

No. 303

Did the Gasoline Price Increases Change  
Consumer Evaluations of Cars in Japan  
during 1970-83?: A Note

by  
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April 1986

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## Abstract

This note examines if consumers changed evaluations about cars significantly over the period 1970-83 in Japan, following Ohta and Griliches (1983) for the U.S. cars. The estimated coefficients of cars characteristics did not change significantly over time in the hedonic regression, implying no significant change in the consumer evaluation.

Key Words: Hedonic Regression; Oil Shock; Seemingly Unrelated Regression; Standard Error of Regression;

## I. INTRODUCTION

This note examines if the consumer evaluation of cars changed significantly over the period 1970-83 in Japan. Presumably the gasoline price increases in the two oil shocks of 1973 and 1979 may have affected it significantly (see Table 1 for the relevant CPI components). We will examine this by testing the constancy of the estimated coefficients of the characteristics (weight, horsepower, etc.) of domestic passenger cars over time in the hedonic regression, following Ohta and Griliches (1983) for the U.S. cars. Section II will describe the data and III will present the empirical result with conclusion.

## II. DATA

We collected the following data for each sample car: (1) vintage, (2) introduction month, (3) used car price in April and October, (4) weight (in kg. WT), (5) number of doors (ND), (6) number of cylinders (NOC), (7) wheelbase (in mm, WB), (8) length (in mm, L), (9) width (in mm, W), (10) displacement of engine (in cc), (11) horsepower (in ps, HP), (12) automatic transmission dummy (AT=1 if it is a standard equipment, 0 otherwise), (13) power steering dummy (PS=1 if standard, 0 otherwise), (14) air conditioning dummy (AC=1 if standard, 0 otherwise), (15) fuel economy with speed of 60 km/h (in km/l). Capital letters in the parentheses above are abbreviations to be used later.

(1) to (5) were taken from Leddo Bukku (Red Book), (6) to (11) from Jidōsha Gaido Bukku (Japanese Motor Vehicles Guide Book) and (12) to (14) were from Catalogues issued by automobile manufacturers. Data of (15) on and after the 1976 vintage were obtained from the Guide Book and those before 1976 were from Catalogues. A summary of data is shown in Table 2.

### III. EMPIRICAL RESULTS

We choose used car price rather than new car price as the data to infer about consumer evaluation of cars because of the following reason. New car price data are listed prices, which are not always equal to actual transaction prices because of discount. Used car price data of Red Book are based on the actual transaction prices and so they reflect the consumer evaluation more correctly.

Our analysis will follow Ohta and Griliches (1983) for the U.S. cars. They distinguished between the car's characteristics  $x$  that enter consumer utility function and its fuel economy. Weight and horsepower are the former examples, because they contribute to the quality of ride and speed, respectively, which will increase utility directly. Consumers do not feel utility directly from the amount of gasoline used and so the fuel economy does not enter the utility function: It affects only the budget constraint through gasoline cost.

Then they derived a hedonic regression equation that takes gasoline cost into account. They parameterized gasoline cost to estimate instead of imposing some arbitrary estimate of it. Consumer taste change changes the coefficient of utility-bearing characteristics  $x$ . They showed that the estimated coefficients of  $x$  did not change significantly over time for 1970-81 in the U.S., if the gasoline cost parameters were allowed to change over time. Even if the gasoline cost variables were not included, the constancy of the coefficients was not rejected except for the two oil shock periods. It was rejected without them, however, in the shocks.

First we will test the constancy of the coefficients of  $x$  over time without introducing gasoline cost variables. If the constancy hypothesis is

rejected without them, then we will introduce gasoline cost variables. Otherwise we will not do so.

We will consider the following hedonic regression equation.

$$\log P_{tv}(x) = \text{Constant} + \sum_s \delta_s D_s + \sum_i \alpha_i x_i + u \quad (1)$$

Here  $P_{tv}(x)$  denotes the price at time  $t$  of a car of vintage  $v$  with a vector of characteristics  $x$ .  $D_s$  is a dummy for age  $s$  ( $s=t-v$ ).  $u$  is a disturbance.

Following characteristics are chosen after a few preliminary regressions: HP, NOC, WT, WBW (WB times W), NOD2 (1 if  $NOD < 4$ , 0 otherwise), NOD5 (1 if  $NOD > 4$ , 0 otherwise), AT, PS and AC. HP and NOC contribute to speed and acceleration, WT, WBW and AC to the quality of ride, and AT and PS to the ease of driving and maneuvering.

We use a half-year interval of age dummies instead of a year interval that is used usually in the U.S. studies, because new car models are not always introduced in autumn but are introduced rather evenly over the year in Japan. For example age 3 includes the ages from 2 years and 10 months to 3 years and 3 months in our study. Other age dummies are defined similarly. Whenever our sample structure allows, we will use 1.5 to 4.5 years old cars in estimation, because the cars of these ages will represent the used car market well.

Following Ohta and Griliches, we test the null hypothesis of the constancy of  $\alpha$ 's in (1) between the two adjacent April (A) and October (O) successively, using the same sample cars in these A and O. Then we have two equations in each test: One is equation (1) for A and the other is the one for the adjacent O.

We use F-value in the framework of seemingly unrelated regression (SUR) for formal F-test, because the disturbances of these two equations are

highly correlated owing to omitted characteristics (see Theil, 1971, p.314 for SUR F). Now there is a problem that F-values will increase with the number of observations in large sample in economic applications. So economic hypotheses are easily rejected in large sample. Our sample size is large (see the column of the degrees of freedom in Table 4). We adopt the following Leamer's critical value  $L_B$  to avoid this problem (Leamer 1978).

$$L_B = (n-K) \cdot (n^{q/n} - 1) / q \quad (2)$$

where  $n$  is the number of observations,  $K$  is the number of parameters in the unconstrained regression and  $q$  is the number of parameters to be constrained by the null hypothesis.

Since  $L_B$  is based on very rigid assumptions such as sample dominance, we use  $\Delta SER$  criterion as a practical test following Ohta and Griliches. Here  $\Delta SER$  is equal to the standard error of regression (SER) of the constrained regression minus SER of the unconstrained. If it is smaller than .01, we do not reject the null hypothesis practically. Since the left hand variable is the logarithm of price, an increase in SER by .01 implies an increase in the standard deviation of the unexplained component of price of 1 percent. Since SER is around .2 in our regression, the .01 criterion implies that we are willing to accept up to about 5 percent deterioration in fit. We use the SER of OLS rather than the SUR one in this test because we are interested in the decrease in "fit" due to the imposition of the null hypothesis and because OLS minimizes the actual sum of squared residuals while the SUR method does not do so, minimizing instead a transformed version of it.

Although we will report F-values as formal test results, we use  $\Delta SER$  criterion as the basis for our final decision, because the applicability of  $L_B$  is very limited as stated above.

Table 3 lists hedonic regression results for 1975A and 1980 as examples. Estimated coefficients are correctly signed except for that of AC (insignificantly negative) and  $R^2$  is high.

Table 4 lists the results of tests. Although the F-values are larger than the critical  $L_B$  in some half year comparisons, all the  $\Delta SER$  values are far less than .01. So we conclude that the coefficients of the characteristics were practically stable over half-year comparisons for 1970-83 in Japan, even without taking gasoline cost into consideration. This implies that consumers did not change relative evaluations among cars in the oil shocks as well as in other years. The two oil shocks did not affect the price structure of Japanese car market significantly.

This finding is in contrast with that of Ohta and Griliches (1983) for U.S. in the two oil shock periods, as explained before. This will be because almost all of the Japanese domestic cars are small and fuel-efficient (see Table 2 for the average and the standard deviation of fuel economy), while there will be much wider variations in size and in fuel-efficiency among the U.S. cars.

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Table 1. Relevant CPI Components in Japan (1970=100)

Year·Month	General	Gasoline	New Car	Year·Month	General	Gasoline	New Car
1970A	100	100	100	1977A	203.6	232.1	141.6
700	102.4	102.1	100.0	770	208.5	227.8	143.5
71A	105.7	108.9	101.2	78A	211.6	211.5	144.1
710	109.0	109.2	101.2	780	215.6	191.1	145.3
72A	110.4	109.2	101.5	79A	217.1	208.6	147.3
720	113.3	110.4	101.5	790	224.6	271.3	148.0
73A	120.9	120.7	101.5	80A	235.1	304.7	148.4
730	129.4	123.4	106.4	800	242.4	287.0	149.0
74A	151.2	193.2	125.1	81A	247.2	283.4	149.2
740	163.3	193.5	127.8	810	252.4	323.3	155.1
75A	171.6	211.5	129.7	82A	254.0	325.1	156.3
750	178.7	208.3	131.5	820	260.2	340.8	156.6
76A	187.7	215.4	138.9	83A	259.0	307.1	157.2
760	194.1	231.4	140.3	830	263.7	301.8	158.4

Source: Bureau of Statistics, Office of Prime Minister, Annual Report of the Consumer Price Index.

Table 2. Data

Vintage	No. of obs. <sup>a</sup>	Average of				
		Horsepower <sup>b</sup>	Weight <sup>c</sup>	Fuel Economy <sup>d</sup>	New Car Price <sup>e</sup>	Used Car Price at age 3 <sup>f</sup>
1969	49	80.8	875	19.1	64.5	29.2
	18	(23.7)	(190)	(2.4)	(21.0)	(14.0)
70	58	91.7	925	18.5	69.3	34.8
	6	(19.2)	(163)	(1.1)	(19.2)	(10.8)
71	73	94.8	937	20.5	73.7	40.9
	13	(19.1)	(179)	(1.1)	(21.4)	(14.0)
72	87	96.9	957	20.1	78.0	50.7
	14	(24.7)	(235)	(1.4)	(34.5)	(22.1)
73	102	99.9	976	20.3	84.7	62.0
	29	(23.8)	(215)	(1.7)	(36.5)	(27.1)
74	111	100.9	985	19.1	100.3	65.2
	34	(23.4)	(206)	(2.6)	(42.2)	(27.8)
75	102	103.6	1040	18.2	120.7	73.4
	39	(24.9)	(226)	(2.7)	(55.7)	(34.1)
76	115	99.3	1046	18.3	122.9	73.5
	56	(24.3)	(215)	(2.9)	(56.2)	(36.1)
77	142	96.9	1016	18.5	124.7	72.6
	128	(24.4)	(206)	(3.1)	(52.4)	(33.9)
78	137	99.3	1039	19.0	131.9	72.3
	129	(24.3)	(203)	(3.1)	(52.9)	(30.4)
79	162	101.4	1037	19.3	137.9	82.3
	160	(23.2)	(195)	(3.2)	(55.9)	(34.5)
80	184	101.7	1041	19.6	141.2	82.8

	184	(23.7)	(194)	(3.6)	(54.8)	(36.6)
81	168	102.1	1044	20.1	148.8	---
	168	(25.5)	(193)	(4.1)	(59.3)	
82	166	101.2	1028	21.5	149.3	---
	166	(25.4)	(197)	(4.0)	(61.3)	

<sup>a</sup>Total number of observations is shown first and that for which fuel economy data is available is shown next. <sup>b</sup>ps. <sup>c</sup>kg. <sup>d</sup>km/l on the level pavements with speed of 60 km/h. <sup>e.f</sup>10,000 yen.

NOTE: Standard deviations in the parentheses. Averages are calculated for the total observations except for fuel economy.

Table 3. OLS Hedonic Regressions

Variable	1975A		19800	
	Est. Coef.	Std. Errors	Est. Coef.	Std. Errors
Const.	4.595	.107	4.755	.151
HP <sup>a</sup>	.510	.087	.460	.073
NOC	.042	.015	.076	.014
WT <sup>b</sup>	.303	.151	.473	.133
WBW <sup>c</sup>	.212	.047	.126	.055
NOD2	.091	.019	.096	.020
NOD5	---	---	.184	.069
AT	.083	.052	.134	.040
PS.	.168	.049	.173	.039
AC	-.008	.077	-.065	.057
D2	-.103	.035	-.063	.037
D2.5	-.199	.040	-.167	.035
D3	-.348	.037	-.292	.035
D3.5	-.472	.040	-.479	.054
D4	-.545	.040	-.606	.034
D4.5	-.722	.043	-.795	.035
No. of obs.	289		476	
R <sup>2</sup>	.875		.820	
SER	.157		.209	

<sup>a</sup>100ps.    <sup>b</sup>1000kg.    <sup>c</sup>m<sup>2</sup>.

NOTE: DX is a dummy for age X with age 1.5 as base.

Table 4. Test Result

Year-Months Compared	Vintages Used as Sample <sup>a</sup>	Estimated F-Value	$L_B^b$	Degrees of Freedom	$\Delta SER$
1971A-71O	1969.1-69.12	1.57	3.93	7, 80	-.003
71O-72A	69.1-70. 6	4.13	4.86	7, 150	-.003
72A-72O	69.1-70.12	2.52	5.29	7, 202	-.003
72O-73A	69.1-71. 6	1.68	5.66	7, 274	-.002
73A-73O	69.1-71.12	4.00	5.94	7, 344	-.001
73O-74A	69.1-72. 6	3.01	6.12	8, 376	-.001
74A-74O	69.7-72.12	4.29	6.19	8, 418	-.001
74O-75A	70.1-73. 6	1.16	6.35	8, 552	-.001
75A-75O	70.7-73.12	2.48	6.35	8, 548	-.001
75O-76A	71.1-74. 6	5.69	6.49	8, 688	-.001
76A-76O	71.7-74.12	1.56	6.46	8, 650	-.001
76O-77A	72.1-75. 6	4.56	6.43	8, 620	-.001
77A-77O	72.7-75.12	7.17	6.49	8, 686	.001
77O-78A	73.1-76. 6	15.99	6.58	8, 792	.000
78A-78O	73.7-76.12	6.53	6.49	8, 690	.001
78O-79A	74.1-77. 6	7.28	6.56	8, 766	.001
79A-79O	74.1-77.12	9.12	6.74	9, 898	.001
79O-80A	75.1-78. 6	4.10	6.61	9, 804	.001
80A-80O	75.7-78.12	9.25	6.84	9, 920	.000
80O-81A	76.1-79. 6	9.50	6.85	9, 948	.001
81A-81O	76.7-79.12	3.83	6.82	9, 896	.001
81O-82A	77.1-80. 6	3.96	6.91	9,1066	.001
82A-82O	77.7-80.12	8.10	6.92	9,1078	.001
82O-83A	78.1-81. 6	2.33	6.92	9,1066	.001

83A-830      78.7-81.12      4.10      6.96      9,1150      .001

<sup>a</sup>YY and MM in the form YY.MM denote year YY and month MM, respectively.

<sup>b</sup>Leamer's critical value (eq.2 in the text).