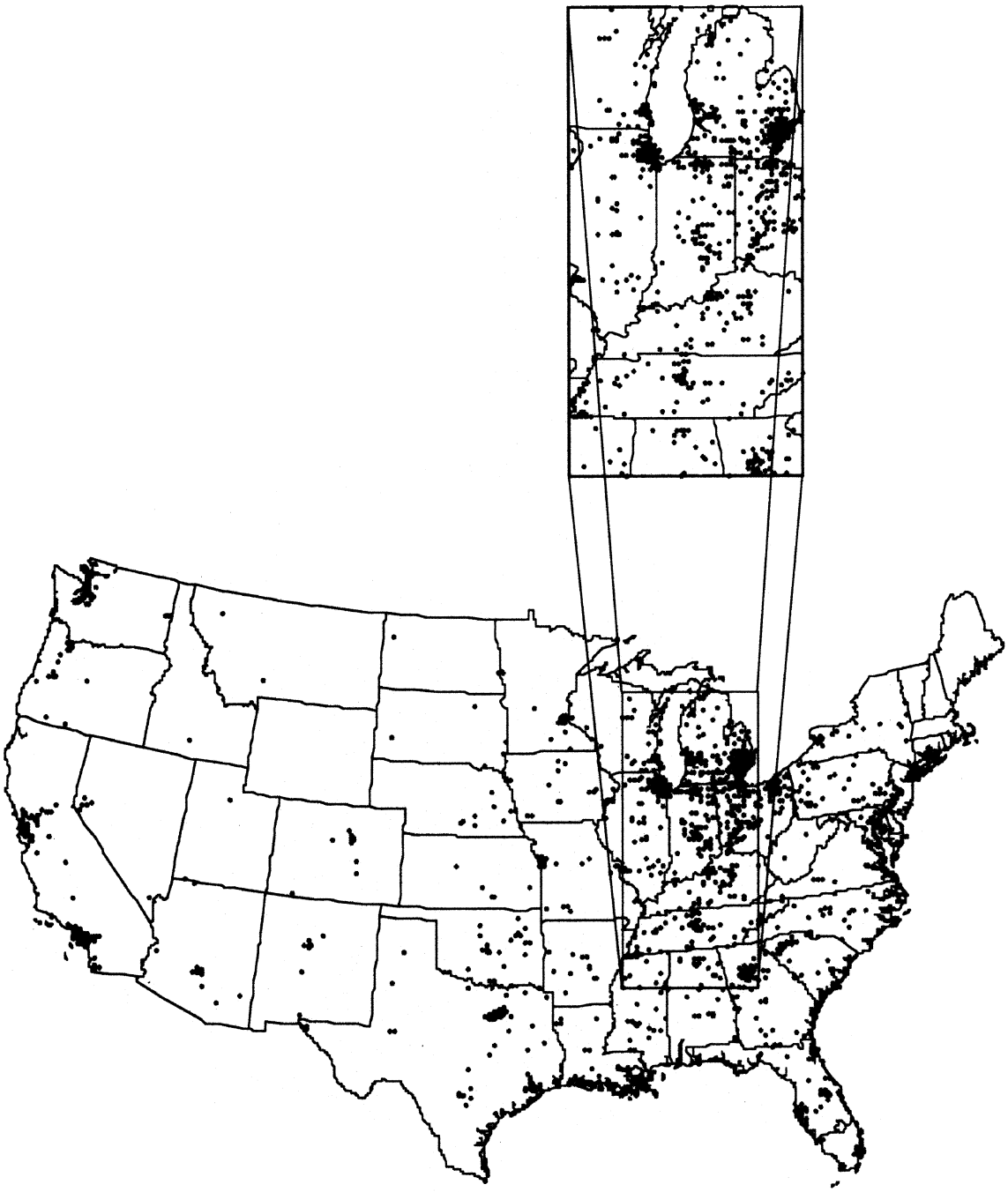

Figure 1. Location of survey recipients.

3. Major findings

The 201 firms collectively represent over 47,700 employees and $14 billion in annual sales revenue. On average, they had been in business for 26.5 years. The majority of the questionnaires were filled out by individuals who are in positions that enable them to make important decisions: presidents (19.9%), vice-presidents (17.4%), and managers in various areas (42.3%). It is neces-

sary to divide the respondents into several groups because of the heterogeneous roles they play in the production chain. In the following analysis, four mutually-exclusive groups are formed: 47 pure first-tier firms (PF); 42 firms that represent the rest of the first-tier firms (RF); 46 low-tier suppliers (LS); and 41 aftermarket suppliers (AS).

3.1. *A hierarchical structure*

In broad terms, automotive suppliers consist of original-equipment-manufacturer (OEM) suppliers that cater to assemblers or other suppliers, and aftermarket suppliers who sell replacement parts and consumables to the general public through retail outlets. Furthermore, a hierarchical order exists among OEM suppliers. The first-tier suppliers provide assembly plants with complex preassembled modules such as engines and seats, while lower-tier firms serve the first-tier firms with basic components. These relationships are illustrated in Figure 2. Some OEM suppliers also sell to the aftermarket, which can be more profitable.[4] In fact, it is not uncommon for suppliers to accept a bad deal from assemblers just to put their parts in vehicles, in anticipation of future replacement demand. Because their markets and functions vary, suppliers in different groups are expected to exhibit somewhat heterogeneous locational and managerial behavior.

In our analysis, the respondents are classified into four groups: PF firms, serving only assembly plants; RF suppliers catering to the aftermarket and/or other suppliers as well as automakers; LS firms, selling to the aftermarket and other suppliers (but not to assemblers); and AS firms, selling only to the aftermarket through retail stores and service stations. Such a classification scheme makes it possible to contrast their differences in terms of a given firm's position relative to other suppliers in the industry pyramid. As shown in Table II, PF is characterized by a very large-scale operation, much higher sales revenue per employee, and strong commitment to autoparts manufacturing. LS firms have more diversified markets than first-tier suppliers do. The AS firms are smaller than those in the other groups in size, but seems more involved in the automotive business than the RF and LS firms. Also apparent is the differing level of dedication to customers. If foreign customers are eliminated, most first-tier suppliers serve only a handful of domestic

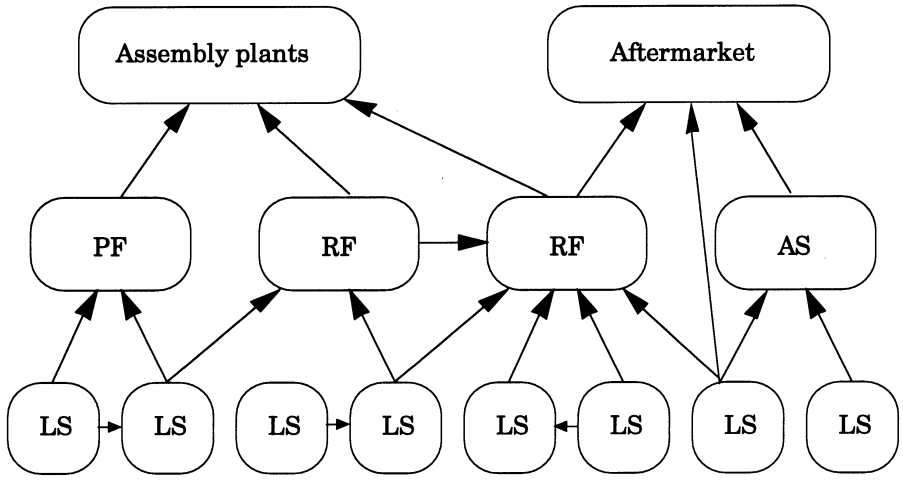

Figure 2. A hierarchy in the automobile industry.

TABLE II
Descriptive characteristics of firms

Group	No. of employees	Sales ($ mil.)	Autoparts sales (%)	No. of customers
PF	531	230	91	29
RF	279	94	78	93
LS	183	26	68	379
AS	118	22	86	2,413

customers. In contrast, the large number of customers for the AS firms illuminates the role they play in the industry.

Differences can also be found in the types of parts each group produces. In general, first-tier firms tend to specialize in bulky and vehicle-specific modules, whereas low-tier firms and aftermarket suppliers produce small standardized components and replacement parts. From Table III, it is clear that PF firms function as full-service suppliers, producing all kinds of non-standardized parts in a more integrated form. The RF suppliers appear to be less involved than PF firms in the production of exterior and interior parts. The LS group specializes in basic materials and electrical components, whereas the AS firms concentrate on the powertrain (small engine components such as spark plugs) and electrical parts (starters, alternators, connectors, and batteries) which are standardized and easily replaceable.

3.2. *Locational preferences*

The automotive industry has long been characterized by a high degree of regional concentration. Recent literature on industrial agglomeration explains the tight clustering through an assembler's preference for a variety of differentiated parts and the economies of scale achieved at firm level on the part of suppliers.[5] At the same time, advances in transportation and communication technology made regional concentration less important, suggesting that the automotive sector would also undergo a considerable degree of geographic dispersion. The past couple of decades have witnessed the rise of simultaneous globalization and regionalization of industrial activity, and many now seem to believe that the two might be complementary rather than contradictory modes of industrial and spatial organization.

To understand where U.S. suppliers fit in the picture, the firms were asked to choose three factors out of 16 items, shown in Table IV, which most heavily influenced their decision in selecting their current manufacturing sites. Many respondents selected more than three locational determinants. Figure 3 shows the percentage distribution of each factor, weighted against all factors chosen by the first-tier suppliers. As expected, proximity to customers (Item I) turns out to be critical to the pure first-tier suppliers. For them, maintaining short distances to assembly plants is the most important consideration, followed by good labor relations. At this level, any disruption of production and delivery flows would be devastating because, given the minimal inventory level that is maintained by the assembly plant, the lack of a major part means a complete shutdown of the assembly line. Close proximity offers the additional benefits of joint product development and informal exchange of information. On the other hand, RF suppliers seem to be somewhat insulated from the two factors mentioned above, probably because they can fall back onto less restrictive aftermarket sales.

Figure 4 presents a slightly different preference structure of low-tier suppliers and aftermarket suppliers. Unlike those in the first tier, an LS firm

TABLE III
Parts produced by firms (% for each group)

Group	Materials	Exterior	Interior	Chassis	Powertrain	Electrical
PF	57	30	28	34	34	19
RF	52	14	10	29	52	26
LS	46	13	13	15	30	43
AS	29	12	2	17	41	49

Note: The row sums are greater than 100 because a given firm may produce more than one item.

TABLE IV
Proposed factors for choosing current location

Item	Description
A	Low labor cost
B	Availability of labor
C	Good labor relations/low unionization rate
D	Availability of capital/low interest rate
E	Low transport cost of input
F	Low transport cost of output
G	Transport facilities (highways, airports)
H	Good infrastructure (utility, communication)
I	Proximity to assemblers/markets
J	Land availability and cost
K	Availability of warehousing
L	Availability of business services
M	Proximity to other parts manufacturers
N	Amenities (cultural and climatic)
O	Local government incentives
P	Proximity to owner's residence
Q	Other

cannot possibly be situated near the large number of customers who are geographically dispersed. The greater distance is compensated for by better transportation facilities (Item G). LS firms also need more warehousing space to stock up on overproduced parts as well as incoming inputs (Item J). This need for space becomes more acute for aftermarket suppliers. Interestingly, many AS plants are set up near the owners' residences, which could be far from the customers (Item P).[6]

Respondents showed little interest in local government incentives (Item O). Perhaps such bidding wars are more pronounced when different states are trying to host an assembly plant, because government officials are well aware that suppliers tend to follow assemblers. It is also worth noting that the localization economy (Item M) was found not to be very influential for all four groups, although the externalities (informal technology transfer, etc.) are generally regarded as very important factors for firms locating together.[7] In other words, the survey results suggest that any spatial agglomeration of suppliers may be simply the outcome of their individual decision-making with regard to forward linkages with their customers. Regional clusters observed in the automotive industry indeed differ from the agglomeration patterns identified by Alfred Marshall, in that

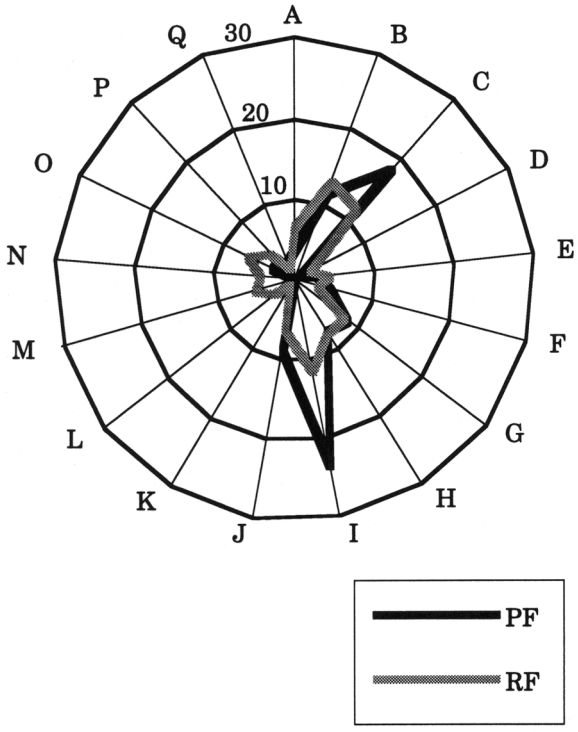

Figure 3. Factors of current location for first-tier firms (% of responses).

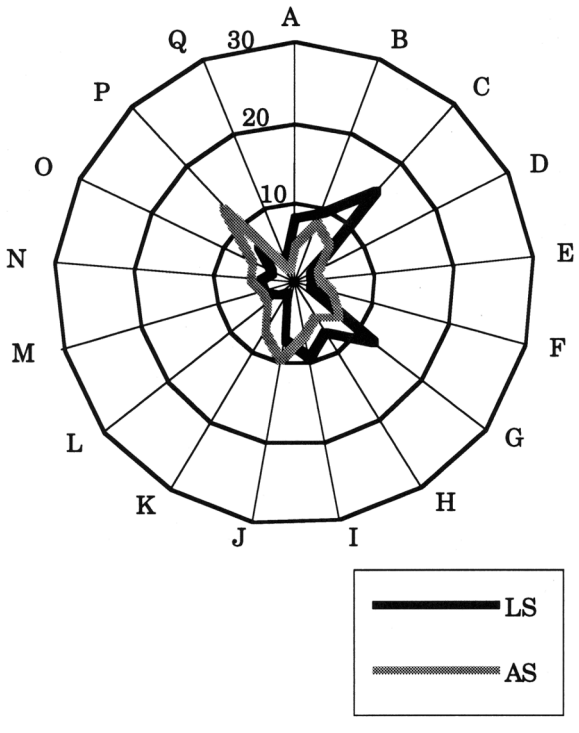

Figure 4. Factors of current location for LS and AS (%).

they take the form of hub-and-spoke nexus consisting of complexes of suppliers surrounding a central hub or anchor assembly facility, where the hub firm plays a key role in organizing the entire production system.[8]

Figures 5 through 8 show the location of each group of suppliers, plotted according to their postal codes. Because some firms use post office boxes as their mailing address, the postal codes for actual manufacturing sites were solicited in the questionnaire.[9] The maps show an increasing degree of dispersion moving down the supplier hierarchy, which, in general, seems to reflect their locational determinants discussed earlier. That is, pure first-tier suppliers are more tightly clustered around the assembly plants in the Midwest than are RF and LS companies, while aftermarket suppliers are located near large markets in the South.

As a simple graphic measure of dispersion, Figure 9 presents the distribution of suppliers by their distance from Detroit, the epicenter of the automobile industry. According to the figure, the distribution of each OEM supplier group displays considerable differences: 60% of PFs are located within a 200-mile radius of Detroit, while only 40% of RFs and 30% of LSs can be found there. The reversal in density of RF and LS at the tail (greater than 1,000 miles) is explained by the fact that they also sell to aftermarket outlets in Texas and Florida. In sharp contrast to OEM suppliers, AS firms gravitate toward major markets away from the Midwest, confirming the observations made by Glasmeier and McCluskey (1987) that aftermarket suppliers show a markedly decentralized pattern because final consumers are widely dispersed around the country.

It is also possible to examine the locational patterns of the firms, given a particular pulling factor. Figures 10 and 11 show the geographical distribution of firms, with the relevant factors superimposed. Most firms quoting good transport facilities as one of their location determinants (58) are shown to be situated on or near the interstate highway network. However, the relationship between expected and actual locations is not always obvious, and this is shown by looking at

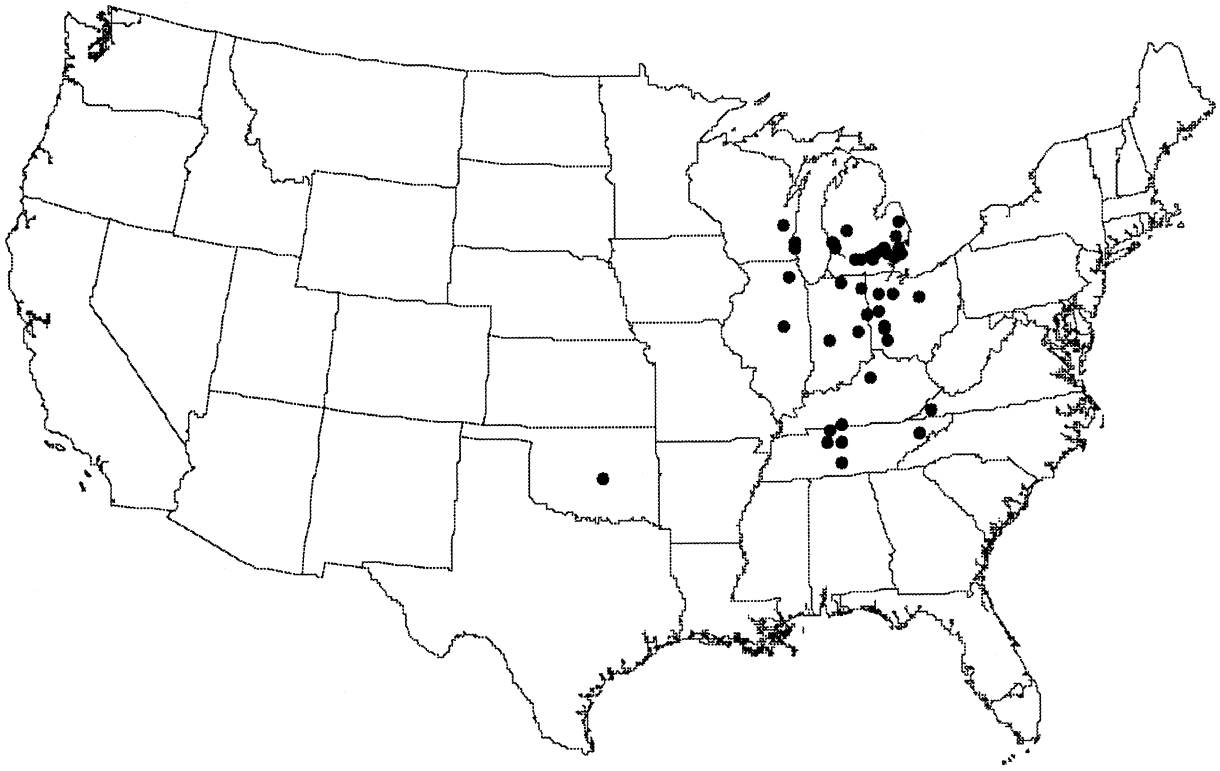

Figure 5. Geographic distribution of pure first-tier suppliers.

Figure 6. Geographic distribution of the rest of first-tier suppliers.

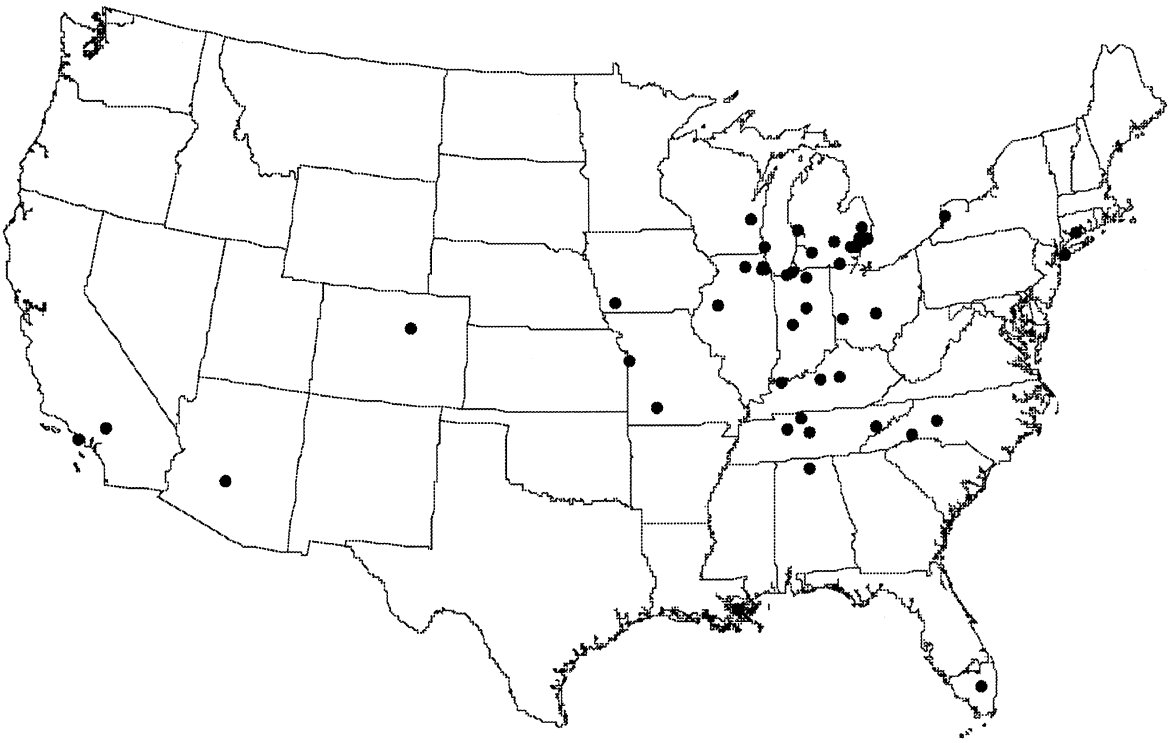

Figure 7. Geographic distribution of low-tier suppliers.

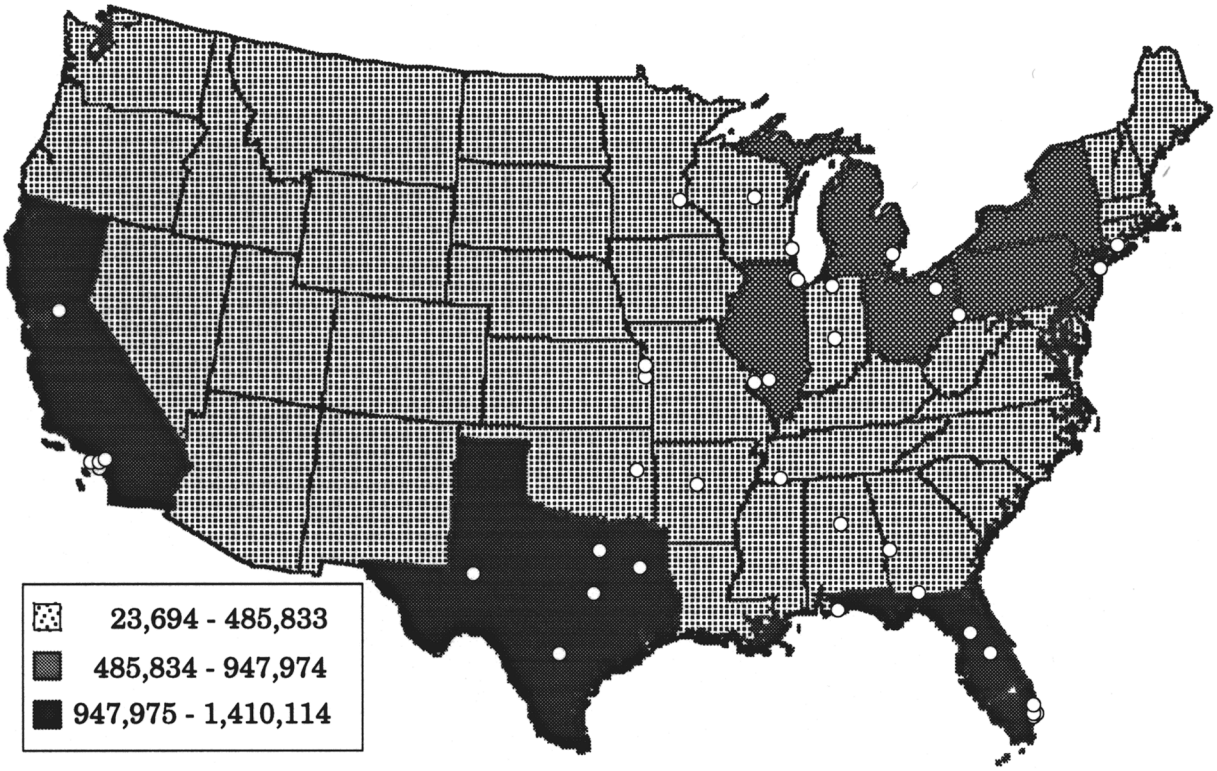

Figure 8. New-vehicle registrations by state in 1993 and geographic distribution of aftermarket suppliers. *Source:* Automotive News Market Data Book (1994).

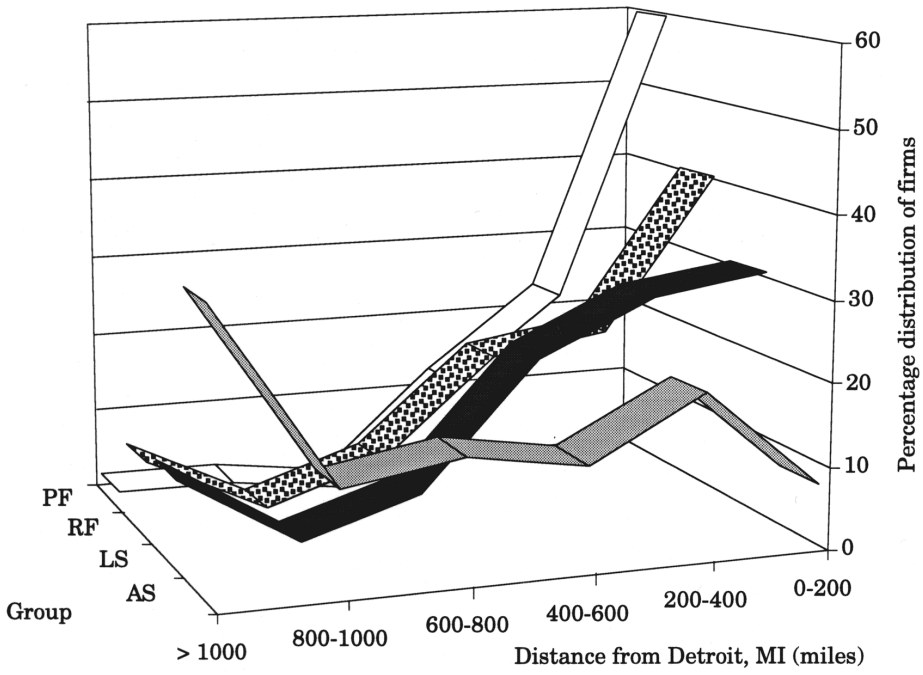

Figure 9. Distribution of firms by distance from Detroit.

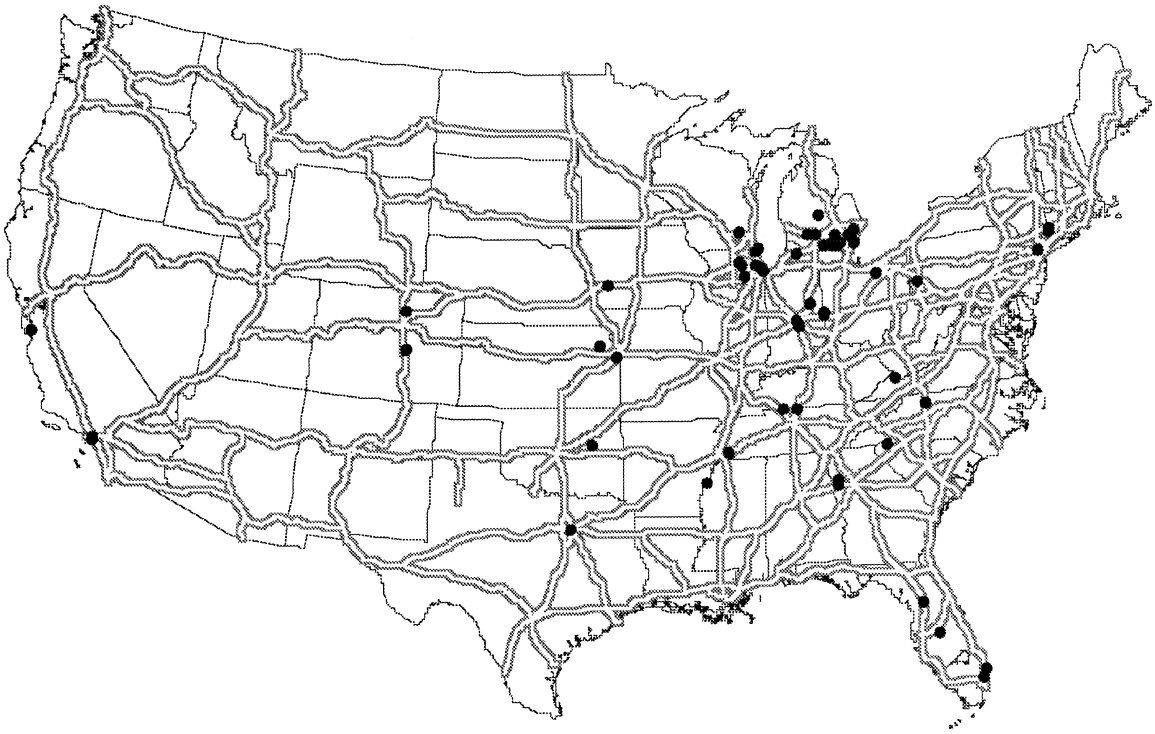

Figure 10. Interstate highways and firms attracted to transport facilities.

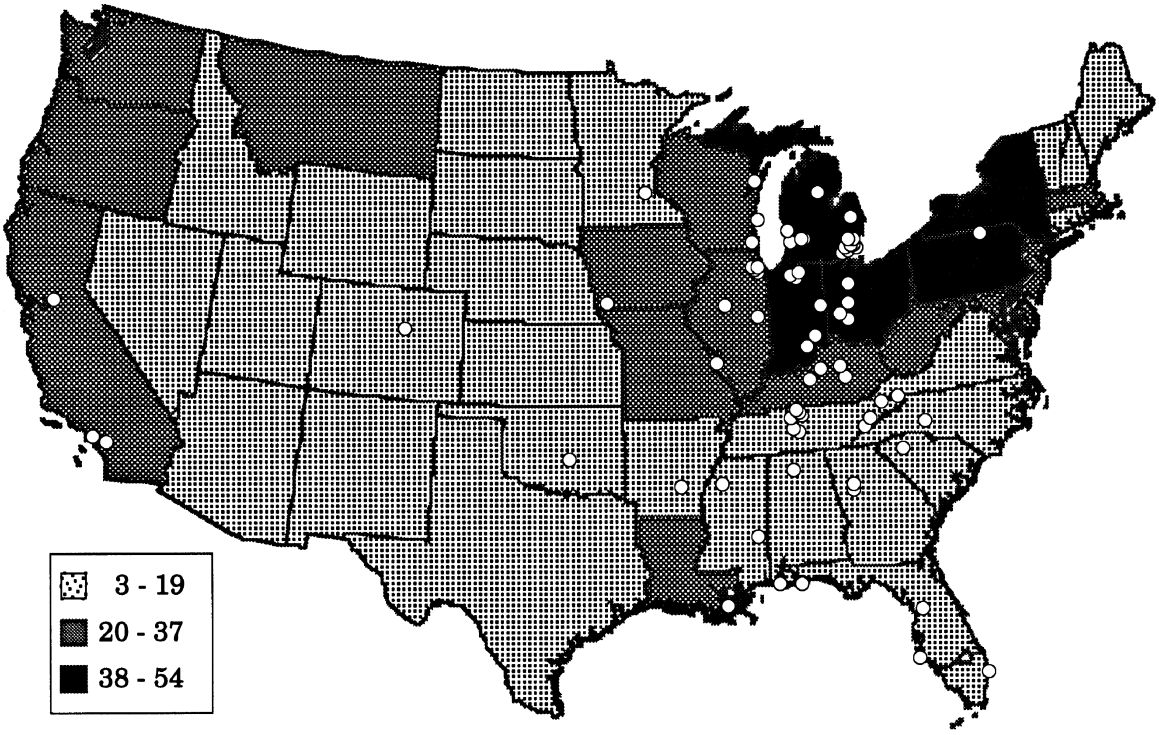

Figure 11. Unionization rate in each state (%) and firms attracted to good labor relations/low unionization. *Source:* Distribution, September 1989, p. 70.

the rate of unionization: 72 firms indicated that "good labor relations/low unionization rate" is one of the most important factors. Surprisingly, 17 out of 44 firms located in Michigan cited this factor, despite the fact that the state has the highest unionization rate in the entire U.S., implying that the two notions (good labor relations and low unionization rate) are not necessarily synonymous. Further study is needed to clarify this issue.

Alternatively, one might wish to compare the locational propensity of indigenous firms and foreign firms. Forty-one suppliers indicated that they were of either Japanese origin or a joint venture, and most of these were in the first-tier. They tend to locate in what is known as the transplant corridor, between interstate highways I-65 and I-75 in the Upper South, where Japanese assembly plants can also be found (Figure 12). A similar picture emerges when the firms are classified according to their age. Old firms are found primarily in the traditional manufacturing belt, whereas newer establishments tend to prefer greenfield sites in the Upper Southern states (Figure 13). Although the data set does not permit mapping out of suppliers and their respective customers, it would be interesting to investigate changes in the average distance between them over time and to see how these changes mirror the overall developments in their production linkages.

3.3. *Changing supplier-customer relationships*

In the 1980s, "Just-In-Time" (JIT) was a buzzword that resonated throughout the American manufacturing industries as they were undergoing waves of process innovation. The basic philosophy of so-called "lean production" entailed manufacturing only the amounts of products for which there were indicated demands, thereby reducing inventory costs and eliminating defects. Of course, the practice of JIT alone does not necessarily help achieve successful waste-free manufacturing operations. Yet, high delivery frequency, along with increasing inventory turns, provides the best available measures of progress in lean production systems.[10]

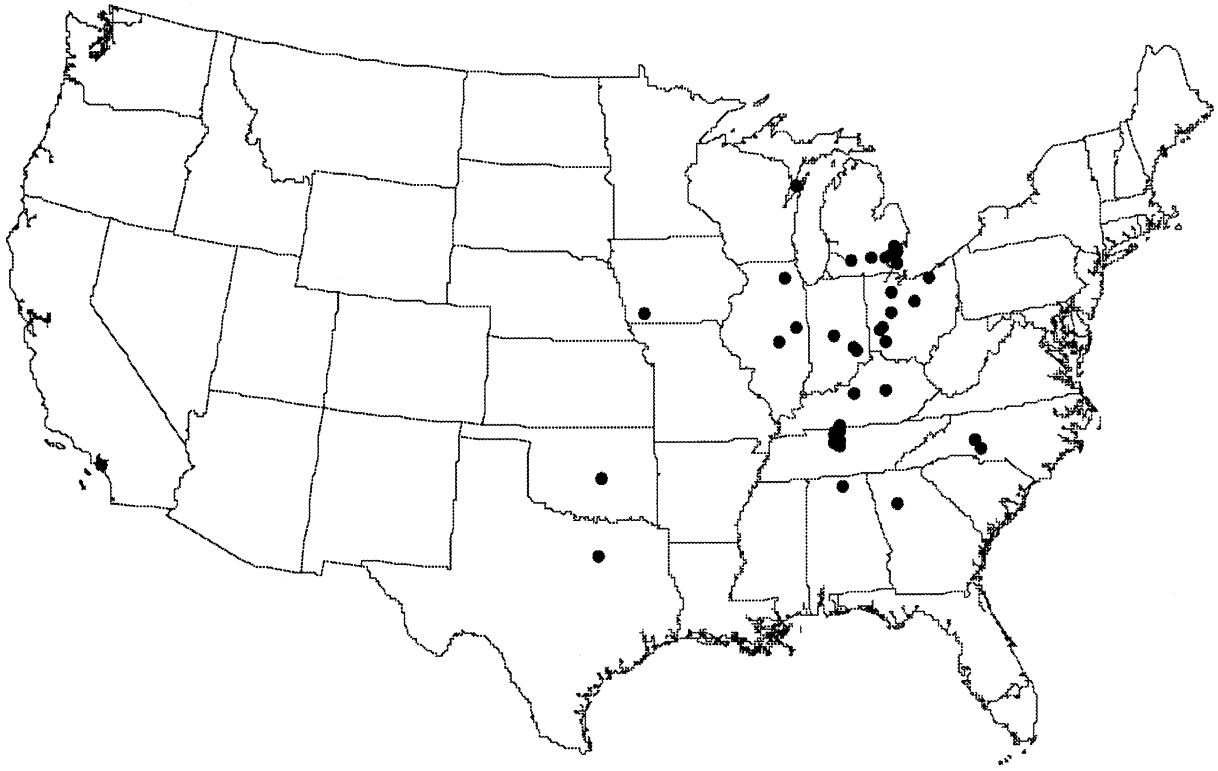

Figure 12. Location of Japanese-affiliated suppliers.

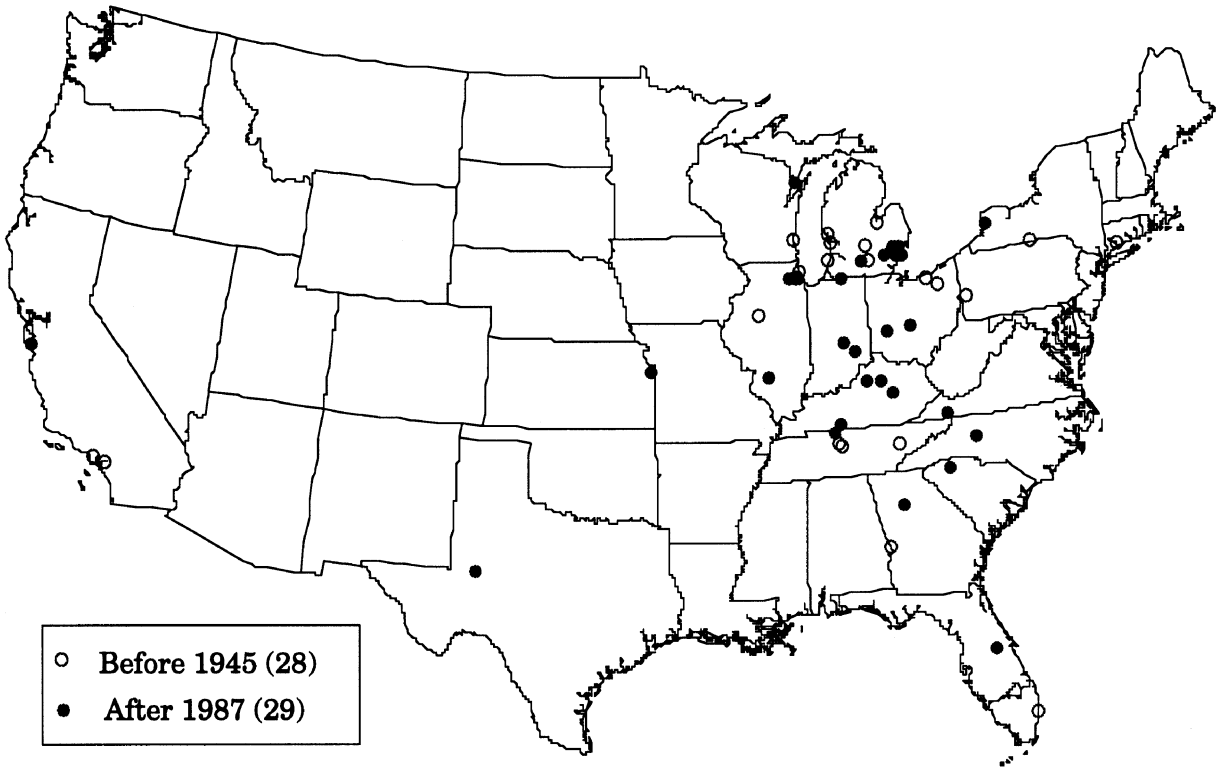

Figure 13. Location of firms by year of establishment.

According to the survey, first-tier suppliers are increasingly tied to assembly plants in the form of long-term contracts. Furthermore, most first-tier suppliers get involved in joint developments of new products at an early stage: 81% of PF and 74% of RF participate, compared with only 22% of LS and 5% of AS. Table V shows various measures of ties between suppliers and customers. Clearly, the first-tier firms are closely linked with assembly plants and less so with their own suppliers, while the LS and AS firms exhibit much weaker linkages in both directions. At the same time, JIT delivery is claimed to be widely practiced. The distance between each pair of groups is manifested in the number of deliveries each firm makes per day. Namely, it shows (1) short distances between assemblers and first-tier suppliers; (2) relatively long distances between first-tier and low-tier firms; and (3) close proximity between aftermarket suppliers and their customers.[11]

The need to exchange information frequently and extensively, and the need to resolve difficul-

TABLE V
Supplier-customer relationships

Group	Long-term contract with customers (%)	Long-term contract with suppliers (%)	Practice JIT in outputs (%)	Practice JIT in inputs (%)	Average output delivery frequency	Average input delivery frequency
PF	80.9	57.4	89.4	74.5	5.4	2.6
RF	92.9	69.0	88.1	76.2	4.4	1.8
LS	43.5	34.8	78.3	65.2	1.1	1.6
AS	29.3	43.9	53.7	48.8	4.5	1.3

ties associated with design, manufacture, installation and operation all seem to indicate that firms prefer to develop their manufacturing bases in close proximity to one another. However, exactly what makes first-tier suppliers maintain much closer relationships with their customers than do lower-level firms? McCann (1993) offers a more plausible explanation as to why JIT mandates proximity: a firm does not locate so as to minimize just total transportation costs, but rather to minimize its total logistics costs, which include the costs of the ordering, the holding, and the transportation of goods.

The value added at the point of production, as the argument goes, is the primary factor that governs the optimum location of the firm. As the delivery frequency increases for a fixed total volume of material, the total transport cost per unit carried also increases. The firm's optimal location moves towards the market as the value added per unit of output at the point of production increases because the costs of holding finished-goods inventories (warehousing, interest and insurance payments, etc.) rise, requiring more frequent delivery of outputs and economy in their transportation. This is achieved only by reducing the output-delivery distance. In our case, then, the first-tier suppliers manufacturing sophisticated modules would feel a greater need to be close by their customers than do low-tier suppliers.

As shown in Figures 14 and 15, the JIT has made remarkable progress in the early 1990s. Between 1989 and 1993, inventory turns for outputs increased by 76%, 33%, 19%, and 52% for each respondent group. Input figures were even more striking, registering 125% for PF, and 40%, 35%, and 60% for the remaining groups, respectively. The significantly higher output inventory turns of PF (compared with those for inputs) seem to suggest that they manufacture essential parts on short notice in an effort to reduce defects, while stocking up on sufficient input materials just in case.

A typical passenger car is built from over 20,000 components. Rather than maintaining too many suppliers or attempting to produce everything in-house, an assembly plant relies on several hundred first-tier suppliers, the number of which is rapidly declining year by year. This trend is reinforced by the spread of "single sourcing", in which automakers rely on only one supplier for any given part.[12] It is being met with parallel action on the part of the suppliers. Only a few years ago, suppliers were cautious about dedicating their entire resources to just one or two customers. It was too risky, and they concluded that they could prosper as a second- or third-tier supplier. That kind of fear has been somewhat mitigated as both assemblers and suppliers have come to recognize the value of a stable and coop-

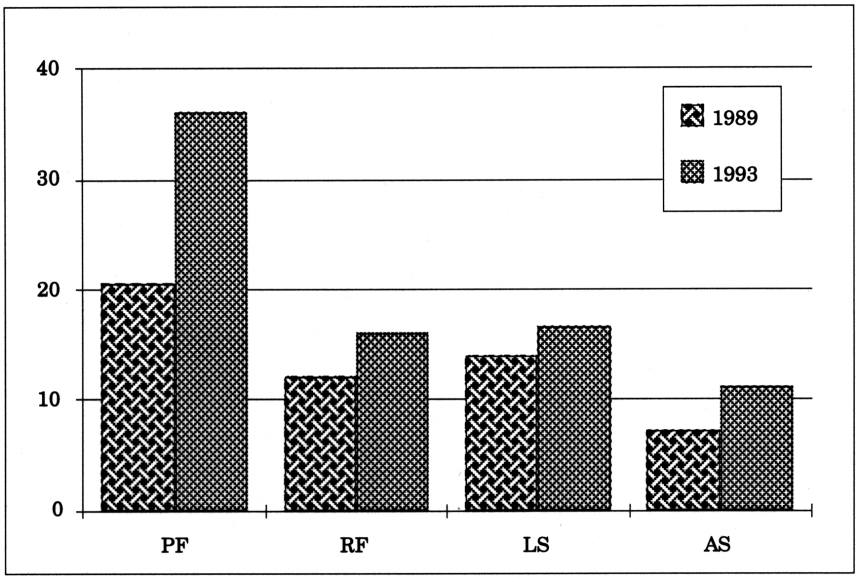

Figure 14. Growth in output inventory turns.

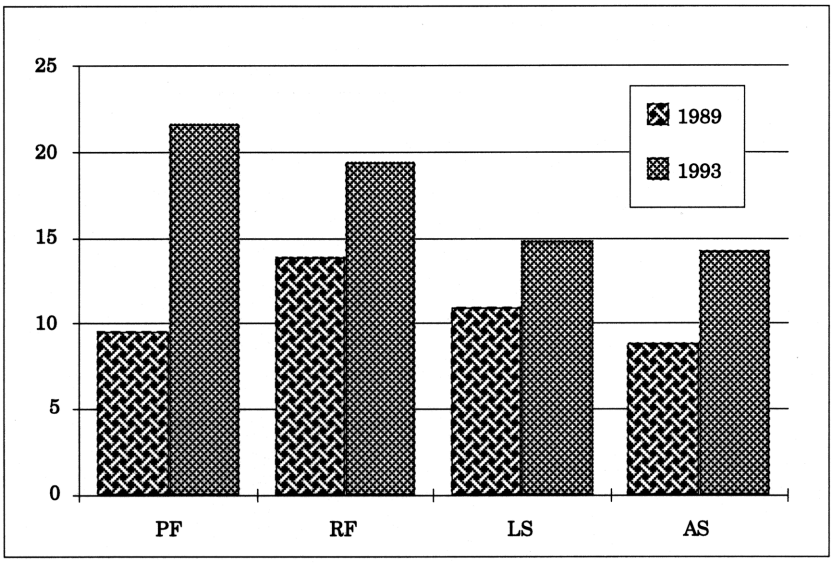

Figure 15. Growth in input inventory turns.

erative relationship, which is required to maintain a successful lean-production system.

Were suppliers reducing the number of their own suppliers as well? The reality is quite the opposite. According to our survey, a typical PF firm increased the number of its own suppliers by 40% during the 1989–1993 period. Actually, first-tier suppliers increasingly bear a heavy burden in acting as quality filters; the defect rates of incoming parts can be up to five times the level of complaints by customers (i.e., assemblers).[13] Comparable figures are 43% for RF, 31% for LS, and 26% for AS firms.

Even though the general picture looks encouraging to the advocates of lean-production practice, our survey statistics on delivery frequencies and number of suppliers are not sufficient to attest to the real changes in supplier-assembler relationships, as Womack et al. (1990) point out:

> It is true that supplier engineering, combined with long-term contracts, . . . more frequent deliveries, and single-sourcing of many components characterize a new North American supply system . . . [but] all have been driven by cost pressures and mass-production logic: single-sourcing for achieving economies of scale, just-in-time for shifting the burden of inventories, and more (p. 161).

Indeed, in a survey conducted elsewhere, 74% of the GM's suppliers who were interviewed said that they feel that the industry giant will find a new substitute if a supplier fails to meet the cost and quality targets.[14] In this regard, Womack et al. (1990) are quick to emphasize that the Japanese tradition of tight linkages is not based on blind trust, but on mutual benefits such as joint analysis of costs, fair determination of prices, and sharing of profits. The U.S. assemblers will have to redefine their relationships with their suppliers for the better. If genuine cooperation between the two parties is to be realized, multiple bidding and other old habits need to give way to more sensible measures to increase the joint profits of both parties over time.

3.4. *Mexican connection*

One of the main objectives of the survey was to uncover the implications of the NAFTA for U.S. parts suppliers by investigating, in conjunction with the findings on their locational factors and customer relationships, how they are responding to the threats and opportunities represented by free trade. Firms were asked to express their views on Mexico as a potential production site by indicating what they think the country has to offer, again among the factors presented in Table IV. The total number of responses was significantly lower than that for current locational factors (315 vs. 569), possibly reflecting their ignorance or lack of interest in Mexican operations.

Roughly speaking, what attracts U.S. suppliers

is invariably the cheap labor south of the border. For PF firms, existing assembly plants in Mexico (Item I) also provide an incentive, as shown in Figure 16. Moreover, they are currently utilizing Mexico to a greater extent as a market and/or a manufacturing base, are more willing to move or expand there in the future, and intend to accompany their customers in the event that the customers decide to move south of the border (Table VI).[15] In this hypothetical situation, the size of potential migrants increases drastically in each category. In total, 42 (47%) of first-tier firms expressed willingness to follow their major customers into Mexico, should this become the case. The RF firms showed even more enthusiasm than the PF firms, perhaps due to an added benefit of Mexico's market potential.

During the years following the introduction of NAFTA, the impact of free trade was clearly visible, despite the severe recession of 1995 in Mexico. According to USTR (1998), between 1993 and 1996, U.S. exports of vehicles to Mexico recorded a 548% increase amounting to $1.3 billion, while parts exports dwindled. Imports of

TABLE VI
Interests of respondents in Mexico (%)

Group	Exporting to Mexico	Has twin plants in Mexico	Planning to move/ expand	Will follow customers
PF	23	23	17	38
RF	19	12	12	57
LS	15	7	11	33
AS	15	2	7	20

Mexican vehicles (mostly compact) more than tripled, from $3.7 billion to $11.3 billion, and Mexican parts exports to the U.S. increased from $7.4 billion to $11.6 billion. In Mexico, retooling of existing plants is actively under way for compact cars and light trucks, in which they have a competitive edge. For instance, Volkswagen's Puebla plant is now the sole supply point worldwide for the New Beetle. Around the plant, investment by European suppliers is growing. However, new automakers and suppliers in Mexico face a number of challenges; for example, transportation can be difficult and time-consuming in the interior,

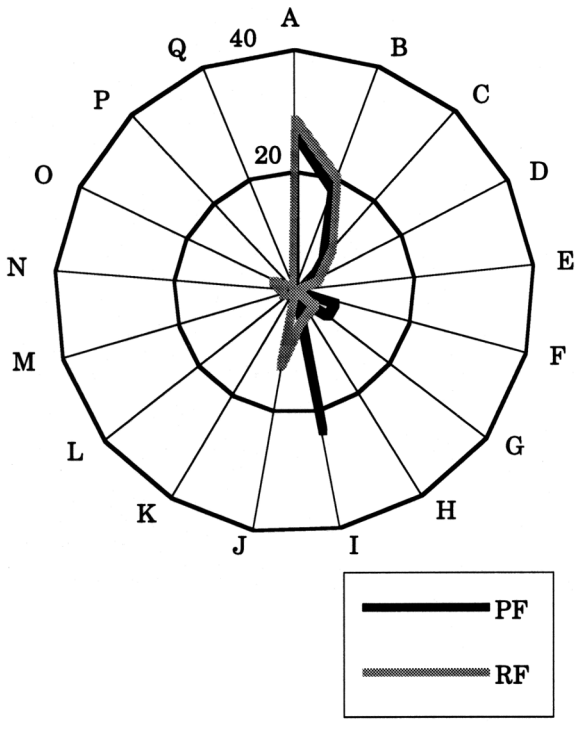

Figure 16. Perceived benefits from Mexican operation for first-tier firms (%).

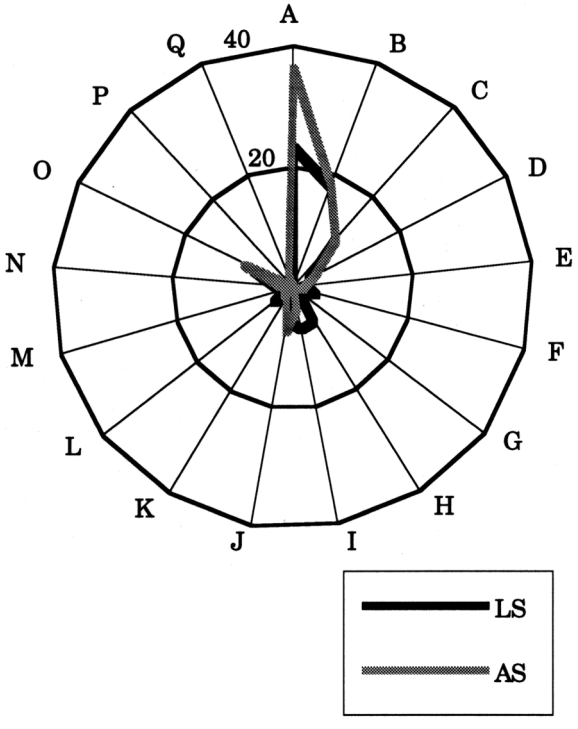

Figure 17. Perceived benefits from Mexican operation for LS and AS (%).

not to mention political instability and lagging domestic demand.[16]

It is a mixed blessing for indigenous parts makers in Mexico. In 1992, there were 396 Mexican-owned companies, compared with only 24 foreign-owned suppliers. By the end of 1995, there were equal numbers (155 each) of foreign and Mexican-owned suppliers.[17] Exposed to fierce international competition, they are undergoing a metamorphosis. The worry of a complete shakeout has not materialized yet, as some firms are now said to be comparable with others in North America in terms of quality, productivity, absenteeism and turnover rate.

Based on these facts, along with the survey results, some careful speculations can be made about how the automotive firms would react to NAFTA. Obviously, the first impact is felt by final assemblers. In addition to providing a new market niche, Mexico could be the optimal production and distribution point for all of North America, depending on the market structure and types of automobiles. As for parts-manufacturers, the survey reveals their conditional preferences about Mexican operations. Although Mexico's cheap labor is quite appealing, suppliers (especially first-tier) will not make their moves unless their customers move first. This seems to explain why a mass southerly exodus of the auto industry is yet to occur; as politically-sensitive automakers are still very cautious about relocation, parts suppliers have no good reason to move first. Given the strong hierarchical structure, the probable reaction of suppliers will be to remain watchful of their customers. Despite high hopes, Mexico offers limited prospects to many U.S. suppliers for now. It would be worthwhile to go back and ask the survey respondents the same questions after the terms of NAFTA are fully implemented in 2004.

4. Conclusions

This paper has presented the main results of a postal survey on U.S. automotive suppliers. The approach taken is unique in that careful grouping is attempted according to their place in the industrial structure and not just their sales revenue or employment size. To reiterate the major findings, there exist considerable characteristic differences among the four groups of suppliers, according to the roles they play in the value chain. Their locational patterns clearly reflect these differences. Among the results, it is noteworthy that the popular notion that low unionism is a prerequisite for maintaining good labor relationships is not warranted. In addition, cautious cooperation between assemblers and suppliers appears to be stronger than ever, thanks to wide adoption of lean production, which is epitomized by the just-in-time inventory system.

The survey results summarized and discussed in this paper should not be read as definitive statements of what the suppliers are doing and will do in the future. Some sort of non-response biases and selection effects are bound to exist in this type of postal survey, calculating the exact magnitudes of which is beyond the scope of this paper. Nonetheless, the findings strongly support general perceptions on both locational and technological inter-firm linkages that exist in the U.S. automobile industry today. The findings may have policy implications, too. If the Mexican government is serious about developing a full-fledged automotive complex, it should begin to focus on luring assembly plants. The first step is to improve its transportation links with the U.S. to help reduce vehicle distribution costs, a foremost concern for the assemblers. Once they set their feet in Mexico, it would surely trigger a chain reaction where large first-tier suppliers begin to relocate, followed by their own suppliers.

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Notes

[1] See, for example, Hufbauer and Schott (1992), Kim (2003), Markusen et al. (1995), and Womack (1991).

[2] The study by Smith and Florida (1994) is justifiable in this regard because most of the Japanese transplant suppliers are in the first tier.

[3] The actual response rate must have been higher because many of the survey recipients are presumably not related to the auto industry, including the 53 firms that returned blank forms citing that reason. Incidentally, firms in states with high concentration of the auto industry showed greater interest in participating in the survey (and presumably receiving the result thereof). Regionwise response rates are as follows: West

(AZ, CA, ID, NV, OR, WA), 15/175 (8.6%); Great Plains (CO, MT, ND, NM, SD, UT, WY), 2/37 (5.4%); Midwest (IA, IL, IN, MI, MN, OH, WI), 112/874 (12.8%); Upper South (AR, KS, KY, MO, NE, OK, TN, WV), 29/215 (13.5%); South (AL, FL, GA, LA, MS, NC, SC, TX), 33/369 (8.9%); East (CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT), 10/136 (7.4%).

[4] For instance, if a $9,846 Ford Escort is rebuilt from replacement parts, it would cost $38,652 (*Automotive Industry*, July 1990). This figure includes the share for distributors, but it still shows how lucrative the aftermarket business can be for suppliers.

[5] An excellent survey of this line of work is provided in Ottaviano and Puga (1998).

[6] This poses an interesting question in terms of modeling because most econometric studies tend to overlook this factor. Rubenstein (1988, p. 292) suspects there are economic incentives offered by the community that business owners may not realize.

[7] Manufacturers of similar products can share inputs and a pool of labor. Face-to-face contact promotes innovation and knowledge spillovers among the firms.

[8] It is possible that existing firms indirectly attract new entrants, unknowingly, by creating an experienced labor pool and various local business services.

[9] There are over 43,000 ZIP codes (5-digit) in the U.S. As their density roughly corresponds to that of the population, they can be an accurate plotting tool except in the western desert areas. ZIP+4 codes can pinpoint location with an accuracy of 1,500 feet in metropolitan areas. However, such a high level of precision is not required for this study.

[10] Inventory turns are defined as the ratio of annual cost of sales to the dollar value of inventories.

[11] Although prevalent in auto assembly worldwide, JIT is said to be less useful for process industries (e.g. steel-making) as well as when the number of units manufactured at a time is small (ships and airplanes). McCann and Fingleton (1996) found that the firms in Scottish electronics industry tend to develop economies of localization as they change to JIT sourcing.

[12] Single sourcing assures a homogeneous and improving quality of parts, but it has a downside as well. For instance, a strike at a bumper supplier facility in August 1994 crippled as many as 15 GM assembly plants in a matter of hours.

[13] Supply-side economics, *Ward's Auto World*, December 1994.

[14] Suppliers, OEMs still differ, *Ward's Auto World*, July 1994.

[15] "Twin plant" usually means division of labor carried out just across the border. However, firms seem to use the term in a broader sense. Most of the 20 respondents who claimed to have twin plants in Mexico are located in the Midwest, with only one in the border state of Texas.

[16] Mexico lures overseas suppliers, *Automotive News*, June 26, 2000.

[17] Mexico beckons, *Ward's Auto World*, December 2000.

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