Product Differentiation and Oligopoly in International Markets

The Case of the U.S. Automobile Industry

Pinelopi Koujianou Goldberg

Presenter: Zhuopai Li, Qinzhu Sun, Shiyu Sun

June 14, 2021

Overview

Research Territory

Imperfect Competition for International Trade

- Models of imperfect competition for international trade
- Applied work is limited
  Dixit (1988) and Krishna et al.(1989):Calibration
  Feenstra (1984, 1985, 1988), Levinsohn (1988), and Feenstra and Levinsohn (1989): on automobile market
- Trade policy on welfare
  Need an econometric model for applied work

Research Niche

Imperfect Competition on Automobile Industry

- Number of competing firms is small enough to justify the assumption of oligopoly
- Products are highly differentiated
- A major target of trade policy

Trade Policy

- (1980s) Imports tariff of cars is 2.9 percent
- (1980s) Imports tariff of compact trucks is 25 percent
- (1981.5) "Voluntary Export Restraint" (VER) for Japanese auto sales

Previous Research

Use Disaggregate Consumer Data

Advantages

- Composed of logit-based models that estimate automobile demand at the individual level
- Allow for a high degree of product differentiation and account for consumer heterogeneity
- Circumvent the problem of price endogeneity

Disdvantages

- Neglect supply side and market equilibrium consideration
- Inadequate in a forecasting context, as prices are determined by market forces
- Limits the use of such approaches for policy formulation

Previous Research

Use Aggregate Consumer Data

Disdvantages

- Endogeneity of prices
- The existence of a well defined reduced form often requires strong assumptions about the functional form of the demand system

- Ignore the existence of an outside good
  Impossible to derive the aggregate demand curve

Present Research

- Model
  Combining a disaggregate model of automobile demand with an aggregate oligopoly model
- Discrete choice model of demand
  - Nested logit model
  - Micro data from the Consumer Expenditure Surve
  - Combined with population weight to determine aggregate demand
- Supply side
  - An oligopoly with differentiated products
  - Nash Equilibrium with prices as strategic variables

Present Research

Topic of Interest

- Quota Restrictions
- Exchange Rate Pass-through
  - Quantify the effects of the VER on market shares, automobile prices, and quality upgrading
  - Compare quotas to an equivalent tariff, find different effect on prices
- Explanation for insensitivity of import prices to exchange rate movements
  - Estimate the effects of exchange rates on import prices
  - Assess the significance of trade restrictions, quality upgrading, and exchange rate pass-through on prices

Automobile Choice Model

Consumers are assumed to maximize an indirect utility function of the form

$$U_j^h = \bar{V}_j^h + \varepsilon_j^h$$

where j and h stand for vehicle and household

$\bar{V}_j^h$ the utility function from the vehicles and the consumer's characteristics

ε_j^h captures the effects of unmeasured variables, personal idiosyncrasies, maximization error

Partition the whole set of vehicles into k disjoint subsets according to the criteria of newness (n), market segment (c), and origin (o), so that each vehicle make (m) is indexed by (n, c, o, m)

$$U_{b,n,c,o,m}^h = \bar{V}_{b,n,c,o,m}^h + \varepsilon_{b,n,c,o,m}^h$$

where the subscript b stands for buy

Automobile Choice Model

Assume that $\bar{V}$ is a linear function of consumer and vehicle characteristics

$$U^h_{b,n,c,o,m} = \alpha' B^h_b + \beta' N^h_{b,n} + \gamma' C^h_{b,n,c} + \delta' O^h_{b,n,c,o} + \zeta' M^h_{b,n,c,o,m} + \varepsilon^h_{b,n,c,o,m}$$

- The decision to purchase
- Utility derived from owning a new as opposed to used car
- Owning a car of a particular market segment, origin, and make, respectively
  - A car's make is the brand of the vehicle, while the model refers to the name of a car product and sometimes a range of products

Assume the error term follows the generalized EVD

The joint probability of choosing a new vehicle type

$$P^h_{b,n,c,o,m} = P^h_b * P^h_{n/b} * P^h_{c/n,b} * P^h_{o/c,n,b} * P^h_{m/o,c,n,b}$$

Automobile Choice Model

- Nested Logit:McFadden (1978)

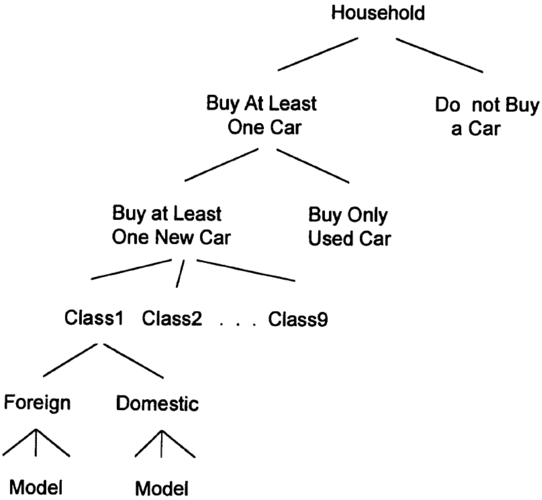


FIGURE 1.—Automobile choice model.

Automobile Choice Model

- Nested Logit:McFadden (1978)

$$\zeta' M^{h}_{b,n,c,o,m} = \zeta_1' M1^{h}_{b,n,c,o,m} + \zeta_2 \left(INC^{h} - PRICE_{b,n,c,o,m} \right)$$

The vector $M^{h}_{b,n,c,o,m}$ includes all relevant characteristics other than price and income, INC stands for income of household h, and ζ_2 is the price parameter to be estimated

Aggregation

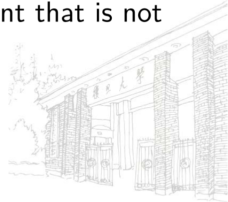
- Aggregate demand is defined as the sum of individual household demands
- Consumer Expenditure Survey provides weights for each household,reflecting the representativeness of that household in the United States population
- Aggregate Demand

$$D_{b,n,c,o,m} = \sum_h P^h_{b,n,c,o,m} w^h + \sum_h \eta^h_{b,n,c,o,m} w^h$$

  $P^h_{b,n,c,o,m}$ is selection probability, w^h is the individual household weight, $\eta^h_{b,n,c,o,m}$ is a mean zero, stochastic component that is not observed by either the econometrician or the firm

- Expected Demand

$$ED_{b,n,c,o,m} = \sum_h P^h_{b,n,c,o,m} w^h$$



Aggregation

Supply Side and Market Equilibrium

The firms participating in the market are of three types: domestic, foreign non-Japanese, and Japanese producers facing the VER

$$\max_{p_{it}^{w}} E_t \Pi_t^f = E_t \left\{ \sum_{i=1}^{n_{ft}} \left(p_{it}^{w} - c_{it}\right) q_{it} - F_{ft}\left(X_{ft}\right) \right\}$$

At equilibrium:

$$E_t q_{it} = E_t D_{it} = E_t \left\{ \sum_h P_{it}^h w^h + \sum_h \eta_{it}^h w^h \right\} = \sum_h P_{it}^h w^h$$

For foreign producers:

$$\max_{p_{tt}^{w}, \lambda_{ft}} E_t L_t^f = E_t \left\{ \sum_{i=1}^{n_{ft}} \left(e_t p_{it}^{w} - c_{it}\right) q_{it} - F_{ft}\left(X_{ft}\right) + \lambda_{ft} \left(D_{ft} - \sum_{j' \in V_f} q_{j' t} \right) \right\}$$

Aggregation

Subject to Quota

(a) Domestic Firm:

$$E_t D_{it} + \sum_{j=1}^{n_{ft}} \left(p_{jt}^w - c_{jt} \right) \frac{\partial E_t D_{jt}}{\partial p_{it}^w} = 0 \quad (i = 1, \ldots, n_f)$$

(b) Foreign Firm:

$$e_t E_t D_{it} + \sum_{j=1}^{n_{ft}} \left(e_t p_{jt}^w - c_{jt} \right) \frac{\partial E_t D_{jt}}{\partial p_{it}^w} = 0 \quad (i = 1, \ldots, n_f)$$

(c) "Subject to Quotas" Foreign Firm:

$$e_t E_t D_{it} + \sum_{j=1}^{n_{ft}} \left(e_t p_{jt}^w - c_{jt} \right) \frac{\partial E_t D_{jt}}{\partial p_{it}^w} - \lambda_{ft} \sum_{j' \in V_f} \frac{\partial E_t D_{j't}}{\partial p_{it}^w} = 0$$

$$\sum_{j' \in V_f} E_t D_{j't} \leqslant D_{ft}, \quad \lambda_{ft} \geqslant 0$$

Data Description

- Consumer Expenditure Survey

  Since 1984 the CES also contains detailed information on the automobile holdings of the interviewed households, including the **make/model and purchase price of each car** and a large set of vehicle characteristics

  A comparison with Census data shows that the sample is representative of the U.S. population

Data Description

- Potential Problem1
  - Only nine percent of the sample households purchase a new vehicle each year, which seems to underestimate the total sales of new vehicles in the United States.
  - It is consistent with other publications of the Bureau of Labor Statistics and the U.S. Department of Commerce
  - One explanation for this divergence is the existence of fleet sales
- Potential Problem2
  - New car models in the sample is relatively small
  - Limit the ability to introduce model fixed effects
- The CES was supplemented by information on approximately 200 models per year for the period 1983-87

Identification Assumptions

The main identification assumption is that the variables on the right-hand side of the demand system are uncorrelated with the individual error term in the demand equation.

Among the variables included in the demand equation, there are two sets for which the above assumption may seem suspect:

- existing stock of cars;
- prices.

Identification Assumptions

The Existing Stock of Cars

- This issue is identical to the ones associated with the use of lagged dependent variables; if the error term of the demand equation is serially correlated, the obtained parameter estimates are inconsistent.
- However, dealing with serial correlation in the nested logit model is difficult. Eliminating these variables from the demand estimation would lead to implausible purchasing patterns, as the decision to buy clearly depends on the current stock.
- Therefore, I maintain the assumption that the error terms in the demand specification are not serially correlated.

Identification Assumptions

Prices

Similarly, I assume that prices are not correlated with the consumer specific error term of the demand equation. This assumption is justified on the basis of two considerations:

- Use of micro data;
- Expected profit maximization.

Identification Assumptions

Prices

Use of micro data: In principle, an aggregate component in the error term can arise from two sources:

- The first source is a macroeconomic shock, such as a recession. Such a shock manifests itself in household characteristics that are observed, such as income, employment status, assets, etc. By controlling for these variables in the demand estimation I remove the aggregate component from the error terms.

Identification Assumptions

Prices

- A second aggregate component in the error term is unobserved product characteristics that are perceived in the same way by all consumers. Micro data allow one to estimate this aggregate component as a fixed effect. In this presence, the utility function becomes
$$U_j^h = \bar{V}_j^h + \xi_j + \varepsilon_j^h. \tag{1}$$
- In the current data set, however, new automobile models are sometimes associated with only one observation in the sample so that model specific effects cannot be estimated.
- To accommodate this unfortunate feature, I decompose the product specific unobserved attributes ξ_j into market segment component ξ_j^c, origin component ξ_j^o, and brand compotent ξ_j^{br}:
$$\xi_j = \xi_j^c + \xi_j^o + \xi_j^{br}. \tag{2}$$

Identification Assumptions

Prices

- The second argument supporting the exogeneity of prices comes from the assumption that producers maximize expected profits. This assumption implies that under fairly general conditions prices are uncorrelated with the demand error.
- To clarify, let us without loss of generality focus on the maximization problem of a domestic producer.

$$\max_{p_{it}^{w}} E_t \left\{ \sum_{i=1}^{n_{ft}} (p_{it}^{w} - c_{it}) \left(\sum_{h} p_{it}^{h} w^{h} + \sum_{h} \varepsilon_{it}^{h} w^{h} \right) \right\}. \tag{3}$$

Identification Assumptions

Prices

- Firms observe the actual marginal cost c_{it} while the econometrician only observes the deterministic component $\bar{c}_{it}$. Thus from the econometrician's perspective the supplier's problem is

$$\max_{p_{it}^w} E_t \left\{ \sum_{i=1}^{n_{ft}} (p_{it}^w - \bar{c}_{it} - u_{it}) \left(\sum_h p_{it}^h w^h + \sum_h \varepsilon_{it}^h w^h \right) \right\}. \qquad (4)$$

- Assuming that the error terms of the cost and demand equations, u_{it} and ε_{it}^h are independent, the demand error drops out of the maximization condition so that it does not affect the determination of prices.

$$\Rightarrow \quad \max_{p_{it}^w} E_t \left\{ \sum_{i=1}^{n_{ft}} (p_{it}^w - \bar{c}_{it} - u_{it}) \sum_h p_{it}^h w^h \right\}. \qquad (5)$$

Empirical Results and Interpretation

This section summarizes the results from the estimation of the demand and supply systems.

- First, I present the results from estimating the automobile choice model and testing alternative specifications.
- Next, I analyze the implications of the estimated parameters for aggregate market shares and price elasticities of demand.
- Finally I report the supply side results, with emphasis on the marginal costs, markups, and cost parameters implied by the model.

Estimation Results of the Automobile Choice Model

Model Choice

TABLE B1

Model Choice: Small Cars
Number of Observations: 707
Log of Likelihood Function: −517.9

Variable	Parameter Estimate	Standard Error
PP10	−4.747	0.862
PP20	−4.501	0.356
PP11	−2.927	0.328
PP21	−2.755	1.277
TRANS	3.516	0.225
PS	0.615	0.202
AIRC	5.777	0.255
HPD	−0.018	0.588
HPDYOUNG	−0.203	0.903
FUELC	−7.143	0.740
+15 Brand Dummies		
(All of them highly significant)		

TABLE B2

Model Choice: Big Cars
Number of Observations: 980
Log of Likelihood Function: −414.5

Variable	Parameter Estimate	Standard Error
PP10	−4.445	0.602
PP20	−3.745	0.332
PP11	−3.076	0.649
PP21	−2.171	0.396
TRANS	0.877	0.281
PS	5.525	0.364
AIRC	8.956	0.429
HPD	3.580	0.864
HPDYOUNG	0.275	1.760
FUELC	−1.381	0.744
+16 Brand Dummies		
(5 of them significant at the 10% level)		

TABLE B3

Model Choice: Luxury and Sports Cars
Number of Observations: 185
Log of Likelihood Function: −334.7

Variable	Parameter Estimate	Standard Error
PP0	−1.223	0.174
PP1	−0.517	0.220
TRANS	1.693	0.296
PS	−1.585	0.621
AIRC	3.468	0.529
HPD	0.174	1.162
HPDYOUNG	0.514	2.176
LENGWID	5.030	5.218
LENGWIDF	−1.344	1.707
FUELC	0.231	0.931
+10 Brand Dummies		
(3 of them significant at the 10% level)		

Estimation Results of the Automobile Choice Model

Foreign vs. Domestic

TABLE B4

FOREIGN VS. DOMESTIC[a]
Number of Observations: 1867
Log of Likelihood Function: −413.9
0: Domestic; 1: Foreign

Variable	Parameter Estimate	Standard Error
INCL1	0.891	0.024
INCL2	0.988	0.023
INCL3	0.199	0.100
C1	−0.165	0.499
AGE1	−1.193	0.340
EDUC1	0.791	0.197
NE1	0.127	0.243
NC1	−0.435	0.261
WE1	0.460	0.246
ASIAN1	0.584	0.652
BLUEC1	−0.381	0.257
INCOM1	0.347	0.180
D841	0.255	0.359
D851	−0.199	0.367
D861	0.508	0.365
D871	1.743	0.371
CC21	0.147	0.269
CC31	−3.367	0.421
CCLUX1	−0.063	0.297
CCO1	−0.799	0.330

Estimation Results of the Automobile Choice Model

Class Choice

TABLE B5

CLASS CHOICE
Number of Observations: 1992
Log of Likelihood Function: −2115.1
1−9: Class 1−Class 9

Variable	Parameter Estimate	Standard Error
CINCL	0.944	0.024
C2	1.122	0.363
AGE2	−0.363	0.424
INCOM2	0.037	0.208
FAMSIZE2	−0.234	0.118
PERSLT182	0.180	0.170
C3	−10.793	0.469
AGE3	2.365	0.393
INCOM3	0.146	0.209
FAMSIZE3	−0.299	0.107
PERSLT183	0.448	0.156
C4	−17.199	0.672
AGE4	2.891	0.489
INCOM4	0.404	0.278
FAMSIZE4	−0.674	0.153
PERSLT184	0.795	0.225
C5	−5.027	0.506
AGE5	2.972	0.486
INCOM5	1.017	0.222
FAMSIZE5	−0.569	0.145
PERSLT185	0.855	0.203
C6	−3.190	0.519
AGE6	−0.136	0.592
INCOM6	0.419	0.307
FAMSIZE6	−0.110	0.165
PERSLT186	−0.112	0.247
C7	−5.870	0.437
AGE7	0.493	0.449
INCOM7	−0.081	0.241
FAMSIZE7	0.068	0.108
PERSLT187	0.067	0.161
C8	−8.965	0.978
AGE8	2.751	0.890
INCOM8	0.419	0.447
FAMSIZE8	−0.485	0.286
PERSLT188	1.165	0.372
C9	−5.317	1.072
AGE9	−0.691	1.358
INCOM9	1.028	0.437
FAMSIZE9	−0.438	0.387
PERSLT189	0.781	0.508

Estimation Results of the Automobile Choice Model

Used vs. New and Buy vs. Not Buy

TABLE B6

NEW VS. USED
Number of Observations: 6172
Log of Likelihood Function: −3278.6
0: Used; 1: New

Variable	Parameter Estimate	Standard Error
C1	0.917	0.879
NINCL1	0.011	0.006
AGE1	0.795	0.122
INCOM1	0.632	0.082
ASSET1	0.343	0.070
BLUEC1	−0.438	0.077
EDUC1	0.578	0.074
FAMSIZE1	−0.109	0.021
MINOR1	−0.510	0.127
UNEMPL1	−0.268	0.106
NOCAR1	0.392	0.119
A111	1.119	0.114
A211	0.674	0.128
A221	0.445	0.117
A311	0.053	0.289
A321	−0.165	0.160
UNEMPLR1	−0.263	0.055
MACY1	−1.247	0.417
D841	−0.038	0.156
D851	0.431	0.162
D861	0.912	0.168
D871	1.152	0.200

TABLE B7

BUY VS. NOT BUY
Number of Observations: 20571
Log of Likelihood Function: −6578.5
0: Not Buy; 1: Buy

Variable	Parameter Estimate	Standard Error
C1	39.565	4.098
AGE1	−0.910	0.087
EDUC1	−0.306	0.054
INCOM1	0.487	0.063
ASSET1	0.055	0.043
UNEMPL1	−0.325	0.074
ASIAN1	−0.294	0.145
MINOR1	−0.302	0.079
FEMALE1	−0.360	0.05
BIGCITY1	−0.090	0.046
NE1	9.436	0.542
NC1	3.959	0.325
WE1	7.055	0.499
NOCAR1	2.274	0.101
A111	−0.476	0.072
A211	−0.365	0.083
A221	−0.344	0.070
A311	−0.387	0.196
A321	0.015	0.098
UNEMPLR1	0.145	0.105
MACY1	−38.731	2.744
AUTOFIN1	−0.132	0.052
D2-D19 Dummies		
(All of them highly significant)		

Specification Testing

Alternative Specifications

$$T = \left(\hat{\beta}_r - \hat{\beta}_u\right)' \left(\hat{V}_r - \hat{V}_u\right)^{-1} \left(\hat{\beta}_r - \hat{\beta}_u\right) \tag{6}$$

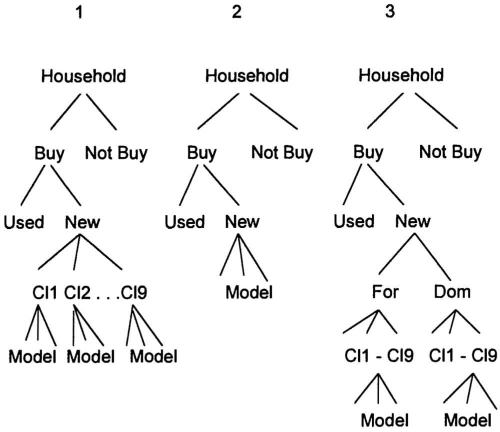


FIGURE 1A.—Alternative preference trees.

Specification Testing

Alternative Specifications

Testing the IIA Property for Specification A

Small Cars		Large Cars		Luxury Cars	
DoF	χ^2	DoF	χ^2	DoF	χ^2
25	49.82 (p-Value 0.002)	26	66.75 (p-Value 0.000)	20	126.74 (p-Value: 0.000)

Testing the IIA Property for Specification B

Small Cars		Large Cars		Luxury Cars	
DoF	χ^2	DoF	χ^2	DoF	χ^2
25	35.64 (p-Value 0.077)	26	41.45 (p-Value 0.027)	20	8.63 (p-Value: 0.986)

χ^2-Tests Based on 3 Consumer Groups

No. of Cells (DoF)	9(4)	33(20)	57(36)
Product Cells Defined By →	*NB/N/U*	*NB/U/C*	*NB/U/CFD*
Consumer Cells Defined By ↓			
Age	6.4	29.7	92.9
Income	15.1	59.3	106.6

Specification Testing

Alternative Specifications

- In summary, the model estimated in the previous section is the only one among the alternatives considered here that is consistent with random utility maximization and does not violate the IIA assumption at each node of the tree.

Specification Testing

The Fit of the Model

Aggregate Market Shares: The difference between actual and expected ones can be split in two components:

- Discrepancy between the CES and the actual market shares: sampling error problem.
- Discrepancy between expected and actual aggregate market shares: difference between estimated and CES shares.
  - The estimation procedure predicts the CES market shares at the higher nodes of the tree exactly. The specification includes choice specific dummies and time effects, so that at the aggregate the model fits the data exactly.
  - The last stage includes brand but not model specific dummies; the predicted aggregate market shares for specific vehicle makes deviate from the actual CES shares. This deviation turns out quite small, suggesting that potential simultaneity bias due to the omission of choice specific dummies at the lower level is not important.

Specification Testing

The Fit of the Model

χ^2 Tests: A better idea about the fit of the model can be obtained by performing χ^2 tests at a more disaggregate level based on finer consumer and vehicle classifications.

Main findings:

- The results are sensitive to both the number of cells and the way the cells are defined; increasing the number of cells tends to increase the probability of rejection, but lowers the power of the test.
- The unconditional tests generally reject the model (with the exception of two cases where age alone was used as a criterion for defining cells).
- The conditional χ^2 tests are more favorable. Tests at the lower levels of the tree that condition on the previous stage nest fail to reject the model.

Specification Testing

Out-of-Sample Predictions

The out-of-sample predictions are performed for the years 1989 and 1990 which are covered by more recent CES surveys. Findings:

- The χ^2 tests tend to reject the model, but the rejection is weaker for conditional tests at the lower level of the tree.
- The model predicts aggregate market segment and origin specific market shares quite accurately, while predictions about the total number of new car purchases in 1989 and 1990 are rather poor.

Overall, statistical testing rejects the hypothesis that the predicted outcomes equal the observed ones, but the results are not a disaster.

Price Elasticities of Demand

One of the strengths of our approach is that it gives plausible own and cross price elasticities of demand. This is the result of using household specific information in weighting vehicle price changes to compute aggregate price indices.

- If a particular household is unlikely to buy a certain vehicle, fluctuations in the price of that vehicle are not going to affect the household's behavior significantly;
- Accordingly, this household will receive low weight in the derivation of the aggregate price effect.

Price Elasticities of Demand

TABLE II

PRICE ELASTICITIES OF DEMAND (AVERAGE BY CLASS)

Class	Origin	Elasticity	Elasticity (first time buyer)	Elasticity (repeat buyer)
Subcompacts	DOM	−3.2857	−3.6245	−2.9816
	FOR	−3.6797	−5.2531	−2.9488
Compacts	DOM	−3.419	−4.8722	−3.1546
	FOR	−4.0319	−5.7229	−3.3733
Intermediate	DOM	−4.1799	−5.3153	−2.8420
	FOR	−5.1524	−6.2232	−4.9274
Standard	DOM	−4.7121	−5.932	−4.3730
Luxury	DOM	−1.9121	−2.5981	−1.1137
	FOR	−2.7448	−3.1272	−1.9959
Sports	DOM	−1.0654	−2.3468	−1.3959
	FOR	−1.5254	3.0211	−1.1429
Pick-ups	DOM	−3.5259	−5.1391	−3.1647
	FOR	−2.6883	−3.9822	−2.1483
Vans	DOM	−4.3633	−5.4977	−3.9790
	FOR	−4.6548	−4.8837	−2.4376
Other	DOM	−4.0884	−4.3185	−3.5694
	FOR	−3.0271	−3.3185	−2.3345

Price Elasticities of Demand

TABLE III

CROSS PRICE SEMI-ELASTICITIES FOR SELECTED MODELS

	Chevette	Civic	Tercel	Escort	Accord
Chevette	−3.2	49.1E − 07	16.4E − 07	0.9E − 07	9.0E − 07
Civic	7.6E − 07	−3.4	35.5E − 07	0.8E − 07	14.9E − 07
Tercel	7.7E − 07	109.8E − 07	−3.4	0.8E − 07	11.6E − 07
Escort	6.3E − 07	34.6E − 07	11.3E − 07	−3.4	12.5E − 07
Accord	6.1E − 07	66.2E − 07	16.2E − 07	1.3E − 07	−3.4
Mazda 626	6.4E − 07	50.1E − 07	15.3E − 07	1.7E − 07	72.2E − 07
Century	5.5E − 07	28.0E − 07	9.6E − 07	0.8E − 07	7.1E − 07
Skylark	5.5E − 07	28.6E − 07	9.9E − 07	0.8E − 07	7.1E − 07
Audi 5000	5.7E − 07	48.6E − 07	16.6E − 07	0.8E − 07	10.1E − 07
Diplomat	4.9E − 07	25.5E − 07	8.7E − 07	0.8E − 07	6.6E − 07
Cad. Fleetwood	0.3E − 07	2.1E − 07	0.7E − 07	0.1E − 07	0.5E − 07
Park Avenue	0.3E − 07	2.1E − 07	0.7E − 07	0.1E − 07	0.5E − 07
Jaguar	0.3E − 07	3.2E − 07	1.0E − 07	0.0E − 07	0.6E − 07
Fiero	0.4E − 07	3.0E − 07	1.0E − 07	0.1E − 07	0.7E − 07
Ferrari	0.4E − 07	4.0E − 07	1.3E − 07	0.1E − 07	0.8E − 07

Marginal Costs and Markups

The first order conditions for profit maximization can be solved for the marginal cost of each product. Then the markup for a specific model can be calculated as

$$\text{Markup} = \frac{\text{Wholesale Price} - \text{Marginal Cost}}{\text{Wholesale Price}}. \tag{7}$$

According to my calculations, markups are on average 38% while previous studies of the industry estimated them to be around 15%. Why?

- Treating a fraction of the payroll as fixed cost would bring marginal costs closer to our estimates.
- Our cost estimates refer to short run marginal cost which in periods of capacity underutilization can be substantially lower than the average production cost.
- Bresnahan and Reiss (1985) find that the ratio of dealer to manufacturer markups is 0.71; 0.5 is not rejected. According to Consumer Reports, dealer markups are between 15 and 25%, which implies manufacturer margins are between 22 and 50%.

Marginal Costs and Markups

MARGINAL COSTS AND MARKUPS

Class	Origin	Cost	Price	Markup	(Price − Cost)
1	DOM	3906	6628	0.36	2722
1	FOR	5688	7840	0.27	2152
2	DOM	3213	6391	0.43	3178
2	FOR	5430	6610	0.19	1180
3	DOM	4773	7134	0.33	2361
3	FOR	9300	12781	0.30	3421
4	DOM	4866	8632	0.40	3766
5	DOM	7247	13458	0.46	6301
5	FOR	10379	18499	0.43	8129
6	DOM	3715	10105	0.69	6390
6	FOR	5822	12823	0.56	7001
7	DOM	5101	8229	0.37	3128
7	FOR	2758	5611	0.41	2583
8	DOM	6937	9634	0.30	2697
8	FOR	12691	15291	0.17	2600
9	DOM	8333	10121	0.15	1788
9	FOR	2750	5174	0.44	2424
Model		**Cost**	**Price**	**Markup**	**(Price − Cost)**
Civic		4884	5680	0.14	796
Escort		3068	4565	0.33	1497
Lynx		3069	4325	0.29	1256
Accord		5286	5854	0.10	567
Audi 5000		7353	14165	0.48	6812
Oldsmobile 98		5372	11295	0.52	5923
Jaguar		10768	19091	0.44	8323
Mercedes 300		13188	22662	0.42	9474
Porsche 944		5714	13136	0.56	7422
Ferrari		7679	19698	0.61	12018

Cost Parameters

The parameters of the cost function are estimated by regressing the estimated marginal costs of specific automobile models on vehicle characteristics and year dummies. An implicit assumption is that the marginal cost of an additional unit of a vehicle characteristic, expressed in the producer's local currency, is constant over the period 1983-87.

- The variables "QUOT1-QUOT5" are dummies specific to Japanese passenger cars that have been interacted with year dummies, which can be treated as year dummies, specific to the firms that produce cars subject to quotas.
- The estimated coefficients suggest that the quantity constraint was binding throughout the 1983-87 period, and had the strongest effects in the first three years.

Cost Parameters

TABLE D1

AMERICAN CARS
Method of Estimation = OLS
Dependent Variable = Cost
Number of Observations = 723
R-Squared = .39

Variable	Parameter Estimate	Standard Error
CONST	3016.040	2141.700
LENGTH	5.516	13.355
WEIGHT	112.694	154.925
CYL	26.207	118.208
HP	11.090	5.724
TRANS	361.135	450.688
PS	740.327	332.998
AIRC	1986.890	509.919
CC1	−2262.860	448.552
CC2	−2085.670	478.650
CC3	−2570.130	478.533
CC4	−3834.170	532.365
CC5	−2861.230	1083.680
CC6	−4990.660	570.242
TRUCK	−2013.490	259.782
D84	−3.716	257.808
D85	118.250	292.342
D86	−42.242	296.495
D87	−165.991	285.044

TABLE D2

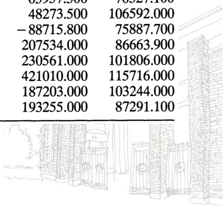
GERMAN CARS
Method of Estimation = OLS
Dependent Variable = Cost
Number of Observations = 133
R-Squared = .66

Variable	Parameter Estimate	Standard Error
CONST	−13822.200	6036.100
LENGTH	38.370	34.490
WEIGHT	−1539.810	1175.560
CYL	2737.140	1303.370
HP	135.348	43.608
TRANS	16480.100	2671.830
PS	5147.300	2447.320
AIRC	−4238.310	2836.990
D84	1735.190	1775.930
D85	2972.010	1726.320
D86	−999.772	1575.090
D87	−4907.460	1420.190

TABLE D3

JAPANESE CARS
Method of Estimation = OLS
Dependent Variable = Cost
Number of Observations = 222
R-Squared = .30

Variable	Parameter Estimate	Standard Error
CONST	−1148240.000	596084.000
LENGTH	3177.790	3328.110
WEIGHT	−103769.000	36389.700
CYL	334971.000	132377.000
HP	1527.310	3411.440
TRANS	54811.700	184056.000
PS	−21558.200	82308.900
AIRC	−497155.000	337027.000
D84	100497.000	109688.000
D85	63957.300	76327.100
D86	48273.500	106592.000
D87	−88715.800	75887.700
QUOT1	207534.000	86663.900
QUOT2	230561.000	101806.000
QUOT3	421010.000	115716.000
QUOT4	187203.000	103244.000
QUOT5	193255.000	87291.100



Quotas

background:

- For the April, 1981-March, 1984 period, Japanese sales to the United States were subject to a limit of 1,832,500 cars per year.
- In April, 1984 the constraint was raised to 2,016,000 units.
- The following year the Japanese government volunteered to limit Japanese auto sales in the U.S. market to 2.5 million annually, and has continued this policy ever since.

Research Question:

1. Were the quota constraints binding during the 1983-87 period?
2. How did the export restraint affect the equilibrium outcome in the automobile industry? In particular what were the effects on sales and market shares, on prices, and on the quality mix?
3. How does the quota constraint compare to an equivalent tariff?

Quotas

Were the quota constraints binding

Comparing the import shares with and without the quota constraint and examining the value of the Lagrange multiplier(components of the deterministic part of the marginal cost) in each year can provide insights as to the extent to which the export constraint was binding.

TABLE V

IMPORT SHARES AND LAGRANGE MULTIPLIERS

Year	No Quota	Quota	Lagrange Multiplier
1983	0.314	0.271	2155
1984	0.363	0.340	2018
1985	0.249	0.243	67
1986	0.339	0.328	402
1987	0.390	0.378	1961

Quotas

The Quota Effects

Solve the model under two different assumptions, quotas vs. free trade, and compare the outcomes.

- Effects on Sales and Market Shares

TABLE VI
EFFECTS OF THE VER ON SALES

Year	Total	Passenger Cars	American	Japanese	Other
1983	−33,478 (0.3%)	−90,899 (1.1%)	+209,990 (2.0%)	−340,321 (15.0%)	+39,432 (7.0%)
1984	−37,808 (0.3%)	−124,990 (1.6%)	+140,807 (1.5%)	−298,477 (9.4%)	+32,680 (6.4%)
1987	−29,991 (0.02%)	−106,632 (1.0%)	+57,510 (0.5%)	−185,843 (4.5%)	+21,702 (2.8%)

- Price Effects

In general, quotas raise prices:
The price increase is most pronounced in Japanese passenger cars subject to quotas, which experience an average increase of 14% each year during 1983-84.63 The prices of domestic vehicles and other imports also rise, but less (0.5-0.9% per year)

Quotas

The Quota Effects

- Effects on Quality

quality upgrading: a movement towards market segments that include more expensive car

TABLE VII

PERCENT CHANGE IN MARKET SEGMENTS (1983)

Class	Domestic	Foreign
Subcompact	1.9	−18.0
Compact	2.5	−15.3
Intermediate	4.2	7.5
Standard	3.3	—
Luxury	3.0	4.4
Sports	4.2	7.6
Trucks	5.0	10.1
Vans	0.3	0.8
Other	3.1	4.0

- The decrease in Japanese subcompact sales is larger than the corresponding decrease of compact sales.
- The share of higher priced intermediate, standard, and luxury automobiles in both the American and the foreign production rises.

The overall "quality" of automobile sales increases.

Quotas

Comparison to an Equivalent Tariff

- Tariff on Japanese Imports
- General Tariff on Imports

TABLE VIII

EQUIVALENT TARIFF LEVELS

Year	Tariff on Japanese Products	General Tariff
1983	64%	65%
1984	62%	62%
1987	55%	57%

Because the different pass-through patterns between Japanese and other, primarily German, imports.

Quotas

Summary

- In summary, the impact of the VER on domestic production and therefore domestic employment was rather limited. In contrast, the price effects of the quota constraint were significant:
- The prices of new automobiles increased slightly, reducing purchases of new cars, while the relative prices of higher priced cars decreased, inducing a shift towards higher quality imports.

Exchange Rate Pass-Through in the Automobile Industry

Sylized facts

During the 1980's, the dollar experienced dramatic swings which were not reflected in the import prices of foreign automobiles.

- Q1:What are the implications of the model with respect to exchange rate pass-through?
- Q2: if incorporating quota restrictions and quality change, can the model reproduce the price patterns observed during 1983-87?

Exchange Rate Pass-Through in the Automobile Industry

Q1:What are the implications of the model with respect to exchange rate pass-through?

TABLE IX
PASS-THROUGH EFFECTS IMPLIED BY THE MODEL

	Without Quota		With Quota	
	\$ + 20%	\$ − 20%	\$ + 20%	\$ − 20%
Jap. Subcompact	−3.1	5.0	−0.3	0.2
Compact	−3.6	6.0	−0.2	0.4
Trucks	−3.9	4.9	−4.7	5.1
Ger. Intermediate	−14.0	24.2	−12.0	24.0
Luxury	−15.1	20.3	−11.2	22.2
Sports	−12.1	16.1	−12.0	21.3

1. Exchange rate pass-through on import prices is asymmetric
2. The pass-through coefficient for Japanese cars is smaller than German's.
3. In the presence of a quota Japanese import prices are insensitive to exchange rate movements.

Explanation:The model suggests that price elasticities for Japanese and German cars differ

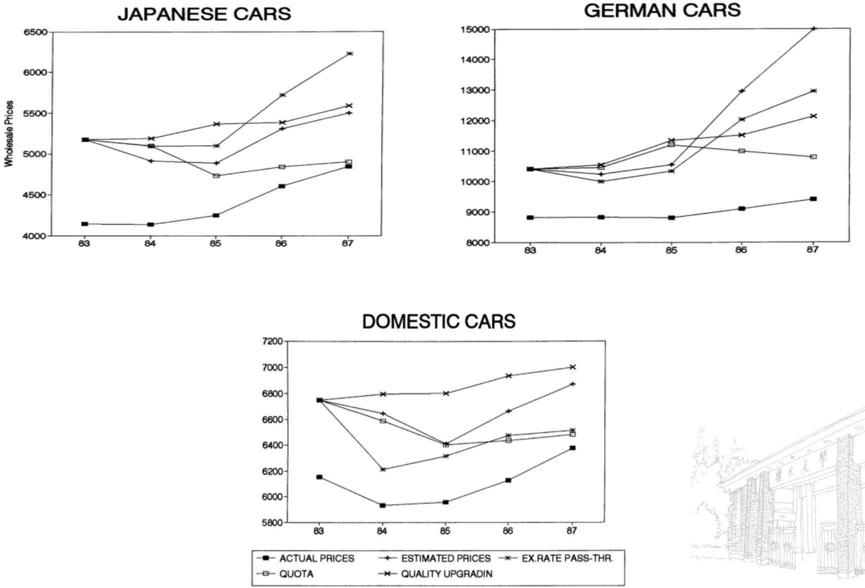
Exchange Rate Pass-Through in the Automobile Industry

Next, apply the model to 1983-87. Price movements across years are the result of three component:

1. quota restriction
2. exchange rate changes
3. quality change of vehicle makes

Compute the equilibrium in each period holding two of the three components constant

Exchange Rate Pass-Through in the Automobile Industry



1. Exchange rate pass-through cannot be analyzed without considering the impact of trade restrictions and quality change on import prices
2. the static model is useful in predicting actual prices when the dollar appreciates, but not as useful when it depreciate.
   Because the model ignores the influence of demand dynamics on profit maximization.

The End