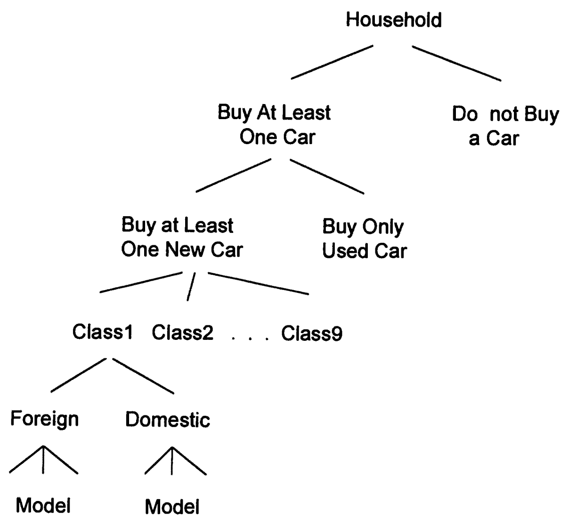

FIGURE 1.—Automobile choice model.

As shown in McFadden (1978, 1981), the assumption of the generalized extreme value distribution implies that the conditional choice probabilities at each node s of the tree, as well as the marginal probability of purchasing a car, will be given by multinomial logit formulas that have the following general form:

$$P^h_{i_s/j_{s-1}} = \exp\left(X^h_{i_s}\theta_s/\lambda_{j_{s-1}} + I^h_{i_s}\lambda_{i_s}/\lambda_{j_{s-1}}\right) \Big/ \sum_{k \in C_{j_{s-1}}} \exp\left(X^h_{k_s}\theta_s/\lambda_{j_{s-1}} + I^h_{k_s}\lambda_{k_s}/\lambda_{j_{s-1}}\right)$$

where

$$I^h_{i_s} = \log\left[\sum_{p \in C_{i_s}} \exp\left(X^h_{p_{s+1}}\theta_{s+1}/\lambda_{i_s}\right)\right].$$

The subscript i_s denotes a specific alternative within the choice set $C_{j_{s-1}}$, where j_{s-1} denotes the previous stage choice on which the current decision is conditioned (similarly the subscript $s+1$ refers to one tree node below the current one), $X^h_{i_s}$ represents a vector of explanatory variables specific to alternative i_s at stage s, and θ_s is the parameter vector specific to stage s to be estimated. The inclusive value terms $I^h_{i_s}$ measure the expected aggregate utility of subset i_s while the coefficients $\lambda_{i_s}/\lambda_{j_{s-1}}$ which are estimated along with the parameters θ in the model, reflect the dissimilarity of alternatives belonging to a particular subset. As McFadden (1978) has shown, the nested structure depicted in Figure 1 is consistent with random utility maximization if and only if the coefficients of the inclusive value terms lie within the unit interval. As the dissimilarity coefficients approach 1, the distribution of the error terms tends towards an iid extreme value distribution and the choice probabilities are given by the simple multinomial logit model. As the coefficients approach 0, the error terms become perfectly correlated and consumers choose the alternative with the highest strict

TABLE 1

SELECTED INDICATORS OF CT SCANNERS, 1973–82

Year	Price* ($ Thousands)		Speed† (Seconds)		Resolution‡ (Millimeters)		Unit Sales	Body (Percentage of Sales)	Number of Firms	R & D§
	Head	Body	Head	Body	Head	Body				
1973	310	...	300	...	3.1	...	16	0	1	1.0
1974	370	...	300	...	1.7	...	74	0	1	7.8
1975	379	365	285	195.0	1.8	1.6	221	.45	4	28.6
1976	374	471	105	63.0	1.7	1.5	374	.76	9	58.2
1977	354	573	95	19.0	1.7	1.3	385	.85	12	46.6
1978	167	620	96	7.1	1.6	1.2	248	.72	10	37.0
1979	154	667	150	6.6	1.5	1.1	273	.70	9	33.7
1980	154	739	115	5.5	1.5	1.0	270	.80	8	29.6
1981	150	827	115	4.9	1.5	.8	392	.92	8	22.6
1982	150	850	115	2.6	1.5	.7	428	.94	8	n.a.

* Weighted average of all scanners in the market (annual sales as weights).
† Minimum scan time, simple average.
‡ Spatial resolution, simple average.
§ R & D expenditures on CT by U.S. firms, constant 1982 dollars (millions).

TABLE 3

MULTINOMIAL LOGIT ESTIMATES FOR BODY CT SCANNERS (Quadratic Form with Residual Price)

	1976	1977	1978	1979	1980	1981
RPRICE	11.252	.993	1.020	.485	.695	−.277
	(6.4)	(4.8)	(4.8)	(1.8)	(2.4)	(−2.5)
SPEED	−2.292	2.138	4.624	−8.669	11.347	−7.504
	(−7.3)	(2.8)	(1.0)	(−1.5)	(2.0)	(−.5)
SPEED^2	.236	−1.264	−8.283	31.292	−34.838	74.161
	(4.0)	(−3.4)	(−.6)	(1.9)	(−1.6)	(1.4)
RESOL	69.107	9.113	−34.126	−15.283	−18.129	32.877
	(7.3)	(2.4)	(−6.3)	(−5.0)	(−3.6)	(−3.9)
RESOL^2	−23.360	−2.533	15.096	6.291	7.738	−24.028
	(−7.6)	(−1.5)	(5.8)	(3.8)	(2.7)	(−4.2)
RTIME	−3.931	5.082	2.385	3.288	3.161	−2.591
	(−5.3)	(7.0)	(2.0)	(3.3)	(2.8)	(−2.8)
RTIME^2	1.054	−2.370	−1.511	−1.401	−2.093	5.560
	(4.5)	(−6.7)	(−2.0)	(−2.1)	(−2.2)	(3.9)
$\rho^2 = 1 - [L(\beta^*)/L(\beta^0)]$	.29	.12	.16	.16	.20	.14
Corr(π^*, π)	.999	.877	.900	.870	.722	.547
	(.0001)	(.0001)	(.0001)	(.0001)	(.0024)	(.082)
Number of scanners	8	15	16	16	15	11
Number of observations	285	324	164	177	193	153

NOTE.—Asymptotic t-values are in parentheses.

TABLE VI

A SAMPLE FROM 1990 OF ESTIMATED OWN- AND CROSS-PRICE SEMI-ELASTICITIES: BASED ON TABLE IV (CRTS) ESTIMATES

	Mazda 323	Nissan Sentra	Ford Escort	Chevy Cavalier	Honda Accord	Ford Taurus	Buick Century	Nissan Maxima	Acura Legend	Lincoln Town Car	Cadillac Seville	Lexus LS400	BMW 735i
323	−125.933	1.518	8.954	9.680	2.185	0.852	0.485	0.056	0.009	0.012	0.002	0.002	0.000
Sentra	0.705	−115.319	8.024	8.435	2.473	0.909	0.516	0.093	0.015	0.019	0.003	0.003	0.000
Escort	0.713	1.375	−106.497	7.570	2.298	0.708	0.445	0.082	0.015	0.015	0.003	0.003	0.000
Cavalier	0.754	1.414	7.406	−110.972	2.291	1.083	0.646	0.087	0.015	0.023	0.004	0.003	0.000
Accord	0.120	0.293	1.590	1.621	−51.637	1.532	0.463	0.310	0.095	0.169	0.034	0.030	0.005
Taurus	0.063	0.144	0.653	1.020	2.041	−43.634	0.335	0.245	0.091	0.291	0.045	0.024	0.006
Century	0.099	0.228	1.146	1.700	1.722	0.937	−66.635	0.773	0.152	0.278	0.039	0.029	0.005
Maxima	0.013	0.046	0.236	0.256	1.293	0.768	0.866	−35.378	0.271	0.579	0.116	0.115	0.020
Legend	0.004	0.014	0.083	0.084	0.736	0.532	0.318	0.506	−21.820	0.775	0.183	0.210	0.043
TownCar	0.002	0.006	0.029	0.046	0.475	0.614	0.210	0.389	0.280	−20.175	0.226	0.168	0.048
Seville	0.001	0.005	0.026	0.035	0.425	0.420	0.131	0.351	0.296	1.011	−16.313	0.263	0.068
LS400	0.001	0.003	0.018	0.019	0.302	0.185	0.079	0.280	0.274	0.606	0.212	−11.199	0.086
735*i*	0.000	0.002	0.009	0.012	0.203	0.176	0.050	0.190	0.223	0.685	0.215	0.336	−9.376

Note: Cell entries i, j, where i indexes row and j column, give the percentage change in market share of i with a \$1000 change in the price of j.

TABLE V

A SAMPLE FROM 1990 OF ESTIMATED DEMAND ELASTICITIES WITH RESPECT TO ATTRIBUTES AND PRICE (BASED ON TABLE IV (CRTS) ESTIMATES)

Model	Value of Attribute/Price Elasticity of demand with respect to: *HP/Weight*	*Air*	*MP\$*	*Size*	*Price*
Mazda323	0.366	0.000	3.645	1.075	5.049
	0.458	0.000	1.010	1.338	6.358
Sentra	0.391	0.000	3.645	1.092	5.661
	0.440	0.000	0.905	1.194	6.528
Escort	0.401	0.000	4.022	1.116	5.663
	0.449	0.000	1.132	1.176	6.031
Cavalier	0.385	0.000	3.142	1.179	5.797
	0.423	0.000	0.524	1.360	6.433
Accord	0.457	0.000	3.016	1.255	9.292
	0.282	0.000	0.126	0.873	4.798
Taurus	0.304	0.000	2.262	1.334	9.671
	0.180	0.000	−0.139	1.304	4.220
Century	0.387	1.000	2.890	1.312	10.138
	0.326	0.701	0.077	1.123	6.755
Maxima	0.518	1.000	2.513	1.300	13.695
	0.322	0.396	−0.136	0.932	4.845
Legend	0.510	1.000	2.388	1.292	18.944
	0.167	0.237	−0.070	0.596	4.134
TownCar	0.373	1.000	2.136	1.720	21.412
	0.089	0.211	−0.122	0.883	4.320
Seville	0.517	1.000	2.011	1.374	24.353
	0.092	0.116	−0.053	0.416	3.973
LS400	0.665	1.000	2.262	1.410	27.544
	0.073	0.037	−0.007	0.149	3.085
BMW 735i	0.542	1.000	1.885	1.403	37.490
	0.061	0.011	−0.016	0.174	3.515

Notes: The value of the attribute or, in the case of the last column, price, is the top number and the number below it is the elasticity of demand with respect to the attribute (or, in the last column, price.)

examining the elasticities and markups it, together with the other estimated coefficients, imply. We note first that the estimates imply that demands for *all* 2217 models in our sample are elastic. The last column of Table V lists prices and price elasticities of demand for our subsample of 1990 models. We find that the most elastically demanded products are those that are in the most "crowded" market segments—the compact and subcompact models. (The Buick Century is an exception to this pattern.) The Sentra and Mazda 323 face demand elasticities of 6.4 and 6.5 respectively, while the \$37,490 BMW and \$27,544 (in 1983 dollars) Lexus face demand elasticities of 3.5 and 3.0 respectively.

Table VI presents a sample of own and cross price semi-elasticities. Each semi-elasticity gives the percentage change in market share of the row car associated with a \$1000 increase in the price of the column car. Looking down the first column, for example, we note that a thousand dollar increase in the price of a Mazda 323 increases the market share of a Nissan Sentra by .705

TABLE IV

ESTIMATED PARAMETERS OF THE DEMAND AND PRICING EQUATIONS: BLP SPECIFICATION, 2217 OBSERVATIONS

Demand Side Parameters	Variable	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Means ($\bar{\beta}$'s)	*Constant*	−7.061	0.941	−7.304	0.746
	HP/Weight	2.883	2.019	2.185	0.896
	Air	1.521	0.891	0.579	0.632
	MP$	−0.122	0.320	−0.049	0.164
	Size	3.460	0.610	2.604	0.285
Std. Deviations (σ_β's)	*Constant*	3.612	1.485	2.009	1.017
	HP/Weight	4.628	1.885	1.586	1.186
	Air	1.818	1.695	1.215	1.149
	MP$	1.050	0.272	0.670	0.168
	Size	2.056	0.585	1.510	0.297
Term on Price (α)	$\ln(y-p)$	43.501	6.427	23.710	4.079
Cost Side Parameters					
	Constant	0.952	0.194	0.726	0.285
	$\ln(HP/Weight)$	0.477	0.056	0.313	0.071
	Air	0.619	0.038	0.290	0.052
	$\ln(MPG)$	−0.415	0.055	0.293	0.091
	$\ln(Size)$	−0.046	0.081	1.499	0.139
	Trend	0.019	0.002	0.026	0.004
	$\ln(q)$			−0.387	0.029

cients that are approximately the sum of the effect of the characteristic on marginal cost and the coefficient obtained from the auxiliary regression of the percentage markup on the characteristics. Comparing the cost side parameters in Table IV with the hedonic regression in Table III we find that the only two coefficients that seem to differ a great deal between tables are the constant term and the coefficient on size. The fall in these two coefficients tells us that there is a positive average percentage markup, and that this markup tends to increase in size.

The coefficients on *MPG* and size may be a result of our constant returns to scale assumption. Note that, due to data limitations, neither sales nor production enter the cost function. Almost all domestic production is sold in the U.S., hence domestic sales is an excellent proxy for production. The same is not true for foreign production, and we do not have data on model-level production for foreign automobiles. The negative coefficient on *MPG* may result because the best selling cars are also those that have high *MPG*. By imposing constant returns to scale, we may force these cars to have a smaller marginal cost than they actually do. Due, to the positive correlation between both *MPG* and size and sales, conditional on other attributes, the coefficients on *MPG* and size are driven down. We can attempt to investigate the accuracy of this story by including ln(sales) in the cost function, keeping in mind that for foreign cars this is not necessarily well measured. (Note, though, in Table I that about 80%

TABLE III
RESULTS WITH LOGIT DEMAND AND MARGINAL COST PRICING
(2217 OBSERVATIONS)

Variable	OLS Logit Demand	IV Logit Demand	OLS ln (*price*) on *w*
Constant	−10.068	−9.273	1.882
	(0.253)	(0.493)	(0.119)
*HP/Weight**	−0.121	1.965	0.520
	(0.277)	(0.909)	(0.035)
Air	−0.035	1.289	0.680
	(0.073)	(0.248)	(0.019)
MP$	0.263	0.052	—
	(0.043)	(0.086)	
*MPG**	—	—	−0.471
			(0.049)
*Size**	2.341	2.355	0.125
	(0.125)	(0.247)	(0.063)
Trend	—	—	0.013
			(0.002)
Price	−0.089	−0.216	—
	(0.004)	(0.123)	
No. Inelastic Demands	1494	22	*n.a.*
(+/−2 *s.e.'s*)	(1429–1617)	(7–101)	
R^2	0.387	*n.a.*	.656

Notes: The standard errors are reported in parentheses.
*The continuous product characteristics—hp/weight, size, and fuel efficiency (*MP$* or *MPG*)—enter the demand equations in levels, but enter the column 3 price regression in natural logs.

In the second column of Table III, we re-estimate the logit utility specification, this time allowing for unobservable product attributes that are known to the market participants (and hence can be used to set prices), but not to the econometrician. To account for the possible correlation between the price variable and the unobserved characteristics, we use an instrumental variable estimation technique, using the instruments discussed at the end of Section 5.1.

The use of instruments generates substantial changes in several of the parameter estimates. All characteristics now enter utility positively and all but *MP$* are statistically significant. Moreover, just as the simultaneity story predicts, the coefficient on price increases in absolute value (indeed it more than doubles). Our interpretation of this finding is familiar: products with higher unmeasured quality components sell at higher prices. Note that now only 22 products have inelastic demands—a significant improvement from the OLS results. Seven to 101 demands are estimated to be inelastic when we evaluate elasticities at plus and minus two standard deviations of the parameter estimate.

These results seem to indicate that correcting for the endogeneity of prices matters. One can also see the importance of unobservable characteristics by examining the fit of the logit demand equation. The simple logit specification

TABLE VIII

A SAMPLE FROM 1990 OF ESTIMATED PRICE-MARGINAL COST MARKUPS AND VARIABLE PROFITS: BASED ON TABLE 6 (CRTS) ESTIMATES

	Price	Markup Over MC $(p - MC)$	Variable Profits (in $'000's) $q*(p - MC)$
Mazda 323	$5,049	$ 801	$18,407
Nissan Sentra	$5,661	$ 880	$43,554
Ford Escort	$5,663	$1,077	$311,068
Chevy Cavalier	$5,797	$1,302	$384,263
Honda Accord	$9,292	$1,992	$830,842
Ford Taurus	$9,671	$2,577	$807,212
Buick Century	$10,138	$2,420	$271,446
Nissan Maxima	$13,695	$2,881	$288,291
Acura Legend	$18,944	$4,671	$250,695
Lincoln Town Car	$21,412	$5,596	$832,082
Cadillac Seville	$24,353	$7,500	$249,195
Lexus LS400	$27,544	$9,030	$371,123
BMW 735*i*	$37,490	$10,975	$114,802

ments in our treatment of the outside good (see the extensions section below). However, our estimates are much smaller than the corresponding figures for the logit model. Our results also show the expected pattern that consumers of lower priced cars are more likely to stay with the outside good when the price of their most preferred model increases.

Table VIII presents the estimated price-marginal cost markups implied by the estimates of the constant returns to scale case reported in Table IV. In 1990, the average markup is $3,753 and the average ratio of markup to retail price is 0.239.[31] The pattern and magnitudes of the markups reported in Table VIII are quite plausible. The models with the lowest markups are the Mazda ($801), Sentra ($880), and Escort ($1077). At the other extreme, the Lexus and BMW have estimated markups of $9,030 and $10,975 respectively. In general, markups rise almost monotonically with price.

In the third column of Table VIII, we list variable profits for each model (since marginal costs are assumed to be constant in output, variable profits are just sales multiplied by price minus marginal cost). Given our estimates, large markups do not necessarily mean large profits, as the sales of some of the high markup cars are quite small. The models that, according to our estimates, are the most profitable (by a factor of two, relative to the other models reported in the table) are the Honda Accord and the Ford Taurus. Both are widely regarded as essential to each firm's financial well-being.

It seems to us that Tables IV through VIII demonstrate that allowing more flexible utility specifications generates a more realistic picture of equilibrium in the U.S. automobile industry. Conditional on allowing for a more flexible utility specification, there are, however, a number of different variables one might

[31] Interestingly, while the pattern of markups differs considerably between the logit case and the BLP specification, the average level of markups is similar across the two sets of results.

TABLE 5—ESTIMATED PARAMETERS OF THE DEMAND AND PRICING EQUATIONS: BASE CASE SPECIFICATION 1971–1990 DATA, 2,217 OBSERVATIONS

	Variable	Parameter estimate	Standard error
Demand-side parameters			
Means ($\bar{\beta}$'s)	Constant	−5.901	0.712
	HP/Weight	2.946	0.486
	Size	3.430	0.342
	Air	0.934	0.199
	MP$	0.202	0.084
Standard deviations (σ_β's)	Constant	1.112	1.171
	HP/Weight	0.167	4.652
	Size	1.392	0.707
	Air	0.377	0.886
	MP$	0.416	0.132
Term on price (α)	$(-p/y)$	44.794	4.541
Cost-side parameters			
	Constant	0.035	0.310
	ln(HP/Weight)	0.604	0.063
	ln(Size)	1.291	0.106
	Air	0.484	0.043
	Trend	0.018	0.004
	Japan	3.255	0.667
	Japan*trend	−0.036	0.008
	Euro	3.205	0.525
	Euro*trend	−0.032	0.006
	lag[ln(e-rate)]	0.026	0.024
	ln(wage)	0.356	0.079
VER dummies			
	VER81	−0.085	0.187
	VER82	−0.022	0.228
	VER83	0.001	0.248
	VER84	0.403	0.245
	VER85	0.361	0.303
	VER86	0.675	0.307
	VER87	1.558	0.353
	VER88	1.490	0.379
	VER89	1.277	0.458
	VER90	1.063	0.469

Japanese and European marginal costs are trending slightly downwards. The elasticity of marginal cost with respect to wages is just over a third, not unreasonable for a production process with so large a materials component, while exchange rate pass-through is about zero. This last result is somewhat surprising, but experimentation suggests that it is robust. Exchange rates just do not seem to matter much. This finding contrasts to other estimates of exchange-rate pass-through (see Feenstra et. al., 1993), but our estimates are based on more disaggregated data and on a more detailed model of the industry.

There are several ways to interpret the magnitude of the utility and cost parameters. One way which is easy to understand and captures the information on both the utility and cost sides of the model is to examine price-marginal cost markups. These markups depend on the demand elasticities implied by the $\bar{\beta}$'s and σ's as well as the marginal cost function parameters (all of which have been jointly estimated). A representative sample of these markups for a handful of 1990 models representing the quality spectrum is presented in Table 6.[20] These estimates appear quite reasonable and are generally in line with other studies. The standard errors of the markups are presented in column 4 and imply that the markups are quite precisely estimated. (A discussion of how the standard errors are computed is given below in "Implications," subsection C.)

The coefficients on the VER dummies address the following question: Suppose the VER was instead implemented as a specific tax on Japanese automobiles, *and* no other aspect of the model changed. What is the level of that tax that would generate equilibrium prices equal to those we observe when we have the VERs? A coefficient (or tax) of zero would imply that the VER did not raise the prices of Japanese cars, while larger values correspond to a larger implicit tax. These coefficients are given in the bottom panel of Table 5.

In 1981, 1982, and 1983, the point estimates are about zero with a standard error between $187 and $248. In these years, the point estimates imply that the VER had almost no effect on prices, and we cannot reject that the effect was nil. In 1984 and 1985, the point estimates of the implicit tax rise to $403 and $361 respectively, but these estimates have standard errors of $243 and $303. Again, we cannot reject the hypothesis that the VER did not raise Japanese prices, although it should be noted that two standard errors encompass a wide range of implicit taxes; i.e., while we cannot reject that

[20] All 2,217 markups are available on request.

TABLE 6—A SAMPLE FROM 1990 OF ESTIMATED PRICE-MARGINAL COST MARKUPS BASED ON TABLE 4 ESTIMATES

	Price (in 1983 \$)	Markup over marginal cost ($p - MC$)	Standard error of markup	Markup as fraction of price
Mazda 323	\$ 5,049	\$ 1,219	\$164	0.241
Nissan Sentra	\$ 5,661	\$ 1,451	\$171	0.256
Ford Escort	\$ 5,663	\$ 1,653	\$203	0.292
Chevy Cavalier	\$ 5,797	\$ 2,127	\$209	0.367
Honda Accord	\$ 9,292	\$ 2,880	\$198	0.310
Ford Taurus	\$ 9,671	\$ 3,352	\$216	0.347
Buick Century	\$10,138	\$ 4,057	\$231	0.400
Nissan Maxima	\$13,695	\$ 4,343	\$255	0.317
Acura Legend	\$18,944	\$ 6,487	\$383	0.342
Lincoln Town Car	\$21,412	\$ 8,206	\$457	0.383
Cadillac Seville	\$24,353	\$10,231	\$486	0.420
Lexus LS400	\$27,544	\$ 9,973	\$646	0.362
BMW 735i	\$37,490	\$13,521	\$692	0.361

the VER had no effect in 1984 and 1985, neither can we reject that the implicit tax was in the range of \$600–\$800. We adopt as our null hypothesis, though, the absence of any price effect of the VER and are unable to reject this null for 1981–1985. It is perhaps not surprising that the VERs had no effect in 1981, as they were not implemented until midyear. However, the lack of any effect on equilibrium prices in 1982 and 1983 is likely to be surprising to some observers.

As noted in the introduction, there are several plausible reasons why the VER might not have initially led to higher Japanese prices. Several of these reasons are interrelated and at the heart of several of them is the notion that the auto industry is an extremely cyclical industry in which sales tend to be weak during recessions and periods of high interest rates. The early 1980's had both. When interest rates are in the 12–18 percent range, the new auto market is sluggish. In this type of economic environment, Japanese auto firms may have found it difficult to raise prices. Indeed, the VERs may well have been agreed to by the Japanese precisely because the Japanese realized that the promise of export restraints at the agreed level was both politically expedient and economically inexpensive at the time the agreement was made. We return to the impact of macroeconomic variables on our results in the robustness discussion below. Also, Japanese firms may have opted to fill their allocations simply to save those allocations for future years when demand would pick up.

In 1986, the VER begins to have a statistically significant effect on prices in that we can no longer reject that the implicit tax was zero. In 1986, the point estimate of the implicit tax is \$675 (with a standard error of \$307). With an average price of Japanese cars at about \$8,200, the VER is equivalent to about a 8.2 percent tax per Japanese car. (Recall the tax is specific, so it is much larger in percentage terms for inexpensive cars and less for costly ones.) The largest effects of the VERs are from 1987 to 1989, and this is again consistent with the notion that business cycles matter in this industry. (Discussions with the economics staff of General Motors stressed the importance of the business cycle in explaining why, in its view, the policy did not matter in the early years but did in the later years.) During these years, the VER was equivalent to a tax of between \$1,277 (with a standard error of \$458) and \$1,558 (with a standard error of \$353). In 1990, the estimated implicit tax falls to a still hefty \$1,063. The data in Table 1, combined with the fact that our estimate of the effect of the VER in 1990 is not very robust, lead us to interpret the 1990 coefficient with great caution. (For a more extensive discussion of this point, see Section VII.)

These are large effects and, by 1989, may strike some as somewhat surprising. For example, Nissan was almost surely not exporting its allocation at the end of our sample. Many industry observers have noted that although the VERs were still in effect in 1990 (they remained so until 1994), they were not

TABLE 7—THE EFFECT OF THE VER ON PRICES AND PROFITS

		Average price in $1,000's				Total profits in $ millions			
		With VER	No VER	Difference	Standard error of difference	With VER	No VER	Difference	Standard error of difference
1986	Japan	8.253	7.506	0.747	0.017	6334	6222	111	351
	United States	9.107	9.074	0.034	0.009	27551	25927	1623	1662
	Europe	17.079	17.170	−0.091	0.013	3040	2974	66	171
1987	Japan	8.849	7.162	1.687	0.035	7908	7999	−90	426
	United States	9.496	9.304	0.192	0.034	24900	21814	3085	1467
	Europe	18.823	19.050	−0.227	0.020	3012	2863	148	162
1988	Japan	8.955	7.470	1.485	0.033	7544	7654	−110	424
	United States	9.625	9.424	0.201	0.028	26923	24159	2764	1568
	Europe	19.874	20.064	−0.189	0.018	2863	2752	111	154
1989	Japan	9.053	7.989	1.064	0.033	7353	7368	−14	453
	United States	9.888	9.805	0.083	0.017	24648	23064	1583	1410
	Europe	21.435	21.551	−0.116	0.020	3251	3167	84	173
1990	Japan	9.307	8.510	0.797	0.027	7612	7550	61	469
	United States	10.053	9.975	0.078	0.016	23123	21972	1151	1317
	Europe	18.639	18.722	−0.083	0.023	2302	2242	59	122

Notes: Average prices are sales-weighted averages. (Average prices do not match those on Table 2 due to treatment of direct foreign investment and captive imports.)

small effect on prices, U.S. profits increased by about $1.6 billion due to the VER. This is the profit-shifting aspect of a strategic trade policy. The standard errors of the difference in profits is large (t-statistics are somewhere between 1 and 2). Hence, while point estimates suggest that U.S. profits increased, these estimates are not precise. (Since profits depend implicitly on hundreds of elasticities, it may not be that surprising that even if each elasticity is tightly estimated, the change in the level of profits is not that tightly estimated.)

While U.S. profits were much increased by the VER, Japanese profits did not fall a corresponding amount. Our estimates imply that Japanese profits were basically unaffected by the VER. In 1986, point estimates imply that Japanese profits rose by $111 million while in 1988 they fell by $110 million. In other years, the figure is somewhere between these two. These are not large numbers. Neither are they precisely estimated. The standard error of the difference in Japanese profits is on the order of $300–$400 million. Two factors contributed to the relatively small decrease in Japanese profits. First, apparently a large fraction of consumers had relatively inelastic demands for the Japanese models; these consumers preferred paying the increased Japanese prices to shifting their demand to other models. Second, with the VER, as opposed to a tariff, the Japanese firms did not have to pay the implicit tax. Instead they kept the "revenue" such a tax would have generated and this is reflected in the higher prices. VERs are sometimes referred to as bribes to the foreign firm, for Japanese profits might have been lower had the VER instead been implemented as a tariff or regular quota.[24]

The theoretical literature has recognized that a quota (or, in this case, VER) might act to raise industry profits. Our point estimates imply this was indeed the case, although our estimates of the change in profits resulting from the VER have relatively large standard errors.

Profits are only part of the economic welfare equation. Another key component is consumer welfare. We compute the compensating variation in the following way. First take a draw from the estimated distribution of tastes and the distribution of income. This draw can be thought of as a simulated household. Next, compute which product gives the highest utility at the VER (i.e., the actual) prices and the resulting utility. Now find the income which generates the same level of utility at the non-VER prices (i.e., the prices we obtained when we solved for the industry equilibrium in the absence of the VER). The change between this

[24] It should be noted, however, that Japanese profits are actually somewhat lower than what is reported in Table 7. This is because some of the difference between price and cost is kept by the dealer, and these dealers are typically domestically owned.

TABLE 8—DECOMPOSING THE COMPENSATING VARIATION RESULTS FROM 1987

	Mean	Standard deviation	Minimum	Maximum	n
All households:					
Average change in price of originally purchased good	0.018	0.277	−0.499	2.369	10,000
Compensating variation	−0.041	0.300	−2.366	0.483	10,000
Only households which purchased a car:					
Average change in price of originally purchased good	0.161	0.814	−0.499	2.369	1,120
Compensating variation	−0.317	0.817	−2.366	0.483	1,120
Only households which purchased Japanese car:					
Average change in price of originally purchased good	1.208	1.149	−0.432	2.369	266
Compensating variation	−1.242	1.012	−2.366	0.426	266
Only households which purchased non-Japanese car:					
Average change in price of originally purchased good	−0.165	0.098	−0.499	−0.013	854
Compensating variation	−0.030	0.457	−2.063	0.483	854

Note: The "originally purchased good" refers to the good purchased when the VER was in place.

consumer welfare, and tariff revenue. The VER was implemented such that it gave the latter of these back to the Japanese firms or government. Suppose the United States had instead opted for the tariff that would have resulted in the same industry equilibrium observed under the VER. We assume that all imports from Japan generate tariff revenue, and this includes captive imports as well as the made-in-Japan portion of production of models which were also produced in the United States (i.e., Camrys made in Japan raise tariff revenue while those made in Kentucky do not). This policy would have generated almost \$11.2 billion dollars in revenue for the U.S. government. The forgone revenue with a VER is sometimes referred to as the bribe paid in order to induce Japan to agree to the policy in the first place. Our (precise) estimates suggest this was a hefty bribe. When this figure is added to the net change computed in the third column of Table 9, the welfare gain from the VERs totals \$8.34 billion. Our point estimates suggest that if the government been able to impose a tariff without changing any of the other conditions in the market, the implied protection of the automobile industry could have enhanced U.S. welfare for exactly the sort of reasons that came out of the early theoretical models of trade policy and imperfect competition. Nonetheless, this net figure has a standard error as large as the net figure itself. In terms of what *was* precisely estimated, we conclude that the decrease in consumer welfare was about equal to the forgone tariff revenue.

Does this suggest that tariffs on Japanese automobiles would be in the U.S. economic interest? There are several reasons why this might not be so. For example, we do not model retaliation (nor, though, do most theoretical models of strategic trade policy). Surely one reason to implement a VER instead of an outright tariff or quota was that the VER bribed the Japanese government into not retaliating. Furthermore, a tariff directed solely at Japanese products would violate the GATT. Also, we are assuming that the imposition of a tariff would not cause Japanese firms to stop marketing some of their models in the United States. If models were pulled off the U.S. market then consumers with inelastic, as well as those with elastic, demand for that model would be adversely affected.

Just as there are good reasons, though, to wonder whether the \$8.341 billion figure might be unrealistically high, there are also good reasons to believe it is too low. First, we have

TABLE 9—AGGREGATE WELFARE AND THE VER
(ACCOUNTING FOR DIRECT FOREIGN INVESTMENT BY JAPANESE FIRMS)
[IN $ BILLION (1983)]

Year	Change in domestic profits	Compensating variation	Net change	Forgone tariff equivalent	Welfare gain from equivalent tariff
1986	1.623	−1.636	−0.013	1.337	1.323
	(1.662)	(0.316)	(1.654)	(0.566)	(1.792)
1987	3.085	−4.019	−0.934	3.266	2.332
	(1.467)	(0.797)	(1.617)	(0.677)	(1.770)
1988	2.764	−3.338	−0.574	3.012	2.437
	(1.568)	(0.710)	(1.664)	(0.692)	(1.838)
1989	1.583	−2.505	−0.921	2.131	1.209
	(1.410)	(0.470)	(1.464)	(0.708)	(1.641)
1990	1.151	−1.635	−0.484	1.521	1.037
	(1.317)	(0.360)	(1.371)	(0.611)	(1.556)
Total	10.207	−13.135	−2.928	11.269	8.341
	(7.350)	(2.480)	(7.556)	(3.096)	(8.311)

Note: Standard errors are in parentheses.

estimated the welfare effects of the VERs as actually implemented, and there is no reason to believe that they were set to optimize welfare. Second, our theoretical and empirical work did not account for monopoly rents accruing to U.S. workers in the automobile industry.

VI. Sensitivity Analyses

Along the way to the punchlines provided in the last section, we have made several possibly objectionable assumptions. For example, we assumed the firms played a Bertrand game, that firms' underlying cost functions were the same, and that the export limits were either binding or not binding on all firms in any given year. We chose not to ignore direct foreign investment (DFI) or captive imports (CI), but did ignore some key ways in which the macroeconomy might affect automobile demand. We also assumed that quality changes were exogenous. In this section, we ask: do changes in these assumptions affect our major conclusions?[26]

Table 10 provides results from seven of the alternative specifications we tried. The base case was estimated under a Bertrand assumption. We investigate how robust our results are to a Cournot as well as to a Mixed Nash assumption. We also investigate the possibility that the VER led to collusion among Japanese firms while the Japanese firms collectively maintained a Bertrand strategy vis-à-vis non-Japanese firms.

There are many ways to compare results across specifications: demand elasticities, markups, profits (which use information from each of the previous two), and the coefficients on the VER dummies. Since the focus of this study is on trade policy, we opt for the latter.

The first column of Table 10 replicates the VER multipliers from our base case. The second column has the estimates obtained under the assumption of Cournot behavior. These estimates are obtained from a structural

[26] There is also the issue of the shape of our objective function, in particular the presence of local minima, and the ability of our numerical procedures (which includes a choice of starting values and of stopping tolerances) to find its overall minimum. We experimented with alternate starting values and tolerances and sometimes found the minimization algorithm stopping at local minima that were slightly different than the overall minima reported in the text. In particular some of these alternate runs indicated that the VER had a larger effect in 1985 and a smaller effect in 1990 than the results reported in the text suggest (though these dummies were *never* significant in 1981 to 1984, and were always significant between 1987 and 1989). The VER dummy coefficients on 1985 and especially 1990 are least stable. Our selected base case is the most representative of our results, but it may be that the VER had a larger effect in 1985 and a smaller effect in 1990 than the base case results suggest. The results for these years, then, should be interpreted with caution.