CHAPTER III

UNITED STATES AUTOMOBILE INDUSTRY

The structure of the U.S. automobile industry has been transformed under the pressure of Japanese producers' entries (FDI) into the U.S. market. The automobile is a product familiar to everyone. It plays an important, essential and pervasive role in our modern life. It often typifies the trends in contemporary life. The automobile industry is a defining representative of modern industry and one of the largest industries in the world. This outstanding importance gives a central role to the auto industry. In the U.S. and Japan, events in this industry have tremendous influences on the national economies. Therefore, if the Big Three plans to lay off employees or suffers a net loss, these issues always become a major national problem, and the general public pays an immediate attention to it. Hence, international economic policy on the automobile industry including trade issues, is seriously important and equally significant as domestic and security policy. Success in international policy on the auto industry could save not only the auto industry itself, but also maintain the U.S. symbol of strength and competitiveness.

United States Auto Industry Dominance

The long-wave theory of Kondratieff identifies four waves of industrial growth since the Industrial Revolution, with a fifth wave now beginning. During the third wave, which began in the 1890s, the automobile industry emerged as a newcomer and grew very rapidly. "It was linked with many other sectors of the economy" and became "very influential in causing economic growth" (Law, 1991, p.2). Around the 1900s, a new form of industrial organization, mass production, emerged. This industrial trend has been called 'Fordism'. This fact shows that the automobile industry was a leading industry in the new system and it was in an extremely influential position. The dominant position of the automobile industry in those days can be comparable with that of the British textile industry two centuries ago.

Until the 1960s, the U.S. automobile industry had been insulated from foreign competition because of the international horizontal specification. American consumers had grown to prefer larger cars due to availability of cheap gasoline and the necessity for driving a long distance in a large country. On the other hand, Japanese and European consumers had different tastes under the opposite circumstances, and preferred small cars.

Under the mass production system, the automobile industry has characteristics such as interchangeable parts, long planning horizon, and large fixed costs to introduce new car designs (Friedlaender, 1984). Therefore, the economies of scale is required to be competitive and profitable. Also, the automobile industry is characterized by a clear division between employers and employees and by arms-length-relationship between assembly and supplier firms. These strict divided relationship became labor and technical problems since the early 1970s, which attributed to a decline in productivity (Mair et al, 1988).[15] The difference in consumers' tastes and the characteristics of the automobile industry (the need of the economies of scale) lead to little competition between the Big Three and foreign automakers. In short, the U.S. automobile industry did not need any type of formal or informal tariff.

During the period of the U.S. firms' dominance at home, the absence of competition against European or Japanese companies made it possible for the Big Three to maintain and exploit its dominant market power. The Big Three enjoyed a high concentration ratio, which was one of the highest in the manufacturing sector.[16] Also, during the period between 1946 and 1973, GM, Ford, and Chrysler earned an average rate of return on net worth of 19.7 percent, 12.3 percent, and 10.7 percent respectively, compared to an all-manufacturing average of 9.2 percent (White, 1971). This insulation and dominant market power affected the Big Three's decision-making in pricing and product strategies, the root of many of the more recent problems.

The Big Three followed dynamic limit pricing in a collusive and hedonic way. They decided on the price level depending upon how effectively entry was blocked, and not depending, in a fully competitive way, upon consumer demand for cars. During the 1960s, according to Scherer (1980), there was only a $10 to $20 difference in prices between Ford and GM, and only $40 to $50 difference between Chrysler and Ford, for equivalent cars. In other words, GM targeted return on investment and set prices, and other companies imitated (Ramrattan, 1991). Then, as foreign small cars were not threatening to the U.S. automobile industry, the Big Three allowed those fringes to grow in the U.S. market. They had the ability to swell profits, in the long run, by increasing their prices in the absence of highly competitive pressure from foreign producers. On the other hand, when foreign small cars obtained an increasing market share around 1960 and 70, the Big Three not only did not increase but even decreased their prices, and tried to drive the fringe producers out. After succeeding in pushing back the fringes, the Big Three again increased their prices (and weight) and tried to earn more possible profits. This pricing strategy was successful in the first surge of foreign small cars around 1960. The market share of imported cars decreased from 8 percent in 1960 to 5 percent in 1962. (See Table 13.) However, in the second surge of imports, the Big Three could not completely halt the growth of imports. Foreign automakers could continue to increase market share because they had established better dealer networks and name recognition (Kwoka, 1984).

In terms of product strategy, the Big Three emphasized product styling instead of other aspects of product quality. The styling dominance occurred among the U.S. producers because the styling has a significant psychological effect of ownership of a brand-new

Table 13

Market Share, 1960-1991

Year	US Brand Domestic Amount (units)	Share	US Brand Transplant & Import Amount (units)	Share	non-US Brand Import Amount (units)	Share	non-US Brand Transplant Amount (units)	Share	Total Amount (units)
1960	6.14	0.92	0.00	0.00	0.50	0.08			6.64
1961	5.56	0.93	0.01	0.00	0.38	0.06			5.94
1962	6.75	0.95	0.00	0.00	0.34	0.05			7.09
1963	7.33	0.95	0.01	0.00	0.39	0.05			7.73
1964	7.62	0.94	0.03	0.00	0.48	0.06			8.13
1965	8.76	0.93	0.04	0.00	0.57	0.06			9.38
1966	8.38	0.92	0.06	0.01	0.66	0.07			9.10
1967	7.57	0.90	0.08	0.01	0.78	0.09			8.43
1968	8.62	0.89	0.12	0.01	0.99	0.10			9.73
1969	8.46	0.88	0.13	0.01	1.06	0.11			9.65
1970	7.12	0.84	0.12	0.01	1.23	0.15			8.47
1971	8.68	0.85	0.20	0.02	1.33	0.13			10.21
1972	9.32	0.85	0.21	0.02	1.38	0.13			10.91
1973	9.67	0.85	0.22	0.02	1.51	0.13			11.40
1974	7.45	0.84	0.18	0.02	1.21	0.14			8.84
1975	7.05	0.82	0.15	0.02	1.41	0.16			8.61
1976	8.61	0.85	0.12	0.01	1.37	0.14			10.10
1977	9.10	0.82	0.21	0.02	1.85	0.17			11.17
1978	9.28	0.82	0.20	0.02	1.79	0.16	0.02	0.00	11.30
1979	8.16	0.77	0.23	0.02	2.05	0.19	0.17	0.02	10.61

Year	US Brand Domestic		US Brand Transplant & Import		non-US Brand Import		non-US Brand Transplant		Total
	Amount (units)	Share	Amount (units)	Share	Amount (units)	Share	Amount (units)	Share	Amount (units)
1980	6.40	0.72	0.20	0.02	2.17	0.24	0.18	0.02	8.94
1981	6.04	0.71	0.14	0.02	2.18	0.26	0.16	0.02	8.53
1982	5.67	0.71	0.10	0.01	2.12	0.27	0.09	0.01	7.98
1983	6.66	0.73	0.10	0.01	2.28	0.25	0.14	0.01	9.17
1984	7.74	0.75	0.10	0.01	2.33	0.22	0.21	0.02	10.39
1985	7.91	0.72	0.23	0.02	2.58	0.23	0.26	0.02	10.98
1986	7.68	0.67	0.48	0.04	2.88	0.25	0.37	0.03	11.40
1987	6.40	0.63	0.48	0.05	2.76	0.27	0.54	0.05	10.19
1988	6.74	0.64	0.57	0.05	2.61	0.25	0.63	0.06	10.54
1989	6.04	0.62	0.59	0.06	2.36	0.24	0.78	0.08	9.78
1990	5.48	0.59	0.63	0.07	2.11	0.23	1.08	0.12	9.30
1991	4.68	0.57	0.57	0.07	1.78	0.22	1.14	0.14	8.17

Sources: Ward's Automotive Yearbook, various issues.

model on consumers. The change in styling contributes to a decrease in the average period of ownership of a car, more replacement of cars, and finally increases in producers' profitability. On the other hand, many other aspects of quality have an opposite effect, and threaten the replacement-demand-enhancing strategy. Under the circumstance of less competition with foreign producers, the Big Three were not forced to engage in quality competition, and had involved itself in style competition (Kwoka, 1984).

In conclusion, under the protected market, the Big Three had not worked on improving its productivity[17], and not been ready for the challenges such as two oil shocks, increasing government regulations[18], and intensified foreign competition.

Competition with Importers

Due to the oil crises in 1973 and 1979, gasoline prices increased radically and the U.S. consumers' relative demands for cars changed dramatically in favor of smaller cars. Also, Japanese auto producers had consolidated their competitive advantages. There are three sources of competitive advantages: technological change, institutional development and human resources, and strategic behavior of firms and governments (Mody and Wheeler, 1990).

Japanese automakers developed "balanced socio-technical" (BST) and "just-in-time" (JIT) system. BST system is one of the most considerable ownership advantages for Japanese firms. Shimada calls it as humanware technology (1989), which balances and integrates people with a technical system. This whole system represents superior technology in product and process and better management skill. The concept was developed in London's Tavistock Institute of Human Relations. This nontraditional system integrates and coordinates "Strategy, Systems, Structure, Culture, and Human Resources subsystems within a complex changing environment" (Rehder, 1989, p.19).

The JIT system was developed by Toyota, and has the following characteristics: smoothing production without in-process inventories; using flexible machinery adaptable to various variables; and subcontracting ties between assembly and parts firms (Mair et al, 1988). The subcontracting ties, which contribute to lessening in-process inventories, had been established through changes in vertical structure of automobile industry. The ties assure cooperative, long-term and innovative stimulating automobile supplier infrastructure. In this close relationship, assembly firms can make use of their suppliers' easier access to different types of labor, and suppliers can obtain access to pools of capital. This system maintains positive incentives for improvement, which contributes to an increase in productivity (Smitka, 1991).

Under the increasing internationally competitive environment (especially by the Japanese), the Big Three did not respond promptly and effectively. The U.S. domestic firms still did not promote quality[19], which was fundamental in the new competition.

These strategic mistakes led to their losing market share. In other words, the automobile market was disciplined by imports[20], especially by the Japanese.[21] In 1980, the Big Three collectively lost $4.2 billion (see Table 14), and Ford and the United Auto Workers filed a joint petition for relief from imports.

The Reagan administration responded to this sectoral decline in the automobile industry with a bilateral voluntary export restraint (VER) with Japan. In the early twentieth century, the British government used trade barriers to encourage FDI by foreign competitors. Britain had adapted the McKenna tariffs unilaterally as formal trade barriers (Reich, 1989).

The initial VER agreement in May 1981 imposed on import ceiling for Japan of 1.68 million units per year. (See Table 15.) Later, in early 1985, the U.S. government combined this arrangement with a policy of purposely depreciating the dollar against foreign currency, including the Japanese yen. These combined policies had been requested and welcomed by several interest groups. The concern had been about jobs for organized labor, the reduction or eradication of Japanese firms' competitive advantage for manufacturers[22], and the balance of payments. The policies, in the long run, were expected to encourage Japanese automakers to produce cars in the U.S. (Reich, 1989).

Many authors have studied on the probable effects of the VER. Feenstra estimated that Japanese auto prices in the U.S. increased by $1,096 per vehicle by 1984 (1988). According to the executive summary of United States International Trade Commission, the

Table 14

U.S. Auto Industry Net Income (Loss), 1961-1991 ($ millions)
(in constant 1987 dollars)

Year	GM	Ford	Chrysler	AMC	Stude	Totals
1961	3,394.76	1,557.34	42.35	89.65	9.64	5,093.74
1962	5,444.32	1,793.67	244.16	127.76	9.56	7,619.46
1963	5,852.29	1,796.13	594.10	139.00	-62.23	8,381.51
1964	6,262.75	1,825.27	771.73	94.68	29.12	8,983.54
1965	7,484.53	2,475.52	821.75	18.33	37.68	10,837.81
1966	6,099.97	2,112.32	643.61	-43.02		8,812.77
1967	5,370.55	277.56	661.50	-250.21		6,059.39
1968	5,463.45	1,977.92	917.13	15.11		8,373.61
1969	5,137.22	1,641.14	297.21	14.80		7,090.37
1970	1,735.24	1,469.23	-21.66	-160.23		3,226.29
1971	5,217.55	1,770.89	225.50	27.43		7,241.36
1972	5,574.24	2,242.27	568.18	77.72		8,462.42
1973	5,806.30	2,194.92	618.51	208.17		8,827.90
1974	2,115.81	803.79	-116.02	61.35		2,864.93
1975	2,546.75	655.89	-527.44	-55.89		2,619.31
1976	5,550.29	1,879.73	808.03	-88.60		8,149.45
1977	5,970.48	2,992.49	291.95	14.79		9,269.71
1978	5,817.58	2,634.99	-339.30	60.85		8,174.11
1979	4,416.79	1,785.19	-1,675.27	128.16		4,654.81
1980	-1,064.16	-2,152.44	-2,384.52	-275.49		-5,876.60
1981	422.05	-1,343.47	-602.79	-173.13		-1,697.34
1982	1,149.16	-784.96	202.98	-183.17		384.01

Year	GM	Ford	Chrysler	AMC	Stude	Totals
1983	4,277.75	2,141.06	803.78	-168.23		7,054.36
1984	4,963.74	3,194.29	2,637.36	17.00		10,812.38
1985	4,236.23	2,664.62	1,732.20	-132.69		8,500.36
1986	3,039.22	3,390.20	1,448.50	-93.91		7,784.00
1987	3,551.00	4,625.00	1,254.00			9,430.00
1988	4,673.72	5,101.06	971.13			10,745.91
1989	3,896.68	3,537.82	297.97			7,732.47
1990	-1,759.08	761.74	60.23			-937.11
1991	-3,805.98	-1,929.91	-679.49			-6,415.38

Note: Net incomes (losses) are adjusted by the GDP price index (1987 = 1).
Sources: Ward's Automotive Yearbook, various issues.

Table 15

Voluntary Export Restraint (VER), 1981-1992

Year (Japan's fiscal year)	Import Ceiling (million units of cars)
1981 -	1.68
1984 -	1.85
1986 -	2.30
1992 -	1.65

Sources: Ward's Automotive Yearbook, various issues.

effects of the VER (also referred to as the VRA) were estimated as follows:

-The VRA may have caused increases in prices of both new domestic and used domestic and foreign autos in the United States. (See Figure 13.)

-The total estimated cost to the U.S. consumer as a result of the VRA during 1981-84 was $15.7 billion.

-In the absence of the VRA it is estimated that an additional 1 million Japanese autos may have been sold in the United States in 1984.

-The VRA most likely resulted in an additional 44,000 U.S. jobs and additional sales of 618,000 domestically produced autos in 1984.

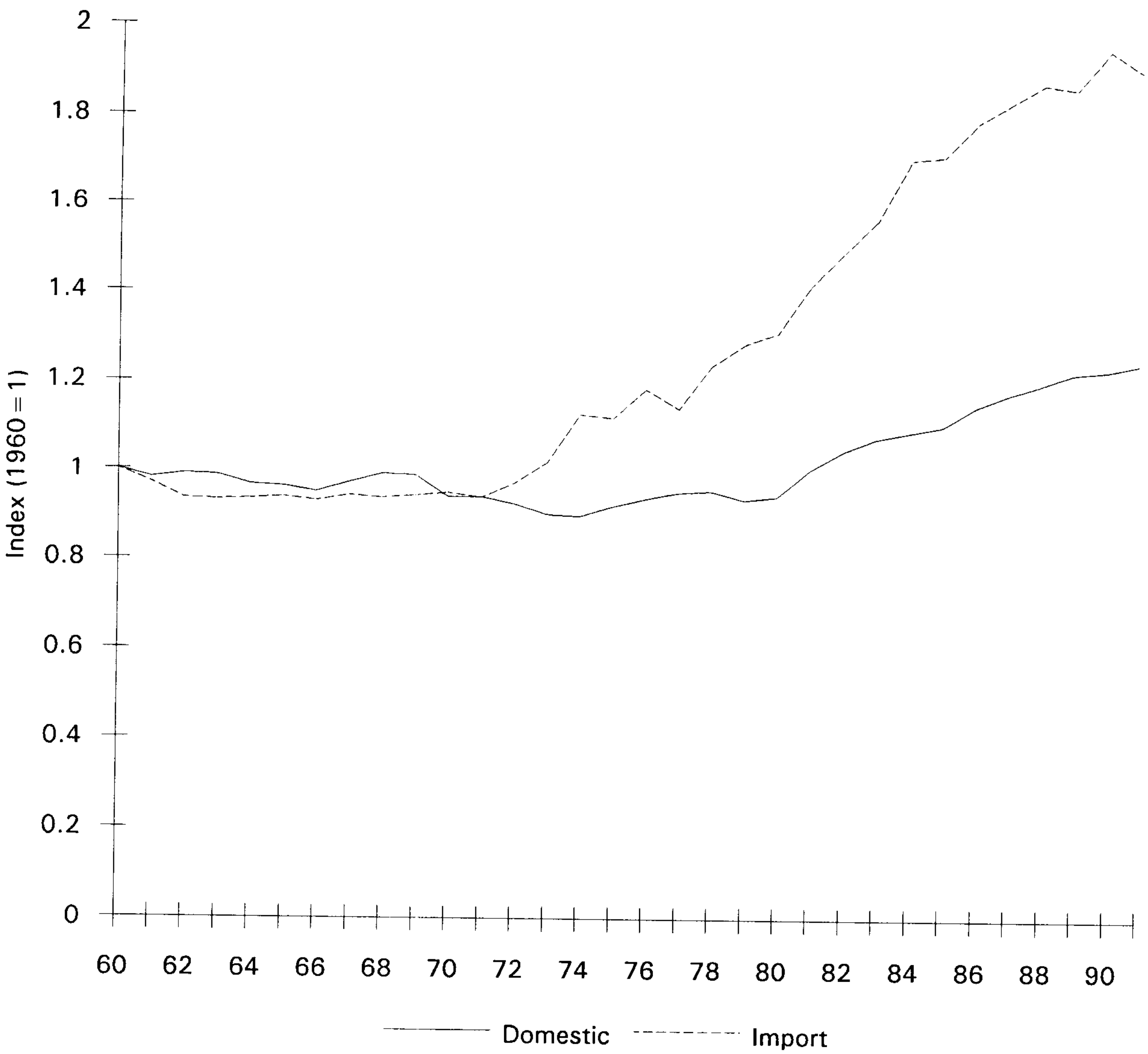
-In the absence of the VRA, it is estimated that the U.S.-Japan trade deficit in autos would have been nearly $2 billion greater in 1983 and almost $4 billion higher in 1984. (USITC, 1985, pp.viii-x)[23]

Winston and his associates claim that, for Japanese auto producers, the VER led to an increase in production in the U.S., an extent of brand loyalty for Japanese firms, and then an enlargement of their market share. For U.S. automakers, VER increased Japanese auto prices first, and then U.S. auto prices, which made it possible for U.S. firms to decrease their outputs and to increase their profits (1987).

The Economist states that protectionist legislation should be temporary and that the VER "has inadvertently denied American

Figure 13

Prices of Domestic and Import Cars, 1960-1991
(in real terms)



Note: Both prices are adjusted by the GDP price index.
Sources: BEA, Survey of Current Business, various issues.

domestic carmakers the full benefits of the falling dollar." In other words, the VER gave seven years instead of three years to catch up with the three-year rise of the Japanese yen (1988, p.69).

Competition with Transplants

Under the VER and threats of further action, combined with the depreciation of U.S. dollar value against the Japanese yen, Japanese car producers were forced to change strategy. They made four responses to these changing environments. They established their own lobby in the U.S.; switched emphasis to upgraded cars; maintained wide profit margins; and most importantly, invested in greenfield production facilities in the U.S. along with transfer of Japanese comparative advantages. First, Japanese auto producers recruited many specialists as lobbyists, and had them gather information or present the views of the Japanese automobile industry. According to the U.S. Attorney General's 1980 annual report, the Japanese were biggest spender on lobbying (Wong, 1989).

Second, in terms of upgrading, Japanese firms increasingly put an importance on more luxury cars on which profits tend to be higher. That is, with a limitation on the number of cars exported, the Japanese shifted to higher-quality auto exports.

Third, in the early years of the VER, the import quota made it possible for Japanese carmakers to maintain or increase market share without cutting their prices. Therefore, prices and profit margins increased more rapidly than before (Economist, 1988).

Finally, the Japanese auto producers began in 1982 to build manufacturing plants in the U.S. (See Table 16.) This movement might represent the quid pro quo FDI referred by Wong (1989). However, the quid pro quo FDI cannot explain perfectly a continuous increase in FDI and success of transplant operations in the U.S. Without expectation of success in FDI, Japanese carmakers would not invest in the assembly lines. Therefore, threat of protection does not tell a whole story of increasing FDI in the U.S., but Japanese comparative advantages in the auto production contribute greatly to Japanese producers' determination of FDI in the U.S. auto industry. Besides, the protection-threat is nothing related to a continuous success in Japanese FDI in the auto industry. Honda's auto plant in Ohio is currently the most efficient facility in the world. Also, plants of Nissan, Toyota, and NUMMI are meeting with a success (Mody and Wheeler, 1990). In sum, the determinants of FDI in the U.S. automobile industry are Japanese firms' competitive, comparative, or ownership advantages along with the protectionist threat.

As a source of competitive advantage, Japanese producers have "moved down the learning curve in automobile production more effectively than any other nation" (Mody and Wheeler, 1990, p.140), through superior learning and automation, i.e., technological innovation. In addition, Japanese firms have succeeded in transferring their "balanced socio-technical" and "just-in-time" systems.[24]

Table16

Japanese (Automobile) Transplants in the United States, 1982-1992

Japanese Makers	Honda	Toyota	Nissan	Mazda	Toyota	Mitsubishi	Fuji, Isuzu
Type of Entry	Sole Entry	Joint Venture with GM	Sole Entry	Sole Entry	Sole Entry	Joint Venture with Chrysler	Joint Venture
Name of Company	Honda of America Manufacturing Inc.	New United Motor Manufacturing Inc.	Nissan Motor Manufacturing Corp.	Mazda Motor Manufacturing Corp.	Toyota Motor Manufacturing Inc.	Diamond-Star Motors Corp.	Subaru-Isuzu Automotive Inc.
Prod. Start-Month (a)	Nov. 1982	Dec. 1984	Mar. 1985	Sep. 1987	May 1988	Late 1988	Late 1989
Location	Marysville, East Liberty and Anna, OH	Fremont, CA	Smyrna, TN	Flat Rock, MI	Georgetown, KY	Normal, IL	Lafayette, IN
Products (b)	Accord Civic	Chevrolet Geo Prizm Toyota Corolla	Sentra Stanza	MX-6 626 Ford Probe	Camry	Plymouth Laser, Eagle, Talon, Summit Mitsubishi Eclipse, Mirage	Subaru Legacy
Employments (b)	11,000	3,500	5,500	3,500	3,975 5,000 by 1994	3,000	2,000

Japanese Makers	Honda	Toyota	Nissan	Mazda	Toyota	Mitsubishi	Fuji, Isuzu
Capacity (b)	360,000 Marysville	240,000	450,000	240,000	220,000	240,000	170,000
	150,000 East Liberty				420,000 by mid '90s		

Sources: a. Shimada, Haruo, 1989, Japanese Management of Auto Production in the United States: An Overview of "Humanware Technology", Table 1, p. 187; and
b. Ward's Auto World, January 1992, pp. 18-28.

These elements have contributed to the comparative advantages of Japanese transplants in the U.S. Their continuing advantages over the several years have given "the Japanese a formidable weapon, a developing belief on the part of U.S. consumers that U.S. automakers could not qualitatively compete with the Japanese in the subcompact and compact segments of the market" (Tay and McCarthy, 1991, p.152). In other words, in the 1980s, Japanese automakers have developed a strong brand loyalty advantage, whereas U.S. carmakers have lost it. The brand loyalty affects current or future market share, which is a key to high long-term profitability (Mannering and Winston, 1991).[25]

The Big Three and U.S. suppliers have had an opportunity to learn high-performance management and organizational systems from Japanese transplants. A study of NUMMI, the GM/Toyota joint venture in Fremont, California, shows increased productivity, quality records, and management/labor relation systems (Rehder and Smith, 1986). In addition, Ford is using the Japanese system for 'Team Taurus' process, and GM is using for 'Four Phase Process', both of which revolutionize the U.S. new product development system (Rehder, 1989).[26]

On the other hand, as costs of the increase in transplants, the Big Three, at the industrial level, continue to lose market share and to experience overcapacity. At the national level, U.S. officials and economists are concerned about the loss of jobs and technological know-how due to imports of high value-added components from Japan by the transplant firms (Rehder, 1989).

As I mentioned earlier, FDI could have considerable effects on employment in a particular industry. The automobile industry is so important for the nation that the effect of FDI on employment cannot be ignored, although FDI has little effect on the overall national level of employment. In 1988, the U.S. General Accounting Office (GAO) assessed the effect of transplants on the U.S. automobile industry. The GAO projected about 360,000 of overall job losses between 1985 and 1990 (1988). The UAW estimated 500,000 jobs lost during the same period.

In addition, under the new management system, there is growing discontent among workers and managers. For example, the New Directions Movement has emerged within the UAW. The organization is calling for less cooperation with companies. At NUMMI, Peoples' Caucus is stirring up discontent about their management/labor relations (Rehder, 1989).

These organizational problems are related to work stress and safety, the role of the union, employee discrimination, and the conflict of cultures. Work stress comes possibly from a repetitive nature with an extraordinary pace of transplant assembly line jobs. In terms of the role of union, Japanese team-based system makes it hard to tell the border between the role of management and union, which tends to limit the union's influence in the company or the industry (Rehder, 1989). With regard to discrimination, in March 1988 Honda agreed to pay $6 million for past discrimination in hiring and promotion (Frantz, 1988), which shows discrimination has been a problem in some transplant operations. In terms of the culture conflict, Japanese tend to be group-oriented, while Americans tend to be more individual-oriented.

In summary, Japanese transplants have had both positive and negative effects on the U.S. automobile industry, and it is very hard to determine the net effect. However, the current and emergent problem for the Big Three is substantial excess capacity in production of assemblers and suppliers, and it is too severe to ignore. The U.S. auto industry (both the Big Three and transplants) is trying to rearrange itself by investing heavily in automations[27] (see Table 17,) or by constructing new plants and discarding old ones at a pace not seen since the emergence of this industry (Rubenstein, 1991). (See Table 18.)

Table 17

Research and Development (R&D) Expenditures in the Automobile Industry, United States and Japan, 1980-1988

Year	U.S. (billions of 1987 $)	Japan (billions of 1987 $)
1980	6.00	4.73
1981	5.35	6.41
1982	5.16	9.18
1983	5.45	8.06
1984	5.91	5.48
1985	6.53	6.89
1986	7.42	5.47
1987	7.27	15.97
1988	7.51	59.68

Note: R&D expenditures are adjusted by the GDP price index of each country.
Source: M. Fuss and L. Waverman, 1992, Costs and Productivity in Automobile Production, p. 230.

Table 18

Assembly Plant Closures and Startups in the United States, 1979-1989

Company	Open as of 1979	Closed 1979-89	Opened 1979-89	Open as of 1989
GM	22 a	5 b	6	23 a
Ford	14	6 c	0	8
Chrysler	7 d	3 d	1	5
Japanese	0	0	6	6
Volkswagen	0	1	1	0
Total	43	14	14	42

a = Including plant transferred to NUMMI
b = Including one converted from car to truck production
c = Including two converted from car to truck production
d = Including one plant inherited from merger with American Motors

Source: Rubenstein, 1991, Impact of Japanese Investment in the US, Table 5.6, p.122.

CHAPTER IV

REGRESSION ANALYSIS

The principal objective of this chapter is to offer an econometric analysis of the impact of Japanese FDI (transplant) on the U.S. automobile industry, as evidenced by the own- and cross-price elasticities of demand for automobiles produced by the Big Three and Japanese transplants. I hypothesize that Japanese auto makers have succeeded in changing the U.S. automobile market structure and now face a price elasticity of demand for their cars that is at least as low, if not lower than, that faced by the Big Three automakers.

Review of Previous Studies

Kenneth Train (1986) categorizes previous investigations of the demand for automobiles in the U.S. into two groups on the basis of the methods employed: disaggregate and aggregate models.

A. Disaggregate, Compensatory Models

Numerous studies of this type have been conducted: Charles River Associates (1980), Hocherman, Prashker, and Ben-Akiva (1982), Mannering and Winston (1983), Winston and Mannering (1984), and Berkovec and Rust (1985).

These studies follow an assumption that an individual consumer (or household) makes a decision on auto ownership in a compensatory manner. In other words, he or she trades off several alternatives among vehicle features (car price, horse power, etc) and his or her own characteristics (income size, age, etc). Then he or she takes the alternative with higher value of characteristics which can compensate for lower value of other characteristics. "Purchase price", "operating cost", and the "income size" are the primary factors that affect consumer choice. Most of the studies in this category have those three factors in their formulas. There are a couple of limitations. The interrelated set of decisions on how many vehicles and on which autos to own, are not fully incorporated. Also, modelling the choice of makes and models of autos is not completely satisfactory (Train, 1986).

B. Disaggregate, Noncompensatory Models

There are two major studies taking this approach. One is by Recker and Golob (1978) and the other is by Murtaugh and Gladwin (1980). Both studies assume that a consumer has rankings among alternatives and each alternative has some minimum acceptable level. The consumer eliminates all the alternatives that have lower value than the minimum level, starting with the most important alternative, and continuing until only one alternative remains. The alternative left is what the consumer chooses. "Vehicle size" is the most important characteristics in both studies (Train, 1986).

C. Aggregate Models

This type of study relies upon the total or aggregate demand for autos, since there are problems in collecting data on individual consumers. These studies have been conducted by Chase Econometrics Associates (1974), Wharton Econometric Forecasting Associates, Inc. (1977), Rubin (1983), and Hartmann (1983). They have examined only the total amount of car sales and ignored the individual's choices of type of autos. "Purchase price" and "average income" are included in every model. Also, some type of lagged dependent variable are included in most of the studies.

There is a limitation with this approach. None of these models includes any noncost dimensions of automobiles, for example, horsepower and space. As a result, "the effect of concomitant changes in noncost characteristics can seriously bias the demand predictions" (Train, 1986, p.132).

Rubin and Hartmann generate an aggregate model with quarterly data. The model is designed to "capture short-run economic developments which impact on U.S. auto sales" (Rubin, 1983, p.2)[28], and adjusts "consumer's stocks to their desired levels" (Hartmann, 1983, p.2). The demand for new automobiles is a function of costs of car ownership, prices of other goods, and consumer's outlook about economic activity. The dependent variable is unit sales of cars. (See Appendix A.) The estimated model "provides a tool to evaluate the effects of many economic scenarios on auto sales" (Hartmann, 1983, p.10).

Estimated Models

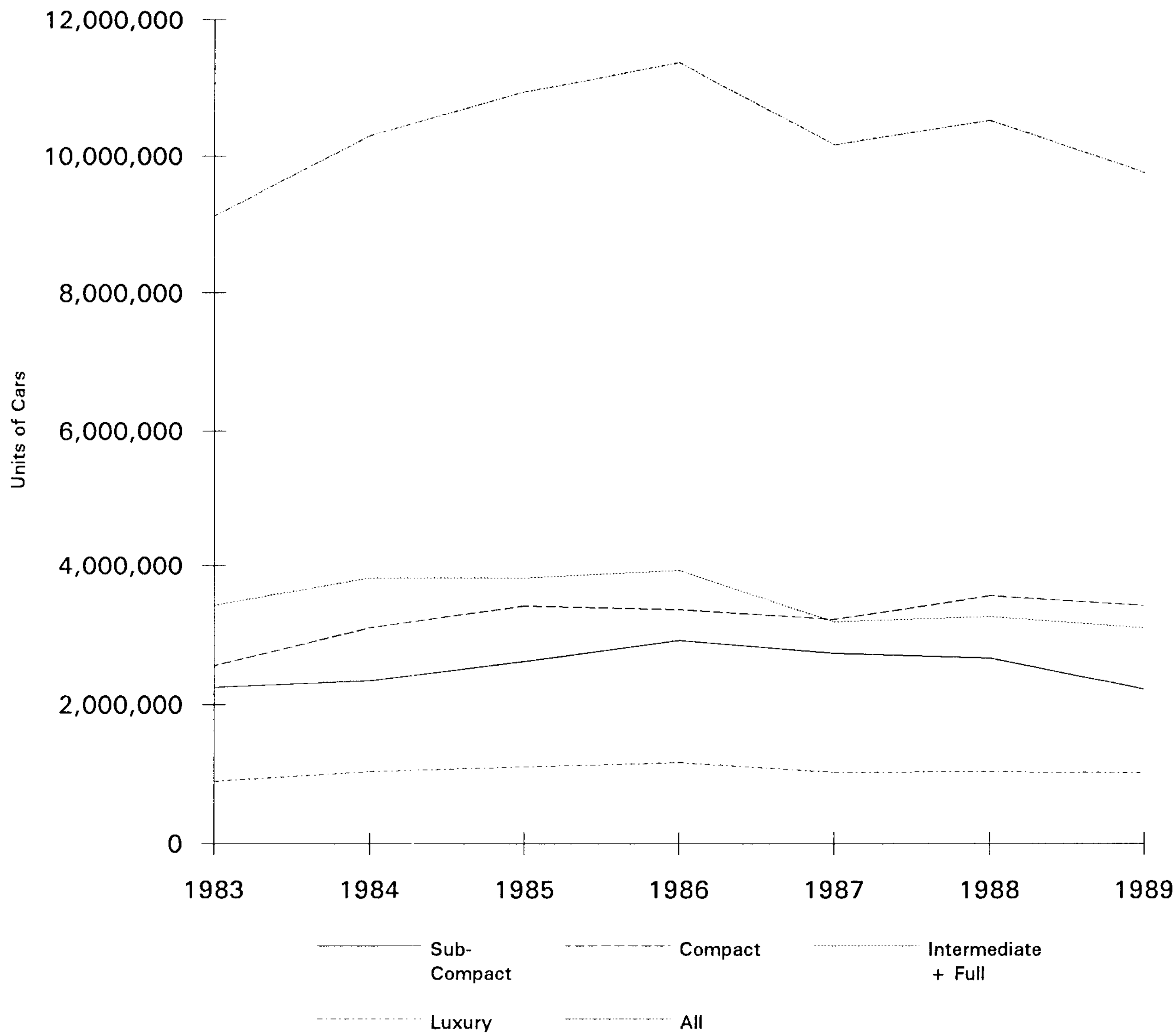
I follow the assumptions of two previous studies conducted by Train and Lohrer (1983) and Berkovec and Rust (1985). I assume that, first, a consumer chooses a class of vehicle, and then chooses make and model within the chosen class.[29] Under these assumptions, I examine the U.S. automobile market (not including Canada and Mexico) for compact-sized cars[30] (see Figure 14,) from 1984 to 1992. I focus on compact-sized cars because, in terms of production strategy in the U.S., Japanese transplants have placed the most importance on that category.[31] I deal with the auto market since 1984 because sales of transplants have increased since around 1984 after the production start for the first assembly line in November, 1982 at Maryville, Ohio plant. (See Figure 15.)

There are two main objectives in this section: to examine the short- to intermediate-run effect of automobile prices on sales, and to isolate the impact of Japanese transplants from other effects. Due to the limited duration of the sample period, I concentrate on the short- to intermediate-run demand. I assume a recursive structure: contemporaneous prices determine contemporaneous demand, but not the other way around. This recursive permits estimation by ordinary least squares in the absence of autocorrelation.[32]

For the second objective, I estimate separate demand equations for compact cars produced by the Big Three and Japanese transplants. Previous studies examine aggregate demand equations

Figure 14

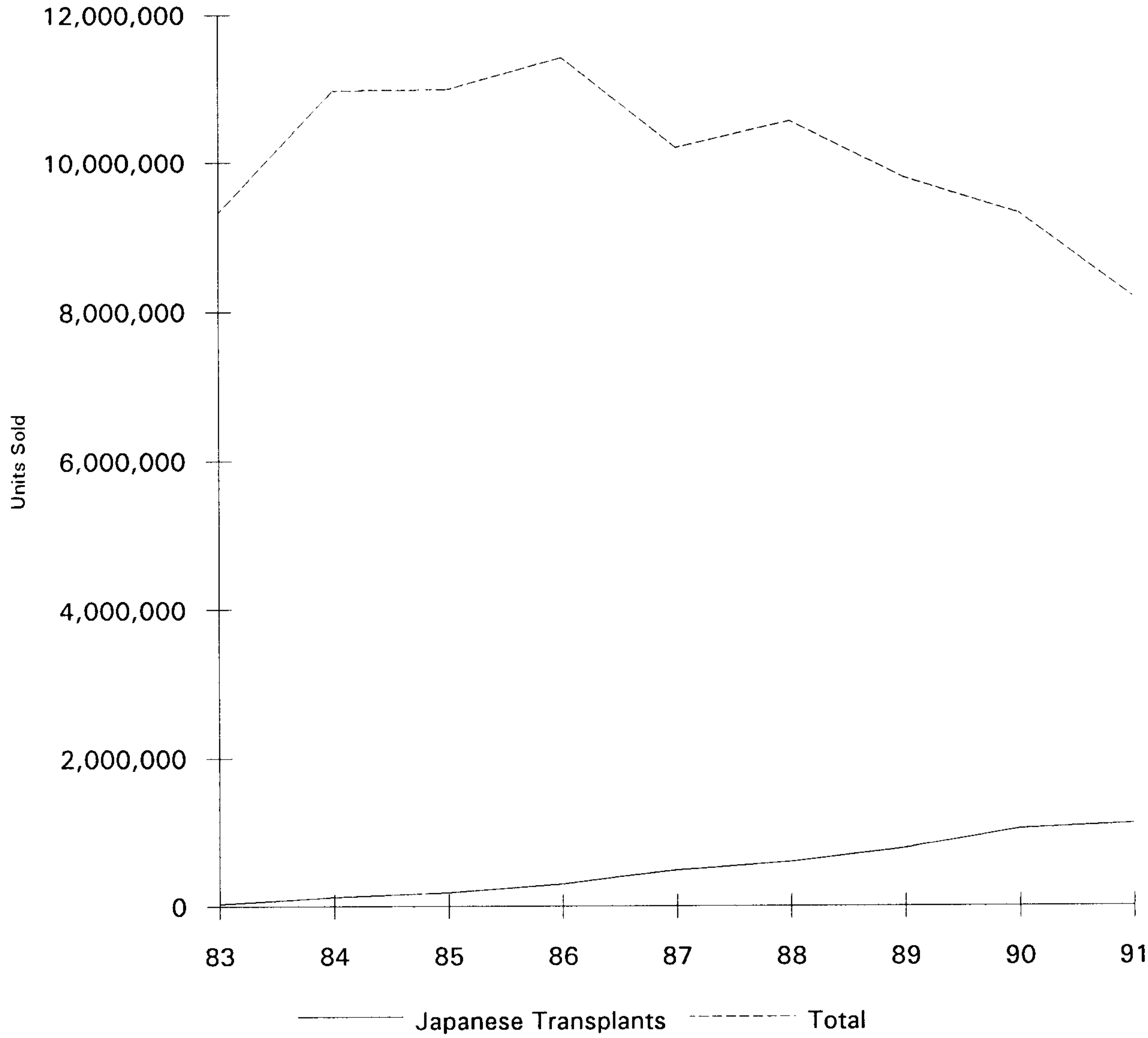
The Change in Market Share
of Each Auto Class
in the United States, 1983-1989



Sources: Ward's Automotive Yearbook, various issues.

Figure 15

Car Sales of
Japanese Transplants
and Grand Total, 1983-1991



Sources: Ward's Automotive Yearbook, various issues.

dealing with both the total number of autos and the share of auto classes. However, they do not investigate demand functions for a particular class itself, for instance, compact-sized cars. Japanese companies put considerable importance on producing compact-sized cars in the U.S. Therefore, to extract main impact of transplants, the demand functions need to be only for compact cars.

With these objectives, I estimate four demand functions: two for a joint-version which has common "best" equations for the Big Three and another for transplants; and other two for a best-version which has one "best" equation for the Big Three and another "best" for transplants. For the joint-version, the equation is chosen depending on goodness-of-fit and the level of autocorrelation, with the restriction that the same variables enter both the U.S. and transplant demand functions. This set makes it possible to compare the coefficient of each variable in the models for comparable specifications. For the best-version, the equation is also chosen depending on goodness-of-fit and the level of autocorrelation, but with no restriction that the same variables enter both equations. I rely upon the Akaike Information Criterion (AIC), etc, as the relevant measure of goodness-of-fit.

The basic model specification has unit sales of automobiles as a dependent variable, and includes both of microeconomic and macroeconomic factors as independent variables. Time-series data are used for variable specifications. These are quarterly from the first quarter of 1984 to the third quarter of 1992. New car price is the Paasche price index of the manufacturer's suggested retail price for the U.S. Big Three and Japanese transplants. (See Appendix B.) This series holds the mix of cars purchased constant. However, it does not reflect rebates, other dealer discounts, and price changes during the model year. Therefore it is not necessarily a market value of new cars.[33] In terms of the effect of the Paasche price index, it is hypothesized that higher values for the index have had a negative effect on new car sales overall.

Other price variables in the model include the price of used cars, imported cars, and gasoline. Both used and imported cars are thought to be major substitute products for new cars. The series used are the consumer price index for used cars and the average price for imported cars. Both include all of the categories instead of just compact-sized cars. Therefore, they do not truly reflect the price just for compact cars. In terms of the effect, it is hypothesized that higher prices for both have a positive effect on vehicle sales. On the other hand, the effect of the price of gasoline is hypothesized to have a negative effect. Interest rates on new car loans reflect the costs of owning a car. It is hypothesized that the higher the interest rates, the lower car sales.

Other microeconomic variables include seasonal dummy and time trend variables. Dummy variables reflect the seasonal effect on new car sales. According to the Complete Car Cost Guide, on the average, auto sales increase in spring and fall.[34] Therefore, the coefficient of dummy variables for the second quarter is expected to be a positive. However, some data are seasonally adjusted and others are not, which might obscure the relationship between the season and vehicle sales.[35] Time trend variables reflect the effect of overall automobile industry trend since 1984. In terms of the effect, under the assumption of changing automobile industrial structure, it is hypothesized that time trend variables have had a negative effect on U.S. auto sales and a positive effect for the Japanese sales.

With regard to macroeconomic variables, the equations include the Consumer Board's Index of consumer sentiment[36] and personal disposal income per capita. Both reflect the effect of consumer expectations and confidence on new vehicle sales, and they are hypothesized to have positive effects.

The functional form for the demand functions is as follows:

$$\log Q\ (US\ or\ J) = a + b_1*\log PNEW\ (US\ or\ J) + b_2*\log CPIUSE + b_3*\log CPIGAS + b_4*DQ1 + b_5*DQ2 + b_6*DQ3 + b_7*\log PM + b_8*\log CCI + b_9*TREND + b_{10}*RATE + b_{11}*\log INCOME.$$[37]

Where: Q -- Unit sales of new cars for the Big Three (US) or transplants (J).

PNEW -- Paasche price index of new car prices of the Big Three (US) or transplants (J) in real terms.

CPIUSE -- Consumer Price Index for used car prices in real terms.

CPIGAS -- Consumer Price Index for gasoline in real terms.

DQ1 -- First quarter seasonal dummy.

DQ2 -- Second quarter seasonal dummy.

DQ3 -- Third quarter seasonal dummy.

PM -- Average price for imported cars in real terms.

CCI -- Conference Board Index of consumer confidence.

TREND -- Trend variable.

RATE -- Nominal interest rate on auto loans minus the percent change in the CPI of all consumer goods.

INCOME -- Personal disposal income per capita in real terms. (See Appendix C.)

a -- Mean of unobserved factors.

b_1, b_2, b_3, b_7, b_8, b_{11}

-- Elasticities.

b_4, b_5, b_6, b_9, b_{10}

-- % change in logQ divided by absolute (1 unit) change in each independent variable.

Through the ordinary least squares procedures, the estimated model is chosen among several alternative model specifications. (See Appendix D.)

The estimated models that jointly yield the best goodness-of-fit values for U.S. and Japanese cars, are given by:

$$\log Q(US) = \underset{(0.81)}{5.34} - \underset{(-2.06)^{b}}{1.43}*\log PNEW(US) + \underset{(6.00)^{c}}{3.19}*\log CPIUSE$$

$$- \underset{(-1.59)^{a}}{0.363}*\log CPIGAS + \underset{(2.57)^{c}}{0.109}*DQ1 + \underset{(4.09)^{c}}{0.162}*DQ2$$

$$+ \underset{(1.22)}{0.893}*\log PM - \underset{(-2.03)^{b}}{0.111}*TREND + \underset{(0.01)}{0.00005}*RATE$$

$$- \underset{(-1.40)^{a}}{1.24}*\log INCOME.$$

Where: t-statistics are in parenthesis,
a = significant (one-tailed test) at 0.10,
b = significant (one-tailed test) at 0.05, and
c = significant (one-tailed test) at 0.01.

Adjusted R^2 = 92.6 %

D.W. = 1.86[38]

L.M. = 14.291[39]

$$\log Q(J) = \underset{(-1.83)^{b}}{-15.5} - \underset{(-1.04)}{1.05}*\log PNEW(J) - \underset{(-5.39)^{c}}{4.22}*\log CPIUSE$$

$$+ \underset{(0.70)}{0.299}*\log CPIGAS - \underset{(-0.87)}{0.0655}*DQ1 + \underset{(0.42)}{0.0308}*DQ2$$

$$+ \underset{(0.81)}{1.01}*\log PM + \underset{(0.77)}{0.079}*TREND + \underset{(0.97)}{0.0113}*RATE$$

$$+ \underset{(2.89)^{c}}{4.54}*\log INCOME.$$

Adjusted R^2 = 92.0 %

D.W. = 1.67

L.M. = 6.045.

The estimated models of the best-version (based on goodness-of-fit (the AIC, etc) and the Durbin Watson Statistics) for the Big Three and transplants are given by:

$$\log Q(US) = \underset{(1.39)^a}{4.85} - \underset{(-2.32)^b}{1.39} * \log PNEW(US) + \underset{(5.91)^c}{3.34} * \log CPIUSE$$

$$- \underset{(-2.12)^b}{0.486} * \log CPIGAS + \underset{(2.28)^b}{0.0917} * DQ1 + \underset{(4.07)^c}{0.163} * DQ2$$

$$- \underset{(-0.82)}{0.092} * \log CCI - \underset{(-3.40)^c}{0.144} * TREND.$$

Adjusted R^2 = 92.5 %

D.W. = 1.86

L.M. = 13.206

$$\log Q(J) = \underset{(-2.31)^b}{-15.5} - \underset{(-1.63)^a}{1.07} * \log PNEW(J) - \underset{(-7.54)^c}{4.69} * \log CPIUSE$$

$$+ \underset{(1.30)}{0.0139} * RATE + \underset{(5.17)^c}{5.62} * \log INCOME.$$

Adjusted R^2 = 92.3 %

D.W. = 1.74 (significant at 0.05)

L.M. = 1.798. (See Table 19.)

The regression results seem to fit the data well. (See Figure 16 and 17.) The F-statistics for all four models are much higher than the critical F-values at the level of significance of 0.01. For the joint-version, many coefficients, especially for the Japanese equation are statistically insignificant (0.10). However, this result is expected, because I have fit the same variables in both the U.S. and Japanese equations, although the significance of each variable is different between two functions. The regression results show that the joint- and best-version for the U.S. as well as for transplants, look similar. The price elasticities for the joint- and best-version are not statistically different for both the Big Three and transplants. (See Appendix E.) As a

Table 19

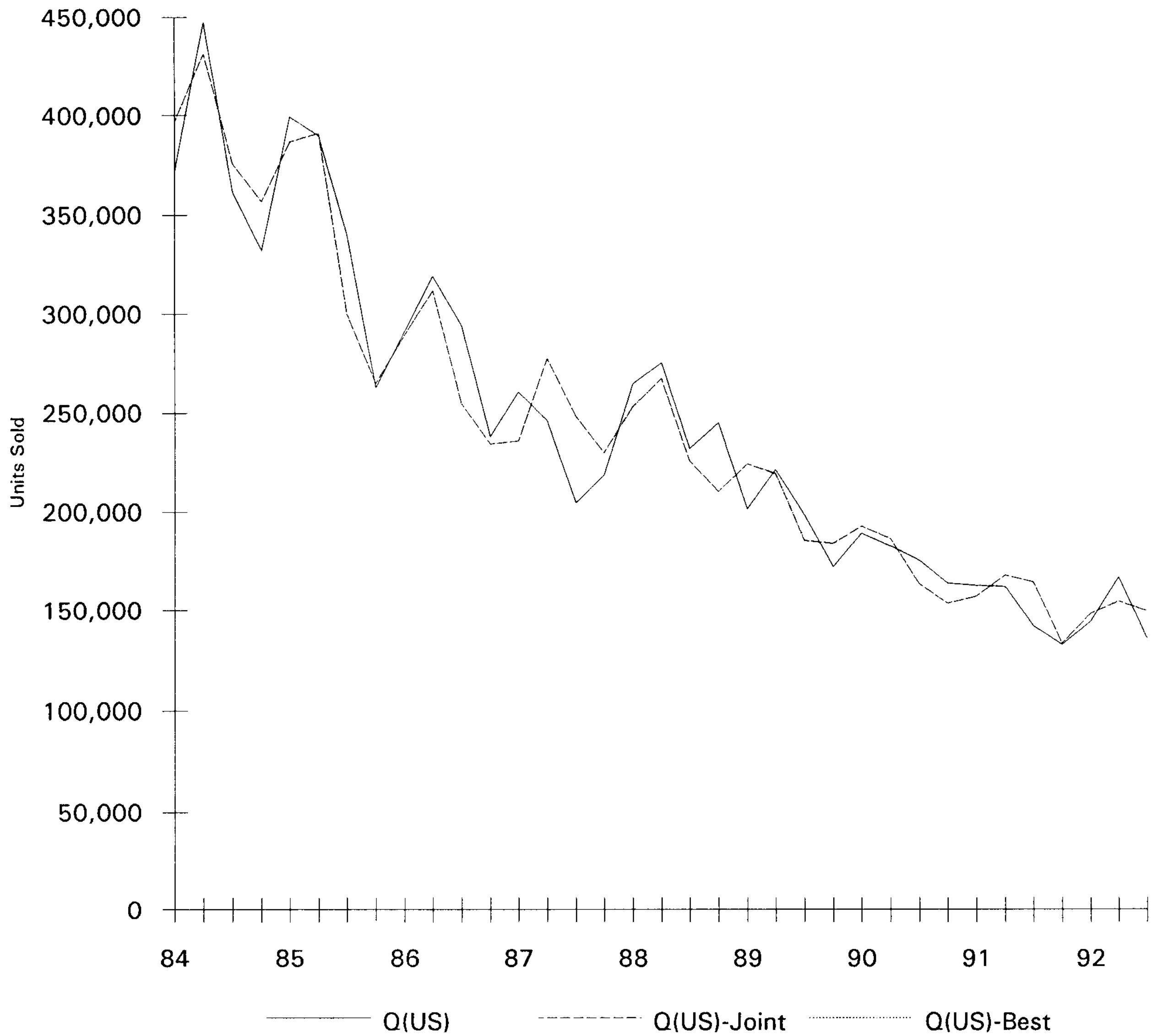
Regression Results: Four Estimated Models

Variale	Joint-Version Big Three	Transplants	Best-Version Big Three	Transplants
CONSTANT	5.340	-15.478	4.852	-15.527
	(-0.810)	(-1.830) b	(-1.390) a	(-2.310) b
P(US)	-1.429	-1.053	-1.391	-1.071
	(-2.060) b	(-1.040)	(-2.320) b	(-1.630) a
CPIUSE	3.189	-4.223	3.342	-4.686
	(-6.000) c	(-5.390) c	(-5.910) c	(-7.540) c
CPIGAS	-0.363	0.299	-0.486	
	(-1.590) a	(-0.700)	(-2.120) b	
DQ1	0.109	-0.066	0.092	
	(-2.570) c	(-0.870)	(-2.280) b	
DQ2	0.162	0.031	0.163	
	(-4.090) c	(-0.420)	(-4.070) c	
DQ3				
PM	0.893	1.010		
	(-1.220)	(-0.810)		
CCI			-0.092	
			(-0.820)	
TREND	-0.111	0.079	-0.144	
	(-2.030) b	(-0.770)	(-3.400) c	
RATE	0.000	0.011		0.014
	(-0.010)	(-0.970)		(1.300)
INCOME	-1.240	4.543		5.617
	(-1.400) a	(-2.890) c		(5.170) c
ESS	0.21290	0.6985	0.23184	0.80080
T	35	35	35	35
k	10	10	8	5
R*R	0.945	0.941	0.940	0.932
R'*R'	0.926	0.920	0.925	0.923
F	47.95 c	44.18 c	60.83 c	103.10 c
dw	1.86	1.67	1.86	1.74
LM	14.291	6.045	13.206	1.798
SGMASQ	0.008516	0.027940	0.008587	0.026693
AIC	0.010771	0.035340	0.010463	0.030447
FPE	0.010949	0.035923	0.010549	0.030507
HQ	0.012557	0.041199	0.011829	0.032874
SCHWARZ	0.016798	0.055114	0.014930	0.038022
SHIBATA	0.009559	0.031361	0.009652	0.029417
GCV	0.011922	0.039116	0.011131	0.031142
RICE	0.014193	0.046567	0.012202	0.032032

a = significant (one-tailed test) at 0.10
b = significant (one-tailed test) at 0.05
c = significant (one-tailed test) at 0.01

Figure 16

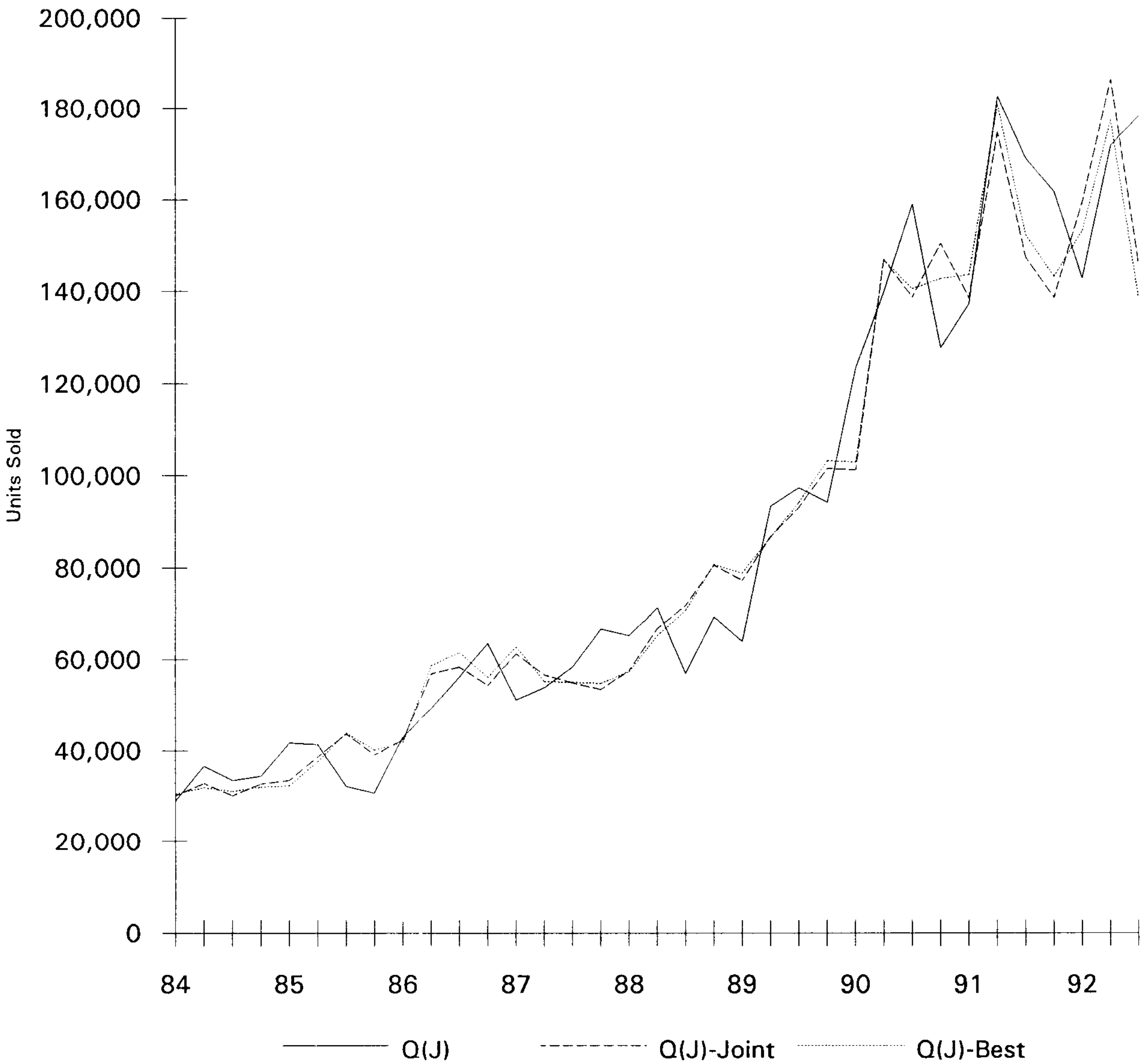
Actual and Estimated Auto Sales
of the Big Three, 1984-1992



Note: The lines for "Q(US)-Joint" and "Q(US)-Best" are so close that it is hard to differentiate them.

Figure 17

Actual and Estimated Auto Sales
of Japanese Transplants, 1984-1992



consequence, it is possible to compare the variables included in the U.S. model with those in the Japanese equation.

The most significant finding of this study is the relationship between the price elasticity of the Big Three and Japanese transplants. A further discussion on this topic is presented in a later section.

Another finding is the relationship between the price of new cars and that of used cars and gasoline. Used cars and gasoline have a substitution effect on U.S. autos. However, they appear to have a complementary effect on Japanese cars. This result shows that U.S. compact cars have a substitutable nature with Japanese vehicles, used cars, and gasoline. In other words, the coefficient of used car and gas price have the same signs as hypothesized in the U.S. equations, but different in Japanese equations.

Prices of imported cars are insignificant at the ten percent level for the joint-version, and not included in the best-version. The signs are the same as expected for both of the U.S. and Japanese auto sales, which leads to imports' substitutes for both U.S. and Japanese cars.

Interest rates are always insignificant at the ten percent level. It seems likely that interest rates move along with the economy and the auto sales. These secular movements might obscure the short-term inverse relationship between the interest rates and quantity sold in the equations. Additionally, it does not affect so much the U.S. models to drop the interest rate variables from the equations, however, it does have fatal effect of a substantial reduction in the Durbin-Watson Statistic (dw) on the Japanese models.[40]

Seasonal dummy variables do not explain very well the auto sales in the Japanese equations, but do in the U.S. models. As hypothesized, the coefficient of DQ2 has a positive sign and significance at the one percent level. However, the coefficient of DQ1 has also a positive sign which is different from the hypothesis. This might result from poor data mixing seasonally adjusted data with non-adjusted, as I noted earlier.

The coefficient of time trend always has a negative sign and is often significant (0.10, 0.05, or 0.01) for the U.S. models. However, it is positive (insignificant at the level of 0.10) in the Japanese models. These results indicate that sales of the U.S. autos have decreased, on the average, over the time period, and those of Japanese transplants have increased, as hypothesized.

The coefficient of income is always negative and generally significant, at least, at the ten percent level in the U.S. equations, which is different from the hypothesis. This result might suggest that a U.S. compact car is an inferior good.[41] However, the coefficient is positive and significant at the one percent level in Japanese functions. The consumer confidence variable (CCI) never is statistically significant (0.10).[42]

Price Elasticities

The price elasticities of demand for new compact cars are shown in Table 20. The elasticities appear to be not comparable to

Table 20

Price Elasticities of Demand

Version	Price Elasticity	t Statistics
U.S. sales (joint-version)	-1.429	(-2.06)
U.S. sales (best-version)	-1.391	(-2.32)
Transplant sales (joint-version)	-1.053	(-1.04)
Transplant sales (best-version)	-1.071	(-1.63)

Note: see Appendix E.

those in earlier studies. For example, the USITC (1985) evaluates that the price elasticity for Japanese autos (imports) in the U.S. is fairly high, and assumes that it is '-2'.[43] Hartmann (1983) concludes that the price elasticity for the U.S. is '-1.11', and one for Japanese is '-1.35'.[44] The previous studies, which focus on all-category cars and Japanese imports, suggest that U.S. auto has a lower price elasticity than Japanese, which is contrary to my estimation. The difference in results might come from poor data of this study or from my focusing on transplant compact-sized cars instead of imported all-category cars. However, I suggest that (a surge of imported cars from Japan after the second oil shock and) increasing transplants' production in the U.S. have changed the U.S. automobile industrial structure. The increase in price elasticities for the U.S. cars and the decrease in that for Japanese, reflect the situation where Japanese have gained more market power in the U.S. market, and that the U.S. Big Three has lost its power. One can see this situation in the fact that the Big Three face a serious difficulty in dealing with overcapacity problem in the U.S., especially smaller car segments. They lost a substantial market share since the 1970s, whereas Japanese transplants have been increasing production capacity in the U.S.

Limitations of the empirical analysis include deficiencies in the data of the prices of new, used, and imported cars, as I mentioned earlier. To obtain more precise price elasticities, it would be useful to overcome these deficiencies by obtaining "transaction" prices of new cars, which include considerations about rebates, other dealer discounts, and price changes during the model year.