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Abstract

Since 1962, South Korea has recognized the motor vehicle industry as a critical industry for economic development. The government has been closely involved in the industry's growth from infancy to its current position among the top five motor vehicle producers in the world. The results of this study strongly suggest that the industry as a whole has achieved a minimally efficient scale of operations. However, cross price elasticity estimates indicate that many rigidities exist in the input markets, particularly with respect to outsourced intermediate products. The restrictions on imports of these products may have to be reduced as South Korea seeks to expand its global trade footprint by participating in bilateral preferential trade agreements, presenting challenges for the industry.

1. Introduction

South Korea officially recognized the strategic importance of a domestic motor vehicle industry in 1962 with the Automotive Industry Promotion Law, a part of the First Five Year Development Plan. The Ministry of Trade and Industry had the authority to determine which companies could be a part of the industry. Government support for the domestic industry was expressed through measures that prohibited imports of cars, subsidized loans, gave export subsidies and tax incentives, and a policy that allowed components to be imported tariff-free. At the time, Kia, Ha-Dong-Hwan, and Saenara (purchased by Shinjin Motors and later becoming a joint venture with General Motors and Daewoo) were the only operating South Korean motor vehicle firms. Hyundai joined the industry in 1967 (Ravenhill, 2001, p.5; Ebert and Montoney, 2007, p. 12; Kim,1998, p. 507). Through a series of takeovers and mergers as a result of financial difficulties, by 2007 the South Korean auto industry consisted primarily of Hyundai-Kia (the largest producer), Daewoo, Renault Samsung Motors (formerly Samsung Motors and purchased by Renault in 2000), and Ssangyong Motor Company, a small manufacturer of sport utility vehicles (Ebert and Montoney, 2007, pp. 13-14).

Starting with the assembly of knockdown kits, the South Korean motor vehicle industry was a minuscule player on the international stage until the 1980s. In the early 1970s, it produced only a few thousand vehicles, far fewer than Brazil, Mexico, and Argentina (Green, 1992, pp. 412-413). For example, in 1971 it produced only 23,000 motor vehicles, amounting to only 0.06% of world output (Ebert and Montoney, 2007, p. 12). However, in the mid-1970s, the South Korean government implemented a policy change that required the industry to change from completely knocked down (CDK) kits to the production of cars with substantial domestic content. The government was intimately involved with the production process, even dictating to a substantial extent the specifications of the domestic models that were to be built. The government also required that the capacity of each plant should be in excess of 50,000 vehicles annually, at a time when the *total* domestic *automobile* output was 12,751 cars. The new rules included exclusion of new entrants to the domestic market, tax reductions and concessions, promotion of vertical integration, preferential financing, and a decree that guaranteed a large market share for domestically-produced cars (Kim, 1998, p. 511). At the end of 1979, the automobile industry faced a crisis caused by domestic uncertainty after the assassination of Park Chung Hee. The Korean Institute of Economics issued a study that argued the domestic motor vehicle industry could survive only if it exported sufficient vehicles to achieve economies of scale. The Automobile Industry Rationalisation Plan: 1981-1989, which had the goals of cost reduction through economies of scale and entry into the North American market, was one outcome of these developments (Catalan, 2010, pp. 224-225; Green, 1992, p. 415; Waitt, 1993, pp. 201-202).

As a result of these events, by 1985, South Korea was producing nearly 265,000 vehicles annually and poised to become a major player in the motor vehicle industry [Associazione Nazionale Fra Industrie Automobilistiche (ANFIA), 1996, p. 269]. By 2006, production had dramatically increased to over 3.8 million units, and South Korea ranked fifth after the United States, Japan, China, and Germany in total number of motor vehicles manufactured. In that year it produced about 6.5% of the total motor vehicle output produced by the top 21 countries (ANFIA, 2007, pp. 37-39). South Korea continued to rank fifth both in world motor vehicle production and in automobile production through 2008 (ANFIA, 2009, pp. 68-70).[1]

As described above, for several decades the Korean government has considered the automotive industry to be a critical element of its development strategies. As a result, the government has been involved in the industry through a variety of policies, including export promotion and, early in the life of the industry, promoting the obtaining of technology through licensing rather than domestic research and development (Lautier, 2001, p. 209). Moreover, the government intervened in this industry and others with policies designed to lower costs of both production materials and financing and had the goal of getting the industry rapidly to a point where it could take advantage of the available economies of scale (Lautier, 2001, pp. 207-209; B.-G. Park, 2003; Y. C. Park, 1990; Waitt, 1993, pp. 200-202; and Waverman and Murphy, 1992, pp. 287-288, 297).

In this paper we will investigate whether in fact the Korean motor vehicle industry as a whole has reached a minimally efficient scale of plant, where economics of scale have been exhausted. In addition, we will look at direct and cross price elasticities between inputs of domestic capital and labor and intermediate goods as well as imported intermediate products to examine how global trade has impacted the industry and will likely impact it in the future. We use a translog cost function to accomplish these goals. There have been some descriptive papers, for example (Ellison, *et. al.*, 1995), that have argued the Korean auto industry has developed competitive lead times and productivity, but we are unaware of any previous econometric studies regarding these issues for that industry.

[1]More detailed histories of the Korean automobile industry can be found in (Catalan, 2010; Kim, 1998; Lee, Lee, Kim, and Lim, 1996; Lee and Jung, 2009; and Ravenhill, 2001).

III. The Translog Cost Function

The production technology of the automobile industry is assumed to be representable by an implicit transformation function:

$$\tau(Y,K,L,D,F,T) = 0, \qquad (1)$$

where Y is real output, K is capital, L is labor, D is insourced (domestically produced) intermediate goods, F is outsourced (imported) intermediate goods, and T represents time-related components, including technological change. If the transformation function in (1) has a strictly convex input structure, there exists a unique cost function

$$TC = f(Y,P_K,P_L,P_D,P_F,T), \qquad (2)$$

where P_K is the price of capital, P_L is the price of labor, P_D is the price of insourced (domestic) intermediate goods, and P_F is the price of outsourced (imported) intermediate goods.

The exact cost function specified in (2) can be approximated with the translog cost function

$$\ln (TC) = \alpha_0 + \alpha_T T + \alpha_Y \ln Y + (1/2)\delta_{YY} (\ln Y)^2 + \sum_i \beta_i \ln P_i \qquad (3)$$

$$+ 1/2 \sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j + \sum_i \rho_{Yi} \ln Y \ln P_i$$

$$+ \sum_i \gamma_{iT} T \ln P_i + 1/2\ \gamma_{TT} T^2,$$

where *i, j = K, L, D*, and *F*.[2] The parameters of the translog cost function (3) can be estimated indirectly by estimating the coefficients of the cost share equations, S_i, where

$$S_i = \beta_i + \rho_{Yi} \ln Y_j + \sum \gamma_{ij} \ln P_j + \gamma_{iT} T, \tag{4}$$

and *i, j = K, L, D, F.*

The minimum requirements for the cost function to describe a "well-behaved" technology are that it be (1) linearly homogeneous in input prices, (2) positive and monotonically increasing in input prices and output, and (3) concave in input prices. The restrictions imposed on the parameters by the requirement that the cost function be linearly homogeneous in factor prices allow the translog cost function and share equations to be written so that only twenty parameters must be estimated. The additional assumption of homotheticity requires that the ρ_{Yi} terms equal zero, and the more restrictive assumption of homogeneity requires that δ_{YY} also equal zero. Only three of the factor share equations are linearly independent since their sum must be equal to unity, so $S_F = 1 - S_L - S_K - S_D$.[3]

The model to be estimated, therefore, consists of the three factor share equations, S_K, S_L and

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[2]Technically, the estimation of this cost function requires that input markets be perfectly competitive. Although many of the input markets relevant to this study are not perfectly competitive, administered or negotiated prices which result in essentially fixed prices from an individual firm point of view can perform a similar role for estimation purposes. The heavy involvement of the South Korean government in the domestic economy in general and in the automobile industry in particular clearly resulted in the latter environment (Waitt, 1993, pp. 200-203).

[3]For a more thorough discussion of the translog cost function see (Truett and Truett, 2007) and (Greene, 2000, pp. 640-644).

S_D, and the translog cost function.[4] Separate stochastic error terms, assumed to reflect errors in optimizing behavior, are implicitly added to these equations. Limited by data availability, time series data from 1977 through 2006 were utilized in the study.[5]

The cost function and share equations are estimated by using the iterative Zellner-efficient method (IZEF). Nonhomothetic and homothetic versions of the model resulted in either violations of the regularity conditions or indications that the model was misspecified, so our final model corresponded to the restrictions for a homogeneous production function. In addition, a

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[4]The data were normalized so that total cost, the output quantities, and the input prices were equal to one in the base period (1977).

[5]The following data were used in estimating the total cost function. Total cost was equal to the value added of the industry plus major production costs (payments for intermediate goods). Before 1991, aggregate industry data for fabricated metal products, machinery, and equipment industry had to be utilized because data for the transportation equipment industry were not available. A dummy variable was added to reflect the change in data. The price of domestic intermediate goods was given by the price index (2000 = 100) of manufacturing intermediate goods. The price of imported intermediate products was given by the price index of transportation equipment (2000 = 100). The price of labor was given by South Korean average monthly wages, divided by the average days worked, to get an average daily wage rate (aggregate fabricated metals and machinery and transportation equipment data before 1991, and transportation equipment data in later years). The data series utilized for the price of capital was the money market interest rate until 1981 and the corporate bond rate thereafter (data supplied by the International Monetary Fund, *International Financial Statistics*). The data for output were calculated from the gross output of the fabricated metals, machinery, and transportation equipment industry before 1991 and the transportation equipment industry thereafter in millions of won. The nominal output data were transformed to real terms using the producer price index (base = 2000) for fabricated metals, machinery, and transportation equipment before 1991 and for transportation equipment thereafter. The share of capital was calculated from the figures for value added less labor costs. The total amount of intermediate goods was given by "major production costs" data, and this figure was separated into foreign and domestic components using the import data for machinery and transport equipment before 1990 and that for transportation equipment thereafter, adjusting the data so that they were in millions of won. The data sources, the Korea National Statistical Office, *Korea Statistical Yearbook*; and the International Monetary Fund, *International Financial Statistics*, are listed in the bibliography.

dummy variable, DUMMY1, was included to reflect the availability of more detailed transportation equipment industry data beginning in 1991. A second dummy variable, DUMMY2, was added to recognize the presence of the East Asian crisis in 1998.

An important focus of this paper is whether or not scale economies still remain that can be utilized by the industry. Another significant issue is the relationships among the domestic and foreign inputs and, therefore, the direct and cross price elasticities of demand for the inputs are calculated.[6]

3. Estimation Results

The estimates of the South Korean transportation equipment cost function parameters are given in Table 1.[7] Most of these coefficient estimates do not have any intrinsic meaning in and

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[6]The cross price elasticities of demand ($E_{ij} = \partial \ln X_i / \partial \ln P_j$) can be expressed in terms of the cost shares and the estimated parameters of the model as

$$E_{ij} = S_j + \frac{X_{ij}}{S_i} .$$

The general formula for the direct price elasticity of demand for input *i* in terms of the parameters of this model is

$$E_i = \frac{\gamma_{ii} + S_i^2 - S_i}{S_i} .$$

[7]The monotonicity and concavity conditions for a well-behaved cost function were satisfied at all of the data points for this version of the model.

The conventional single-equation Durbin-Watson statistic for the total cost equation for the of themselves, but they are used to calculate direct and cross price elasticities of demand for the various inputs. The estimated coefficient of DUMMY1 was insignificant, suggesting that the change in data after 1990 had no significant effect on the results. However, the estimated coefficient of DUMMY2 was significantly less than zero, likely reflecting the substantial decrease in industry profit (capital's share) during the 1998 financial crisis.

The estimate of "$_Y$ is of special interest because "$_Y$ is the cost elasticity (E_C = Mln TC/Mln Y), for a cost function corresponding to a homogeneous production function. An estimate of returns to scale can be calculated as the reciprocal of the cost elasticity. Here the estimated coefficient is 1.04, which would indicate decreasing returns to scale. However, this estimated value is not significantly different from one, so we cannot reject the hypothesis of constant returns to scale. This result certainly suggests that the Korean transportation equipment industry as a whole has reached at least a level of output that is consistent with a minimally efficient scale. Thus, the Korean government was apparently successful in quickly moving the motor vehicle industry as a whole to a point where it has exhausted available scale economies and is operating at an output level where it can be internationally competitive.[8]

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model with the homogeneity restrictions imposed was 2.63, a value that was in the inconclusive range at the 5% level of significance. See Berndt and Christensen (1973, p. 95) for a discussion of utilizing the Durbin-Watson statistic to check for serial correlation in the case of simultaneous equations.

The Regression Specification Error Test (RESET) was also performed on the total cost equation using terms involving the dependent variable estimates up to the fourth power. This procedure also did not indicate model misspecification at the 5% level of significance.

[8]Two other studies on the minimum required volumes to achieve economies of scale in the motor vehicle industry would support the conclusion that the Korean motor vehicle industry has a whole has achieved at least the minimally efficient scale of output. These studies suggest that assembly volumes of 200,000 *per plant* (Australian Industry Commission, 1990, p. 19) and

The direct price elasticity estimates are shown in the appendix in Table A1. All of these estimates are negative, as one would expect. Using a bootstrap procedure (Eakin, *et. al.*, 1990; and Kerkvliet and McMullen, 1997), we found that the estimate of the direct elasticity of demand for labor was significantly less than zero at the 0.5% significance level, while that of domestic intermediate goods was significant at about the 5% level. As one might expect, given the government's strong intervention in the capital markets, the direct price elasticity of demand for capital was significant at only about the 11% level of significance. Again, given government controls over foreign trade, particularly imports, it is not surprising that the direct price elasticity of demand for foreign intermediate goods was significant at only about the 20% level. The two input markets, labor and domestically sourced intermediate goods, that were least affected by government control have direct price elasticities of demand that were significantly negative and suggest the strongest response by the firms to input price changes.

150,000 units of a given *model* (Booz Allen and Hamilton and INFOTEC, 1987, p. 28) are required for capturing available scale economies.

The results of other recent studies involving returns to scale in the motor vehicle industry in other countries have been mixed. For example, Fuss and Waverman (1992, p. 122) obtained results consistent with statistically significant economies of scale in Canada, the United States, Japan, and Germany. However, in a later study, Burnside (1996, p. 184) obtained returns to scale estimates for the United States that were consistent with constant returns to scale. Using Chilean data, Tybout, de Melo, and Corbo (1991, p. 248) and Westbrook and Tybout (1993, pp. 103-104) also obtained results consistent with constant returns. Using Mexican data for the transportation equipment industry, Tybout and Westbrook (1995) did find evidence of economies of scale, but the returns to scale coefficient approached constant returns as output increased. Bloch and Tang (2000, pp. 44-49) found evidence of statistically significant scale economies in the Singapore transport equipment industry, but the Singapore motor vehicle industry operates at far smaller volumes than does that industry in the other countries. Moreover, South Korea, with a small group of manufacturers, now produces more vehicles than all of the countries listed above except for the United States, Japan, China, and Germany. Thus, it is reasonable to conclude that the Korean automobile industry as a whole has reached or surpassed a minimally efficient scale of output.

The cross price elasticity of demand estimates are given in Table A2. These results indicate that all of these inputs are substitutes for one another. Again, using the bootstrap methodology, we found that E_{LD} and E_{DL} were significantly greater than zero at about the 15% significance level, while E_{DK} was significantly positive at about the 11% level. The estimates of E_{DF} and E_{LK} were significantly positive at about the 19% level, and the same was true for E_{KL} at about the 23% level. The other cross elasticity estimates were not significantly greater than zero at any reasonable significance levels. These results are most likely reflective of the strong government intervention in many aspects of this industry. Perhaps some possibilities did exist for substitution between labor and insourced intermediate products as well as for capital and other domestic inputs, although the evidence is not strong in this regard. There appears to be little evidence of significant substitution of outsourced intermediate products for domestic inputs.

We also used the bootstrap procedure to test if the values of any of these elasticities changed significantly over time. The only statistically significant positive changes we found were that E_{LD} and E_{KD} increased over time (6% and 10% significance levels, respectively). Thus, the demands for domestic labor and capital have apparently become more sensitive to the price of insourced intermediate goods. However, E_{LF} and E_{KF} *may have decreased* over the study period (17 and 19% significance levels, respectively). Clearly, these results are consistent with the conclusion that through 2006 little substitution was taking place between outsourced and domestic inputs.

In recent years, South Korea has been involved in the negotiation of bilateral preferential trade agreements with, among others, the European Union (EU) as well as the United States. Both the EU and the U.S. pacts could have a significant impact on the motor vehicle industries in all of the countries that are parties to the agreements. For example, Andreosso-O'Callaghan (2009) finds that while the European Union and South Korea in general have complementary production structures, that is not the case for road vehicles (and electrical machinery). In February, 2011, the European Parliament approved the EU-South Korea agreement, which provides for the removal of an 8% tariff on European Union cars exported to South Korea. It also allows EU manufacturers to sell cars produced to EU standards in Korea without being subjected to further tests. South Korea's National Assembly ratified the agreement in May, and it was put into effect provisionally on July 1, 2011, pending ratification by all members of the European Union.[9]

In the case of the United States, the original preliminary agreement offered some opening of the motor vehicle markets, but also retained some protective measures (Coy, 2007; Hitt, 2007; Maurer, 2007).[10] In modifications to the original agreement, the United States agreed to remove a 2.5 percent tariff on imports of Korean motor vehicles, and Korea agreed to remove tariffs on U. S. cars. However, another major issue involved Korea's practice of suddenly changing motor vehicle safety standards with the practical effect of limiting automobile imports. A compromise was reached that allowed each foreign motor vehicle manufacturer to sell 25,000 cars annually in Korea that do not have to meet the safety regulations.[11]

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[9]See European Parliament Press Release (February 17, 2011), and Olsen (February 18, 2011).

[10]In the Hitt (2007) article, Senator (in 2007) Hillary Clinton was said to have argued that the agreement did not go far enough to open the Korean market to United States automobiles, using trade statistics that indicated South Korea exports 500,000 cars to the United States while importing only 6,000 U.S. vehicles.

[11]Williamson (December 3, 2010), The original 2007 bilateral agreement with the United States was not ratified as a result of pressure from some U.S. automakers and unions to modify

As both the United States and European Union trade agreements are implemented, international pressure will increase on the South Korean industry to increase its competitiveness. Nevertheless, it will still be at least partially shielded from the effects of globalization for some time through a variety of other regulations that make it more difficult for foreign car manufacturers to sell vehicles in South Korea.

4. Conclusions

Since the early 1960s, South Korea has considered the motor vehicle industry to be critical for economic development, and the government has been actively involved in promoting the growth of that industry. One of the South Korean government's goals was to quickly get the industry to the point where it was operating with a minimally efficient scale of output. The results of this study indicate that this goal has been met, since they are consistent with the conclusion that the industry as a whole is operating in the range of constant returns to scale.

The direct price elasticity of demand estimates for the four inputs of capital, labor, insourced (domestic) intermediate products, and outsourced (imported) intermediate products were all negative, as expected. Nevertheless, only those for labor and domestic intermediate goods were significant at about the 5% level of significance. It is noteworthy that these two input markets were those with the least government involvement.

The cross price elasticities of demand were consistent with all of the inputs being substitutes for one another. However, only the cross price elasticities of demand for E_{DK}, E_{DL}, and E_{LD}

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the agreements affecting automobiles. In late 2011, a compromise was reached and the revised version was ratified. See (Choi, 2010; Schott, 2010; and Williamson, June 28, 2010); and were significantly positive at even the 15% level of significance. The low levels of statistical significance of the estimated input direct and cross price elasticities are most likely the result of the heavy government intervention in the industry, particularly with respect to capital and foreign intermediate products.

The study results indicated that E_{KD} and E_{LD} increased significantly over the study period, so perhaps the industry is developing somewhat greater flexibility in substituting the domestic inputs of capital, labor, and intermediate products for one another. On the other hand, the values of E_{KF} and E_{LF} *decreased* over the study period at the 19% and 17% significance levels, respectively. These latter figures suggest that continued government involvement in regulating industry imports has not allowed the free substitution of outsourced inputs for domestic ones.

While the industry appears to be operating in the constant returns to scale range, its degree of international competitiveness will only be apparent if the government allows much freer imports of motor vehicle products. Initial indications are that even the recently negotiated bilateral trade pacts between South Korea and the United States and South Korea and the European Union still afford the industry some protection from foreign competition. If that is indeed the case, this situation will have to change before researchers and policy makers can conclude that this infant industry has truly "grown up."

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Table A1 Direct Price Elasticities

Year	E_{KK}	E_{LL}	E_{DD}	E_{FF}
1977	-0.673	-0.673	-0.539	-1.246
1978	-0.672	-0.674	-0.541	-1.250
1979	-0.680	-0.673	-0.534	-1.235
1980	-0.684	-0.668	-0.505	-1.309
1981	-0.687	-0.666	-0.493	-1.331
1982	-0.684	-0.666	-0.495	-1.341
1983	-0.684	-0.665	-0.476	-1.427
1984	-0.684	-0.664	-0.469	-1.459
1985	-0.683	-0.663	-0.467	-1.466
1986	-0.679	-0.661	-0.461	-1.524
1987	-0.679	-0.658	-0.453	-1.557
1988	-0.681	-0.657	-0.450	-1.549
1989	-0.678	-0.660	-0.463	-1.512
1990	-0.677	-0.661	-0.455	-1.580
1991	-0.677	-0.666	-0.457	-1.609
1992	-0.669	-0.665	-0.461	-1.632
1993	-0.669	-0.662	-0.443	-1.780
1994	-0.668	-0.662	-0.442	-1.797
1995	-0.670	-0.660	-0.437	-1.796
1996	-0.670	-0.661	-0.432	-1.869
1997	-0.665	-0.652	-0.428	-1.888
1998	-0.658	-0.638	-0.407	-2.210
1999	-0.665	-0.646	-0.390	-2.578
2000	-0.667	-0.642	-0.394	-2.314
2001	-0.666	-0.637	-0.373	-3.012
2002	-0.665	-0.644	-0.374	-3.024
2003	-0.665	-0.640	-0.360	-4.290
2004	-0.670	-0.637	-0.348	-4.889
2005	-0.672	-0.635	-0.352	-3.832
2006	-0.673	-0.629	-0.358	-3.131

Table A2 Korean Automobile Industry Cross Price Elasticities

Year	E_{KL}	E_{LK}	E_{KD}	E_{DK}	E_{KF}	E_{FK}
1977	0.125	0.247	0.174	0.119	0.374	0.483
1978	0.127	0.249	0.173	0.119	0.372	0.486
1979	0.124	0.238	0.172	0.112	0.384	0.471
1980	0.116	0.232	0.203	0.118	0.365	0.490
1981	0.113	0.227	0.212	0.118	0.363	0.493
1982	0.112	0.232	0.215	0.122	0.356	0.502
1983	0.112	0.230	0.236	0.127	0.337	0.532
1984	0.110	0.231	0.244	0.130	0.330	0.545
1985	0.109	0.231	0.247	0.131	0.328	0.549
1986	0.107	0.236	0.259	0.138	0.313	0.577
1987	0.104	0.236	0.268	0.141	0.308	0.590
1988	0.102	0.233	0.268	0.138	0.311	0.584
1989	0.105	0.238	0.258	0.140	0.314	0.574
1990	0.107	0.239	0.268	0.143	0.303	0.602
1991	0.113	0.241	0.266	0.143	0.298	0.614
1992	0.112	0.250	0.269	0.151	0.288	0.633
1993	0.109	0.250	0.290	0.157	0.270	0.696
1994	0.109	0.251	0.292	0.158	0.268	0.704
1995	0.106	0.247	0.294	0.156	0.270	0.700
1996	0.107	0.249	0.301	0.158	0.262	0.733
1997	0.099	0.252	0.310	0.165	0.257	0.747
1998	0.090	0.259	0.339	0.178	0.230	0.899
1999	0.094	0.252	0.352	0.174	0.219	1.059
2000	0.091	0.248	0.345	0.170	0.231	0.935
2001	0.088	0.249	0.370	0.176	0.208	1.260
2002	0.093	0.252	0.370	0.177	0.206	1.267
2003	0.090	0.251	0.385	0.179	0.190	1.864
2004	0.088	0.244	0.393	0.175	0.189	2.142
2005	0.087	0.241	0.386	0.171	0.200	1.637
2006	0.084	0.239	0.379	0.169	0.211	1.306

Table A2 Con't. Cross Price Elasticities

Year	E_{LD}	E_{DL}	E_{LF}	E_{FL}	E_{DF}	E_{FD}
1977	0.240	0.082	0.185	0.121	0.338	0.642
1978	0.240	0.084	0.184	0.123	0.338	0.642
1979	0.246	0.083	0.189	0.121	0.340	0.644
1980	0.271	0.079	0.165	0.111	0.307	0.708
1981	0.281	0.078	0.159	0.108	0.298	0.730
1982	0.278	0.077	0.156	0.107	0.296	0.733
1983	0.299	0.078	0.136	0.104	0.270	0.791
1984	0.304	0.077	0.129	0.102	0.262	0.813
1985	0.305	0.076	0.127	0.100	0.260	0.818
1986	0.309	0.075	0.116	0.097	0.248	0.851
1987	0.312	0.072	0.110	0.093	0.240	0.875
1988	0.313	0.071	0.111	0.092	0.241	0.874
1989	0.304	0.073	0.118	0.095	0.250	0.843
1990	0.315	0.075	0.107	0.095	0.237	0.883
1991	0.322	0.081	0.104	0.101	0.233	0.895
1992	0.315	0.079	0.100	0.098	0.231	0.901
1993	0.331	0.078	0.081	0.091	0.208	0.993
1994	0.332	0.078	0.080	0.091	0.206	1.002
1995	0.334	0.076	0.079	0.089	0.205	1.007
1996	0.340	0.077	0.072	0.087	0.197	1.049
1997	0.331	0.069	0.069	0.078	0.194	1.063
1998	0.336	0.061	0.044	0.059	0.168	1.252
1999	0.364	0.067	0.030	0.053	0.149	1.465
2000	0.354	0.064	0.039	0.058	0.160	1.320
2001	0.372	0.063	0.016	0.035	0.134	1.718
2002	0.380	0.067	0.017	0.039	0.134	1.722
2003	0.390	0.066	-0.000	-0.002	0.115	2.428
2004	0.398	0.064	-0.005	-0.022	0.109	2.769
2005	0.391	0.063	0.003	0.009	0.118	2.185
2006	0.378	0.059	0.012	0.027	0.130	1.798

Table 1 Estimates of Automobile Industry Model Parameters

	Estimated Coefficient (t Value)
α_0	-0.045
	(-1.350)
α_Y	1.044)
	(11.990)
β_K	0.265
	(27.986)
β_L	0.138
	(37.089)
β_D	0.388
	(24.156)
γ_{KK}	0.016
	(0.760)
γ_{LL}	0.026
	(3.125)
γ_{DD}	0.027
	(0.470)
γ_{KL}	-0.003
	(-0.311)
γ_{KD}	-0.058
	(-2.287)
γ_{LD}	-0.020
	(-1.602)
α_T	-0.026
	(-1.362)
α_{TT}	0.002
	(3.017)
γ_{KT}	0.002
	(0.731)
γ_{LT}	-0.004
	(-2.826)
γ_{DT}	0.004
	(1.212)
DUMMY1	0.039
	(0.350)
DUMMY2	-0.194
	(-4.102)
Log Likelihood	310.933