'ORT NO. DOT-TSC-NHTSA-80-23 DOT-HS-805 567

REVISIONS TO THE WHARTON EFA AUTOMOBILE DEMAND MODEL: THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL (MARK I)

Colin J. Loxley
Priscilla Luce
Tim Osiecki
Kate Rodenrys
Sheela Thanawala

Wharton EFA, Inc.
3624 Science Center
Philadelphia, PA 19104

DECEMBER 1980

FINAL REPORT

DOCUMENT IS AVAILABLE TO THE PUBLIC
THROUGH THE NATIONAL TECHNICAL
INFORMATION SERVICE, SPRINGFIELD,
VIRGINIA 22161

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
Office of Research and Development
Washington, DC 20590

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-HS-805 567		

4. Title and Subtitle	5. Report Date
REVISIONS TO THE WHARTON EFA AUTOMOBILE DEMAND MODEL: THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL (MARK I)	December, 1980
	6. Performing Organization Code
7. Author(s) C. Loxley, P. Luce, T. Osiecki, K. Rodenrys, S. Thanawala	8. Performing Organization Report No. DOT-TSC-NHTSA-80-23
9. Performing Organization Name and Address Wharton EFA, Inc.* 3624 Science Center 3rd floor Philadelphia, PA 19104	10. Work Unit No. (TRAIS) HS-161/R1408 11. Contract or Grant No. DOT-TSC-1435
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Office of Research and Development Washington, D.C. 20590	13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code

15. Supplementary Notes

*UNDER CONTRACT TO: U.S. Department of Transportation
Research and Special Programs Administration
Transportation Systems Center
Kendall Square, Cambridge, MA 02142

16. Abstract

This report documents revisions made to the Wharton EFA Automobile Demand Model to produce the Wharton EFA Motor Vehicle Demand Model (Mark I). Equations are reestimated for the total desired stock of autos and for desired shares by size class, including the foreign size classes. The automobile data was adjusted to exclude passenger vans, so equations for total new registrations, scrappage, and new registrations by size class are estimated. New data also allowed re-estimated WEFA and EPA miles per gallon equations in cross-section and time series. Vehicle miles traveled are estimated as the sum of urban and rural vehicle miles per car, which are the results of new behavioral equations. Consistent procedures are found for aggregation of vehicle miles and MPGs to produce average fuel economy and gasoline consumption. Automobile price equations and equations for related price indices are reestimated, as are equations for linkages to the WEFA Annual Model. Finally, a forecast through 1987 is presented and discussed.

17. Key Words	18. Distribution Statement
Automobiles, Long-Run Forecasting, U.S. Demand, Annual Stock, New Sales, Scrappage, Fuel Efficiency, Auto Costs	This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	177	

PREFACE

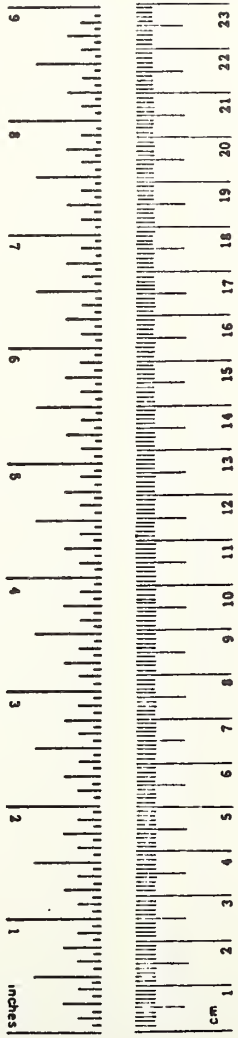
This study is a continuation of a program undertaken by Wharton Econometric Forecasting Associates, Inc. on behalf of the Transportation Systems Center of the Department of Transportation. This research has provided technical information for rule-making support of the Automobile Fuel Economy Regulation program. The authors would like to acknowledge the help provided by other members of the Wharton staff, and the advice and critical comments of the TSC technical monitors, Ron Mauri and Stewart Butler.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

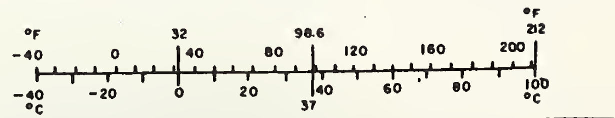
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



CONTENTS

Section		Page
1.	INTRODUCTION	1-1
2.	NEW DESIRED STOCK EQUATIONS	2-1
	2.1 CROSS-SECTION EQUATION RESULTS	2-1
	2.2 "DESIRED STOCK" TIME SERIES	2-2
3.	FOREIGN AND DOMESTIC SHARE EQUATIONS	3-1
	3.1 GENERAL	3-1
	3.2 CROSS-SECTION ESTIMATION RESULTS	3-2
	3.3 TRANSLATION TO TIME SERIES	3-4
4.	TOTAL NEW REGISTRATIONS, SCRAPPAGE, AND NEW REGISTRATIONS BY SIZE-CLASS	4-1
	4.1 GENERAL	4-1
	4.2 ESTIMATION RESULTS	4-1
5.	REVISED FUEL EFFICIENCY, VEHICLE MILES, AND FUEL CONSUMPTION ESTIMATES	5-1
	5.1 ACTUAL "ON-ROAD" NEW CAR MPG	5-1
	5.1.1 Cross-Section Equations	5-1
	5.1.2 Time-Series Estimated Values	5-6
	5.1.3 Time-Series MPG Equations	5-6
	5.2 EPA MPG ESTIMATES	5-12
	5.2.1 Cross-Section Equations	5-12
	5.2.2 Time-Series Estimated Values	5-17
	5.2.3 Time-Series EPA-MPG Equations	5-17
	5.3 VEHICLE MILES	5-29
	5.4 FUEL CONSUMPTION	5-35
6.	AUTOMOBILE PRICE EQUATIONS	6-1
7.	LINKAGES TO THE WHARTON ANNUAL MODEL	7-1
	7.1 GENERAL	7-1
	7.2 EQUATION ESTIMATES	7-2

CONTENTS (CONTINUED)

Section	page
8. THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL AUGUST, 1979 FORECAST	8-1
8.1 EXECUTIVE SUMMARY	8-1
8.2 ASSUMPTIONS	8-4
8.2.1 Economic	8-4
8.2.2 Energy	8-5
8.2.3 Demographic	8-5
8.2.4 Vehicle Design	8-6
8.3 FORECAST REVIEW	8-9
8.3.1 New Car Sales and Registrations	8-9
8.3.2 Imports and Small Cars	8-12
8.3.3 Prices and Costs	8-14
8.3.4 Scrappage and Vehicles in Operation	8-18
8.3.5 Vehicle Miles, MPG, and Fuel Consumption	8-22

Appendices	
A1. PASSENGER VAN STOCK DATA	A1-1
A2. REPORT OF NEW TECHNOLOGY APPENDIX	A2-1

LIST OF ILLUSTRATIONS

Figure No.		Page
2-1.	ACTUAL AND DESIRED STOCK GROWTH RATES, 1958-1975	2-9
8-1.	AUGUST CONTROL FORECAST, NEW CAR RETAIL SALES--PERCENT CHANGE	8-8
8-2.	AUGUST CONTROL FORECAST, IMPORTS MARKET SHARE	8-10
8-3.	AUGUST CONTROL FORECAST, SMALL CARS MARKET SHARE	8-11
8-4.	AUGUST CONTROL FORECAST, SUBCOMPACT NEW REGISTRATIONS--IMPORTS VS. DOMESTICS	8-13
8-5.	AUGUST CONTROL FORECAST, GAS PRICE AND CONSUMER PRICE INDEX--PERCENT CHANGE	8-15
8-6.	AUGUST CONTROL FORECAST, NEW CAR PRICE AND COST PER MILE--PERCENT CHANGE	8-17
8-7.	AUGUST CONTROL FORECAST, CARS IN OPERATION AND VEHICLE MILES--PERCENT CHANGE	8-19
8-8.	AUGUST CONTROL FORECAST, FLEET AVERAGE FUEL ECONOMY AND FUEL CONSUMPTION--PERCENT CHANGE	8-21

LIST OF TABLES

Table No.		Page
2-1.	NEW DESIRED STOCK EQUATIONS	2-3
2-2.	ESTIMATED DESIRED AUTO STOCK, 1958-1975	2-8
3-1.	FOREIGN AND DOMESTIC DESIRED SHARES	3-6
3-2.	DESIRED SHARES ELASTICITIES	3-21
3-3.	DESIRED SIZE-CLASS SHARES	3-22
4-1.	NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS	4-3
5-1.	"ON-ROAD" NEW CAR MPG CROSS-SECTION EQUATIONS	5-3
5-2.	MPG ESTIMATES BY CLASS	5-7
5-3.	"ON-ROAD" NEW CAR MPG TIME-SERIES EQUATIONS	5-9
5-4.	EPA FUEL ECONOMY CROSS-SECTION EQUATIONS	5-14
5-5.	EPG-MPG ESTIMATES BY CLASS	5-18
5-6.	EPA FUEL ECONOMY TIME-SERIES EQUATIONS	5-19
5-7.	VEHICLE MILES EQUATIONS	5-31
5-8.	FUEL CONSUMPTION ESTIMATION	5-38
6-1.	AUTOMOBILE PRICE EQUATIONS	6-3
7-1.	LINKAGES TO THE WHARTON ANNUAL MODEL	7-3
8-1.	AUGUST CONTROL FORECAST, SUMMARY TABLE	8-3
8-2.	THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL, AUGUST 1979 CONTROL SOLUTION	8-23
A1-1.	PASSENGER VAN NEW REGISTRATIONS	A1-4
A1-2.	NORMAL SURVIVAL AND SCRAPPAGE RATES	A1-5
A1-3.	SURVIVAL PROBABILITIES, BY VINTAGE BY YEAR	A1-6
A1-4.	SCRAPPAGE ADJUSTMENT AND NEW REGISTRATIONS	A1-8
A1-5.	PASSENGER VAN STOCK ESTIMATES	A1-9

1. INTRODUCTION

This report describes the enhancement and further development of the Wharton EFA Automobile Demand Model.[1/] The new version, the Wharton EFA Motor Vehicle Demand Model (Mark I), represents an interim operational model, prior to the completion of the light-duty truck demand analysis and its integration into the current model.

While the entire model has been extensively revised, there is a major change in coverage that should be mentioned at this point. All of the vehicle registration data for automobiles include data for certain passenger van models in addition to cars. These have been removed, and the automobile sales and vehicles in operation data have been adjusted accordingly, since these vans are to be included as "personal-use light-duty trucks" for purposes of analyzing and forecasting demand and regulatory policy impacts.

The principle requirements specified for this report were:

(1) To the extent possible, add behavioral equation(s) for the share(s) of imported passenger automobiles.

(2) To the extent possible, add behavioral equations for scrap-size-class.

(4) Re-estimate the desired-stock equation, replacing the family units variable with (a) licensed drivers, and (b) population over age 16, and compare these alternate formulations.

(5) Develop a procedure for estimating annual baseline fuel consumption based on the forecasts of fleet fuel economy and vehicle miles travelled produced by the new model.

[1/] For the original documentation of this model, see George R. Schink and Colin J. Loxley, An Analysis of the Automobile Market: Modeling the Long-Run Determinants of the Demand for Automobiles, Final Report DOT-TSC-NHTSA-79-49, I through III, for the Department of Transportation, Transportation Systems Center, December, 1979. (Hereafter referred to as Schink and Loxley.)

(6) Develop an algorithm for linking the model output to the Wharton Annual Model macroeconomic expenditure and price components.

(7) Modify the output tables to include the above changes, specifically showing scrappage by class, gasoline consumption, linkages to the Annual Model, imports as a share of total registrations, EPA fuel economy ratings by class, and the average total automobile price.

(8) Present a baseline forecast.

(9) Revise and update the database, providing full documentation to TSC.

All of the requirements have been met in this report with the following exception: A behavioral analysis of scrappage by size-class has proved to be infeasible at this time because of inadequate and non-existent data. Although scrappage by class is therefore driven by a complex set of identities, the model has been modified to permit exogenous adjustment of the scrappage by class forecasts.

2. NEW DESIRED STOCK EQUATIONS

In this section some experiments with different formulations for the desired stock equation are described. These mainly include the use of different denominators or "scalars" for the dependent desired stock variable and the appropriate independent or right-hand side variables.

2.1 CROSS-SECTION EQUATION RESULTS

The first equation presented (Table 2-1) is a reestimation of the previous form, since some data revision had taken place. The statistical results were virtually identical to the previous ones (Schink and Loxley, Table A2-1).

The first variant uses stock per licensed driver. Therefore, licensed drivers per family are dropped from the independent variables. The results are statistically slightly stronger; i.e., every variable increases in "power" (higher t-statistics) except "means to work, non-auto" (MTWNA). This is especially true for the income and cost per mile terms. The coefficients are amazingly robust; none changes by a significant amount. The slight increases in the income and cost coefficients are not likely to substantially change previous behavioral conclusions. Finally, it should be noted that for the of KEND*AY /LD equation both the adjusted and unadjusted R^2 are greater, while the standard error of the estimate (SEE) is virtually the same.

The next variant uses population 16 years old and over (N16 +). Here the statistical significance and coefficients of the income and cost terms are clearly lower. Licensed drivers are still a strong factor, and MTWNA becomes slightly more significant. Overall, however, these results must be considered weaker, even though the R^2 and $\bar{R}^2$ have again increased. Note that the SEE is virtually the same as for the licensed drivers variant.

If the denominator variable is now altered to N16.64, population aged 16 to 64 only, then the interesting result is that all the coefficients and their statistical "power" return almost exactly to that found for the original "per family unit" formulation. This similarity is quite extraordinary.

In summary, what these results show is that family units, licensed drivers, and population aged 16 to 64 are highly correlated across states; coefficient estimates are surprisingly robust between these three choices, an encouraging finding; these different formulations are roughly equivalent from a statistical viewpoint, unless one simplistically seeks higher R^2; and the behavioral-simulation implications for income, cost, and demographics are virtually unchanged.

Finally, a comparison of the N16+ results with those for N16.64 suggests that there is a different set of ownership factors for the over-64 group. For this small part of the car-owning population, this is a perfectly plausible result.

2.2 "DESIRED STOCK" TIME SERIES

The procedure for deriving desired stock values over the historical period was discussed exhaustively in Schink and Loxley, Chapter 3. Briefly, U.S. time-series values for the right-hand side independent variables are used to "predict" the desired stock. In the present case, as in the previous model, the percentage of families with incomes (in 1970$) of $15,000 or more was again restricted from falling below 20%, since this is a saturation variable. The only other slight adjustment applied was to scale the entire series so that the "desired" and actual stocks for the U.S. were equal in 1972.

A comparison of the new estimates with the old values (Table 2-2) shows that the former are significantly higher throughout the 1958-67 period, but they move steadily closer. From 1969 on, the new estimates are somewhat lower, especially 1974 (the 0.6 million difference in 1972 is the miniscule passenger van stock). Figure 2-1, compares growth-rates for the actual and desired stocks.

TABLE 2-1. NEW DESIRED STOCK EQUATIONS
(Notes and Definitions)

NOTES

1. OLS Cross-Section estimation, 1972 state data, all U.S. states except Oklahoma, Alaska, Hawaii.

2. Variable definitions (see also Schink and Loxley, Section 3, passim):

(i)	CPMTTCAP	=	Capitalized cost per mile of purchase and operation, all new autos, "desired-share" weighted average.
(ii)	FM	=	"Family Units" - sum of families and unrelated individuals.
(iii)	KEND*AY	=	"Desired Stock" - number of cars in operation
(iv)	LD	=	Licensed drivers
(v)	MTWNA	=	"Means to Work, Non-auto" - total number of commuters using other transport modes.
(vi)	NPMET	=	Fraction of the state population within standard metropolitan statistical areas (can be zero).
(vii)	N16+	=	Population aged 16 and over.
(viii)	N16.64	=	Population between 16 and 64 years of age inclusive.
(ix)	PER15	=	Fraction of families with income $15,000 or more.
(x)	RDIP4	=	$(.4Y + .3Y_{-1} + .2Y_{-2} + .1Y_{-3}) / PC$

where Y = YP$ - TXCP$ - TRTOP$;
YP$ = Personal Income;
TXCP$ = Personal Taxes;
TRTOP$ = Personal Transfer Payments;
PC = State Cost of Living Index, U.S. = 1.0.

TABLE 2-1. NEW DESIRED STOCK EQUATIONS (Continued)

PERIOD: 2 48 EQUATION FOR: KEND*AY/FM

$$
\begin{aligned}
\ln(\text{KEND*AY/FM}) = &-1.91069 \\
&\ (2.40582) \\
&+ .563472 \ln(\text{RDIP4/FM}) \\
&\ (3.13435) \\
&- .101018 \ln(\text{PER15+/100}) \\
&\ (1.92174) \\
&- .199696 \ln(\text{CPMTTCAP/PC}) \\
&\ (.846598) \\
&- .0536255 \ln(\text{MTWNA/FM}) \\
&\ (1.47823) \\
&+ .0990298\ (\text{NPMET} / 100) \\
&\ (1.60921) \\
&+ .421331 \ln(\text{LD /FM}) \\
&\ (3.07246)
\end{aligned}
$$

$\bar{R}^2 = .461$ DW = 1.684 SEE = .059563

CORRELATION MATRIX

	LRDIP4/FM	LPER15+/100	LCPMTTCAP/PC	LMTWNA/FM	NPMET/100	LLD/FM
LRDIP4/FM	1.0000					
LPER15+/100	.70535	1.0000				
LCPMTTCAP/PC	.056466	-.36272	1.0000			
LMTWNA/FM	.23339	.15263	-.10441	1.0000		
NPMET/100	.41876	.69949	-.13635	-.24436	1.0000	
LLD/FM	.0087818	-.37415	.19219	-.17071	-.46534	1.0000
LKEND*AY/FM	.37099	.017263	.17283	-.27602	.092174	.51273

VALUES OF R > 0.29270 ARE SIGNIFICANT AT 95% LEVEL

TABLE 2-1. NEW DESIRED STOCK EQUATIONS (Continued)

PERIOD: 2 48

EQUATION FOR: KEND*AY/LD (Alternate)

$$
\begin{aligned}
\ln(\text{KEND*AY/LD}) = & -2.11324 \\
& \quad (3.52099) \\
& + .606904 \ln(\text{RDIP4/LD}) \\
& \quad (4.31181) \\
& - .112863 \ln(\text{PER15+/100}) \\
& \quad (2.64138) \\
& - .239518 \ln(\text{CPMTTCAP/PC}) \\
& \quad (1.13493) \\
& - .0501665 \ln(\text{MTWNA/LD}) \\
& \quad (1.43991) \\
& + .108841 \ (\text{NPMET} / 100) \\
& \quad (1.95328)
\end{aligned}
$$

$\bar{R}^2 = .501$ DW = 1.651 SEE = .058947

CORRELATION MATRIX

	LRDIP4/LD	LPER15+/100	LCPMTTCAP/PC	LMTWNA/LD	NPMET/100
LRDIP4/LD	1.0000				
LPER15+/100	.77346	1.0000			
LCPMTTCAP/PC	-.091743	-.36272	1.0000		
LMTWNA/LD	.44110	.23713	-.14628	1.0000	
NPMET/100	.62635	.69949	-.13635	-.10595	1.0000
LKEND*AY/LD	.63622	.40945	-.034780	.059441	.57811

VALUES OF R > 0.29270 ARE SIGNIFICANT AT 95% LEVEL

TABLE 2-1. NEW DESIRED STOCK EQUATIONS (Continued)

PERIOD: 2 48 EQUATION FOR: KEND*AY/N16+

$$
\begin{aligned}
\ln(\text{KEND*AY/N16+}) = & -1.60974 \\
& \quad (2.13381) \\
& + .475493 \ln(\text{RDIP4/N16+}) \\
& \quad (2.57628) \\
& - .0648301 \ln(\text{PER15+/100}) \\
& \quad (1.06094) \\
& - .101315 \ln(\text{CPMTTCAP/PC}) \\
& \quad (.412957) \\
& - .0649099 \ln(\text{MTWNA/N16+1}) \\
& \quad (1.74198) \\
& + .0774198 (\text{NPMET/100}) \\
& \quad (1.23811) \\
& + .403021 \ln(\text{LD/N16+}) \\
& \quad (3.12161)
\end{aligned}
$$

$\bar{R}^2$ = .538 DW = 1.730 SEE = .058802

CORRELATION MATRIX

	LRDIP4/N16+	LPER15+/100	LCPMTTCAP/PC	LMTWNA/16+	NPMET/100	LLD/N16+
LRDIP4/N16+	1.0000					
LPER15+/100	.76935	1.0000				
LCPMTTCAP/PC	.034949	-.36272	1.0000			
LMTWNA/FM	.20111	.21182	.11110	1.0000		
NPMET/100	.41876	.69949	-.13635	-.21107	1.0000	
LLD/N16+	.20403	-.16428	.16632	-.20390	-.31452	1.0000
LKEND*AY/N16+	.50873	.21883	.14613	-.30701	.22014	.56874

VALUES OF R > 0.29270 ARE SIGNIFICANT AT 95% LEVEL

TABLE 2-1. NEW DESIRED STOCK EQUATIONS (Continued)

PERIOD: 2 48 EQUATION FOR: KEND*AY/N16.64

$$
\begin{aligned}
\ln(\text{KEND*AY/N16.64}) = & -1.60974 \\
& \ (2.61579) \\
& + .564698 \ln(\text{RDIP4/N16.64}) \\
& \ (3.06439) \\
& - .099761 \ln(\text{PER15+/100}) \\
& \ (1.76712) \\
& - .202186 \ln(\text{CPMTTCAP/PC}) \\
& \ (.852594) \\
& - .0528387 \ln(\text{MTWNA/N16.64}) \\
& \ (1.46824) \\
& + .10033 \ (\text{NPMET/100}) \\
& \ (1.64275) \\
& + .43038 \ln(\text{LD/N16.64}) \\
& \ (3.29983)
\end{aligned}
$$

$\bar{R}^2 = .522$ DW = 1.662 SEE = .059583

CORRELATION MATRIX

	LRDIP4/N16.64	LPER15+/100	LCPMTTCAP/PC	LMTWNA/LD	NPMET/100	LLD/N16.64
LRDIP4/N16.64	1.0000					
LPER15+/100	.77346	1.0000				
LCPMTTCAP/PC	-.091743	-.36272	1.0000			
LMTWNA/N16.64	.44110	.1853	-.11549	1.0000		
NPMET/100	.62635	.69949	-.13635	-.22467	1.0000	
LLD/N16.64	.14603	-.2402	.14441	-.12573	-.38048	1.0000
LKEND*AY/N16.64	.63622	.13991	.12076	-.21926	.15335	.56326

VALUES OF R > 0.29270 ARE SIGNIFICANT AT 95% LEVEL

TABLE 2-2. ESTIMATED DESIRED AUTO STOCK

1958-1975

(millions)

	NEW	OLD
1958	58.7	55.9
1959	60.1	58.0
1960	62.2	60.2
1961	63.1	61.8
1962	65.0	63.6
1963	67.4	65.8
1964	70.2	68.4
1965	73.2	71.5
1966	75.8	74.2
1967	77.9	76.3
1968	78.6	78.3
1969	79.7	80.5
1970	81.8	82.8
1971	84.4	85.4
1972	87.5	88.1
1973	90.7	91.0
1974	90.7	92.5
1975	93.6	NA

FIGURE 2-1. ACTUAL AND DESIRED STOCK GROWTH RATES, 1958 TO 1975

3. FOREIGN AND DOMESTIC SHARE EQUATIONS

3.1 GENERAL

In the previous study, attempts were made to "explain" the foreign shares of the market by size-class. The foreign subcompact share was defined as the share of total subcompact stock or new registrations, and the compact and luxury segments were similarly defined. The results yielded extremely high elasticities in many cases, which quickly became explosive in a time-series simulation.

For our new approach, the foreign shares were redefined as shares of the total. Thus we have:

$$\text{"OLD SHARE"} = \frac{\text{Foreign Subcompact New Registrations, 1971-72}}{\text{Total Subcompact New Registrations, 1971-72}}$$

$$\text{"NEW SHARE"} = \frac{\text{Foreign Subcompact New Registrations, 1971-72}}{\text{Total New Registrations, 1971-72}}$$

The compact and luxury shares were similarly redefined. What this approach does is to recognize the possibility that the relative determinants between domestic and foreign vehicles for each class may well be quite different. It also acts to reduce the volatility of the shares.

The second revision was a more fundamental and far-reaching change. The old approach to costs compared each class (i) to the rest of the fleet, excluding i, (T-i). Thus:

$$\text{RELATIVE COST TERM} = \frac{\text{CPM (i)}}{\text{CPM (T-i)}}$$

The new approach which has been adopted segments the comparison so as to compare costs strictly between neighboring classes, as follows:

For Subcompacts:	Relate to weighted average of other subcompact and compact class CPMs.
For Compacts:	Relate to weighted average of subcompact, mid-size, and other compact class CPMs.
For Mid-size:	Relate to weighted average of compact and full-size class CPMs.
For Full-size:	Relate to weighted average of mid-size and luxury class CPMs.
For Luxury:	Relate to weighted average of mid-size full-size, and other luxury class CPMs.

The cost comparison therefore now includes only the clear substitutes for each class instead of forcing a cross-price elasticity to exist between all classes. Thus, as an example, for foreign subcompacts:

$$\text{CPMSF/SC-SF} = \frac{\text{CPMSF}}{\text{CPMSC-SF}}$$

where

$$\text{CPMSC-SF} = \frac{(\text{SHRSD} * \text{CPMSD} + \text{SHRCD} * \text{CPMCD} + \text{SHRCF} * \text{CPMCF})}{(\text{SHRSD} + \text{SHRCD} + \text{SHRCF})}$$

For each of the eight class-shares now distinguished, equations were estimated, including as independent variables the above relative cost-terms, plus other variables found to be of significance in the previous analysis, such as family size, family income relative to average cost, age distribution, income distribution, etc.

3.2 CROSS-SECTION ESTIMATION RESULTS

Table 3-1 shows some of the estimation results for this changed formulation. For each class, several different forms are presented for comparison. Clearly, some of these are less satisfactory statistically than others. The simulation behavior is also critical. In simulating, some of the estimated equations for certain classes were found to be somewhat unstable because of the relative cost coefficient. For example, for luxury foreign, every formulation attempted so far yields very high cost elasticities.

For the share equations, the dependent variable is a "logit", i.e., log (SHRX/1-SHRX), or log of the "odds." The most variants (four) included in Table 3-1 are for ODDSD. The first equation has a positive income/cost term, opposite to that expected. Including income distribution (PER15+) and dropping licensed drivers (LD/FM), also of perverse sign as in equation #2, yields correct signs and better fit, although the income and cost terms are both weak. Equations #3 and #4 experiment with dropping both income terms. Including metropolitan population (NPMET) clearly produces better results.

Both equations shown are very similar for foreign subcompacts (ODDSF). Here, the licensed drivers variable has the expected positive impact, but persons aged 20 to 29 per family have little effect in contrast to domestics. For domestic compacts, we find a reasonable cost coefficient and the expected signs for both income terms and the family size variable with good levels of significance. The foreign compact relationship suggests a preference by small (one and two member) family units (three and four member families prefer domestic compacts and subcompacts), and a positive influence from the 20 to 29 age group.

The mid-size equation is simply a re-estimation of the formulation used in the preceding model version (Schink and Loxley, Table 3-1). We found that vehicles in this class are apparently sufficiently diverse or flexible to be considered potential substitutes for all other classes. Hence, the mid-size class occupies a pivotal role, and the significant cost term is relative to all other classes.

The domestic full-size and luxury classes interact quite strongly. Both PER15+ and NPMET increase the luxury share and reduce the full-size. Full-size has a significant "trading-up" effect (the positive income/cost term) and loses sales to mid-size as the proportion of three and four member families rises. The alternate full-size equation is weaker. Here the relative cost includes luxury foreign, whereas the first equation compares costs for full-size relative to mid-size and luxury domestic only.

Both the foreign and domestic luxury cost terms include mid-size in the denominator. However, the luxury foreign relative cost term has a very high coefficient, suggesting a rather explosive response to cost shifts. A problem here is the very small size of this share in most states.

Single-equation elasticities are presented in Table 3-2 for purposes of evaluating the single-equation properties. Note that the desired shares are very interdependent and highly simultaneous, due to the relative cost per mile terms.

3.3 TRANSLATION TO TIME SERIES

The key issues and the adjustments required in the translation to the time domain are similar to those in previous study:[1/]

(i) The long-run relationships were estimated with the consumer assumed to be facing the 1972 model offerings "at the margin." Hence, adjustments are required to reflect past supply factors, such as:

- lack of U.S. subcompact models until the 1970's
- lack of U.S. compact models until the mid-1960's
- entry of Japanese subcompacts in the late 1960's
- our own shifting of Ford, Chevrolet and Plymouth full-size back to mid-size during 1959-1964 (Schink and Loxley, Section A1.4.1).

[1/] Schink and Loxley, paragraph 3.3.3.

(ii) The estimation adopts the hypothesis that the market was basically in equilibrium in 1972. Thus, the desired stock and the desired shares are equated to the actual stock and share values. In fact, since we had to use 1971-72 new registration for the shares, the small-car "desired" shares are significantly higher than the actual values by construction. Hence the shares are adjusted for this discrepancy.

(iii) The postulated adjustment process forces the constraint that each desired share should be intermediate between the actual stock share and the new registration share.

The desire shares estimated for the 1958-1977 period are shown in Table 3-3. The values and trends are broadly similar to, or consistent with, the previous estimates (Schink and Loxley, Table 3-2) except, of course, for the explicit foreign/domestic detail.

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES

NOTES

1. See Table 2-1.

2. Variable definitions:

CPM∂/S-∂	=	Capitalized cost per mile, size class ∂, relative to the average for all classes S excluding class ∂.
FM	=	Family units.
LD	=	Licensed drivers.
NCFM3+4	=	Families with three or four members.
NCFM5+	=	Families with five or more members.
NPMET	=	Percent of state population in SMSAs.
NPR∂/R	=	Population in census region ∂ relative to the rest of the U.S.
∂	=	NEW (New England), MTN (Mountain), PAC (Pacific), SA (South Atlantic), ENC (East North Central), WNC (West North Central), WSC (West South Central), ESC (East South Central).
NP20.29	=	Population between 20 and 29 years of age, inclusive.
ODD∂	=	Desired share over one minus the desired share, size-class ∂, ∂ = SD, SF, CD, CF, MD, FD, LD, LF.
PER15+	=	Percent of families with incomes of $15,000 or more.
YDI/FM/CT*Q	=	Disposable income per family relative to capitalized cost per mile for all cars averaged using 1972 desired shares.

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48 EQUATION FOR: ODDSD #1

$$
\begin{aligned}
\ln(\text{ODDSD}) = & -4.80385 \\
& \ (5.03) \\
& -6.40592 \ln(\text{CPMSD/SC-SD}) \\
& \ (1.85) \\
& +.362749 \ln(\text{YDI/FM/CT*Q}) \\
& \ (1.51) \\
& -.384973 \ln(\text{NCFM5+/FM}) \\
& \ (1.63) \\
& -.374033 \ln(\text{LD/FM}) \\
& \ (1.36) \\
& +.734697 \ln(\text{NP20.29/FM}) \\
& \ (2.16) \\
& +.157733 \ \text{NPRNEW/R} \\
& \ (2.24) \\
& +.415821 \ \text{NPMTN/R} \\
& \ (5.99) \\
& +.710566 \ \text{NPRPAC/R} \\
& \ (6.02) \\
& +.22813 \ \text{NPRSA/R} \\
& \ (3.62)
\end{aligned}
$$

$\bar{R}^2 = .645$ DW = 1.942 SEE = .13295

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48

EQUATION FOR: ODDSD #2 (ALT 1)

ln(ODDSD)	=	-2.74142 (2.20)	
		-4.7059 (1.42)	ln(CPMSD/SC-SD)
		-.293615 (0.92)	ln(YDI/FM/CT*Q)
		-.311017 (1.39)	ln(NCFM5+/FM)
		+.712406 (2.25)	ln(NP20.29/FM)
		+.114885 (1.66)	ln(NPRNEW/R)
		+.339668 (4.96)	NPRMTN/R
		+.575919 (4.64)	NPRPAC/R
		+.204312 (3.43)	NPRSA/R
		+.275177 (2.64)	ln(PER15+)

$\bar{R}^2 = .636$ DW = 1.985 SEE = .12498

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48

EQUATION FOR: ODDSD #3 (ALT 2)

$$\ln(ODDSD) = \underset{(6.54)}{-3.62431}$$

$$\underset{(2.96)}{-9.01486} \ln(CPMSD/SC\text{-}SD)$$

$$\underset{(1.45)}{-.345339} \ln(NCFM5+/FM)$$

$$\underset{(1.11)}{-.307719} \ln(LD/FM)$$

$$\underset{(1.95)}{+.668029} \ln(NP20.29/FM)$$

$$\underset{(2.68)}{+.185331} \ln(NPRNEW/R)$$

$$\underset{(6.35)}{+.437897} NPRMTN/R$$

$$\underset{(6.57)}{+.758697} NPRPAC/R$$

$$\underset{(3.84)}{+.242995} NPRSA/R$$

$\bar{R}^2 = .633$ DW = 1.935 SEE = .13515

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48

EQUATION FOR: ODDSD #4 (ALT 3)

$$\begin{aligned}
\ln(\text{ODDSD}) = & -3.53302 \\
& \quad (8.58) \\
& -6.03953 \ln(\text{CPMSD/SC-SD}) \\
& \quad (2.11) \\
& -.231279 \ln(\text{NCFM5+/FM}) \\
& \quad (1.08) \\
& +.497057 \ln(\text{NP20.29/FM}) \\
& \quad (1.62) \\
& +.169096\ \text{NPRNEW/R} \\
& \quad (2.73) \\
& +.395589\ \text{NPRMTN/R} \\
& \quad (6.50) \\
& +.651905\ \text{NPPAC/R} \\
& \quad (6.02) \\
& +.216459\ \text{NPRSA/R} \\
& \quad (3.83) \\
& +.00265838\ \text{NPMET} \\
& \quad (3.35)
\end{aligned}$$

$\bar{R}^2 = .707$ DW = 1.856 SEE = .12065

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48 EQUATION FOR: ODDSF #1

$$\begin{aligned}
\ln(\text{ODDSF}) = & -3.38946 \\
& \quad (7.29) \\
& -4.87433 \ln(\text{CPMSF/SC-SF}) \\
& \quad (1.66) \\
& -.386194 \ln(\text{NCFM5+/FM}) \\
& \quad (2.06) \\
& +.658284 \ln(\text{LD/FM}) \\
& \quad (2.37) \\
& +.331975 \text{ NPRNEW/R} \\
& \quad (3.80) \\
& +.479727 \text{ NPRMTN/R} \\
& \quad (7.69) \\
& +.867458 \text{ NPRPAC/R} \\
& \quad (9.82) \\
& -.490832 \text{ NPRENC/R} \\
& \quad (6.52) \\
& -.469395 \text{ NPRWNC/R} \\
& \quad (7.47)
\end{aligned}$$

$\bar{R}^2 = .916$ DW = 2.278 SEE = .13044

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48

EQUATION FOR: ODDSF #2 (ALT 1)

$$
\begin{aligned}
\ln(ODDSF) = & -3.37867 \\
& \ (7.19) \\
& -5.33475 \ln(CPMSF/SC\text{-}SF) \\
& \ (1.74) \\
& -.457308 \ln(NCFM5+/FM) \\
& \ (2.02) \\
& +.622759 \ln(LD/FM) \\
& \ (2.16) \\
& +.201479 \ln(NP20.29/FM) \\
& \ (0.57) \\
& +.325294\ NPRNEW/R \\
& \ (3.56) \\
& +.493023\ NPRMTN/R \\
& \ (7.35) \\
& +.871716\ NPRPAC/R \\
& \ (9.75) \\
& -.478048\ NPRENC/R \\
& \ (6.03) \\
& -.450721\ NPRWNC/R \\
& \ (6.31)
\end{aligned}
$$

$\bar{R}^2 = .914$ DW = 2.240 SEE = .13162

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48 EQUATION FOR: ODDCD

$$
\begin{aligned}
\ln(ODDCD) = \; & \underset{(3.57)}{3.54098} \\
& \underset{(3.08)}{-2.37497} \ln(CPMCD/SCM\text{-}CD) \\
& \underset{(3.76)}{-1.04112} \ln(YDI/FM/CT*Q) \\
& \underset{(2.40)}{+.226864} \ln(PER15+) \\
& \underset{(5.41)}{+1.13020} \ln(FM3+4/FM) \\
& \underset{(2.00)}{-.432808} \ln(LD/FM) \\
& \underset{(2.88)}{+.119706} \; NPRNEW/R \\
& \underset{(5.69)}{-.350547} \; NPRWSC/R \\
& \underset{(4.49)}{-.276576} \; NPRESC/R \\
& \underset{(2.63)}{+.122279} \; NPRMTN/R
\end{aligned}
$$

$\bar{R}^2 = .662$ DW = 1.873 SEE = .090182

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48

EQUATION FOR: ODDCF

$$
\begin{aligned}
\ln(\mathrm{ODDCD}) = \; & -10.6215 \\
& \;\;(6.21) \\
& -5.78683 \ln(\mathrm{CPMCF/SCM\text{-}CF}) \\
& \;\;(1.02) \\
& -4.67712 \ln(\mathrm{NCFM3{+}4/FM}) \\
& \;\;(2.68) \\
& -1.76231 \ln(\mathrm{NCFM5{+}/FM}) \\
& \;\;(2.19) \\
& +2.22688 \ln(\mathrm{NP20.29/FM}) \\
& \;\;(1.52) \\
& +.970882 \;\mathrm{NPRNEW/R)} \\
& \;\;(3.52) \\
& -1.05921 \;\mathrm{NPRWSC/R} \\
& \;\;(3.51) \\
& -1.12274 \;\mathrm{NPRENC/R} \\
& \;\;(3.77) \\
& -1.0598 \;\mathrm{NPRWNC/R} \\
& \;\;(3.43) \\
& -.921984 \;\mathrm{NPRESC/R} \\
& \;\;(3.39)
\end{aligned}
$$

$\bar{R}^2 = .696$ DW = 1.492 SEE = .46720

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48 EQUATION FOR: ODDMD

$$
\begin{aligned}
\ln(\text{ODDMD}) = \; & .170431 \\
& (0.32) \\
& -1.96554 \ln(\text{CPMM/T-M}) \\
& (4.54) \\
& -.151175 \ln(\text{YDI/FM/CT*Q}) \\
& (1.23) \\
& +.789071 \ln(\text{NCFM3+4/FM}) \\
& (4.74) \\
& +.163106 \text{ NPRNEW/R)} \\
& (3.99) \\
& -.126228 \text{ NPRMTN/R} \\
& (3.64)
\end{aligned}
$$

$\bar{R}^2 = .681$ DW = 1.462 SEE = .078171

TABLE 5-4. EPA FUEL ECONOMY CROSS-SECTION EQUATIONS (continued)

PERIOD: 1 129 (CROSS-SECTION) EQUATION FOR: EPAMPGH

$$
\begin{aligned}
\ln(\text{EPAMPGH}) = \; & 9.78247 \\
& (15.40) \\
& -.728616 \ln(\text{USCURB} + 300) \\
& (6.89) \\
& -.0946762 \ln(\text{USDISP}) \\
& (1.86) \\
& -.0772882 \text{ USFAUTO} \\
& (2.79) \\
& -.152686 \text{ DUM75} \\
& (6.30) \\
& -.0647022 \text{ DUM76} \\
& (2.68) \\
& -.0362308 \text{ DUM77} \\
& (1.49)
\end{aligned}
$$

$\bar{R}^2 = .890$ DW = 1.977 SEE = .092939

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48

EQUATION FOR: ODDFD #2 (ALT 1)

$$
\begin{aligned}
\ln(\text{ODDFD}) = & -5.296 \\
& \ (4.08) \\
& -.827695 \ln(\text{CPMFD/ML-FD}) \\
& \ (0.52) \\
& +1.14408 \ln(\text{YDI/FM/CT*Q}) \\
& \ (3.43) \\
& -1.68049 \ln(\text{NCFM3+4/FM}) \\
& \ (5.68) \\
& -.566527 \ln(\text{PER15+}) \\
& \ (5.24) \\
& -.410528\ \text{NPRNEW/R} \\
& \ (6.13) \\
& -.394882\ \text{NPRMTN/R} \\
& \ (5.85) \\
& -.605177\ \text{NPRPAC/R} \\
& \ (6.39) \\
& +.220694 \ln(\text{NCFM5+/FM}) \\
& \ (1.18)
\end{aligned}
$$

$\bar{R}^2 = .801$ DW = 1.596 SEE = .13001

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48 EQUATION FOR: ODDLD

$$
\begin{aligned}
\ln(\text{ODDLD}) = & -2.29697 \\
& \ (3.89) \\
& -2.9645 \ \ln(\text{CPMLD/MFL-LD}) \\
& \ (1.27) \\
& +.168731 \ \ln(\text{PER15+}) \\
& \ (1.74) \\
& +.00238569 \ \text{NPMET} \\
& \ (1.95) \\
& -.374005 \ \text{NPRNEW/R} \\
& \ (5.58) \\
& +1.97402 \ \text{NPRWSC/R} \\
& \ (2.19) \\
& -2.51549 \ \text{NPRPAC/R} \\
& \ (3.00)
\end{aligned}
$$

$\bar{R}^2 = .610$ DW = 1.783 SEE = .13597

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48 EQUATION FOR: ODDLF#1

$$
\begin{aligned}
\ln(\text{ODDLF}) = \; & -3.85531 \\
& \;\;(3.50) \\
& -8.68357 \;\; \ln(\text{CPMLF/MFL-LF}) \\
& \;\;(4.22) \\
& +.312479 \;\; \ln(\text{PER15+}) \\
& \;\;(1.09) \\
& +.00572897 \;\; \text{NPMET} \\
& \;\;(1.98) \\
& -.632022 \;\; \text{NPRENC/R} \\
& \;\;(3.81) \\
& -.23773 \;\; \text{NPRWSC/R} \\
& \;\;(1.04) \\
& -.264309 \;\; \text{NPRESC/R} \\
& \;\;(1.32)
\end{aligned}
$$

$\bar{R}^2 = .632$ DW = 1.363 SEE = .32965

TABLE 3-1. FOREIGN AND DOMESTIC DESIRED SHARES (Continued)

PERIOD: 2 48

EQUATION FOR: ODDLF#2 (ALT 1)

$$
\begin{aligned}
\ln(\text{ODDLF}) = & -4.73383 \\
& \quad (4.53) \\
& -8.62247 \ \ln(\text{CPMLF/MFL-LF}) \\
& \quad (4.05) \\
& +.714675 \ \ln(\text{PER15+}) \\
& \quad (3.41) \\
& -.616782 \ \text{NPRENC/R} \\
& \quad (3.60) \\
& -.0638977 \ \text{NPRWSC/R} \\
& \quad (0.29) \\
& -.142541 \ \text{NPRESC/R} \\
& \quad (0.72)
\end{aligned}
$$

$\bar{R}^2 = .606$ DW = 1.191 SEE = .34114

TABLE 3-2. DESIRED SHARES ELASTICITIES

EQUATION	Relative CPM	YDI/FM /CT*Q	LD/FM	NCF3+4 /FM	NCF5+ /FM	NP20.29 /FM	PER15+
SHRSD*A#1	-5.93	+0.34	-0.35	--	-0.36	+0.68	--
#2	-4.35	-0.27	--	--	-0.29	+0.66	+0.25
#3	-8.34	--	-0.28	--	-0.32	+0.61	--
#4	-6.04	--	--	--	-0.21	+0.46	--
SHRSF*A#1	-4.28	--	+0.58	--	-0.34	--	--
#2	-4.69	--	+0.55	--	-0.40	+0.18	--
SHRCD*A	-2.02	-0.89	-0.37	+0.96	--	--	+0.19
SHRCF*A	-5.90	--	--	-4.77	-1.80	+2.27	--
SHRMD*A	-1.52	-0.12	--	+0.61	--	--	--
SHRFD*A#1	-1.80	+0.64	--	-1.02	+0.16	--	-0.31
#2	-0.55	+0.77	--	-1.13	+0.15	--	-0.38
SHRLD*A	-2.73	--	--	--	--	--	+0.16
SHRLF*A#1	-8.62	--	--	--	--	--	+0.71
#2	-8.64	--	--	--	--	--	+0.31

(Elasticities for NPMET not evaluated since the variable is linear)

TABLE 3-3. DESIRED SIZE-CLASS SHARES

	Domestic Subcompact	Foreign Subcompact	Domestic Compact	Foreign Compact	Midsize	Fullsize	Domestic Luxury	Foreign Luxury
	SHRSD*A	SHRSF*A	SHRCD*A	SHRCF*A	SHRMD*A	SHRFD*A	SHRLD*A	SHRLF*A
1958	.007	.043	.019	.004	.571	.273	.079	.003
1959	.014	.055	.046	.006	.527	.273	.074	.003
1960	.032	.047	.098	.005	.460	.285	.071	.003
1961	.048	.044	.109	.004	.430	.289	.073	.003
1962	.041	.039	.126	.003	.406	.309	.072	.003
1963	.037	.042	.108	.003	.380	.356	.071	.004
1964	.026	.048	.125	.003	.342	.382	.070	.003
1965	.026	.049	.125	.003	.306	.417	.072	.003
1966	.019	.056	.131	.004	.302	.410	.075	.003
1967	.015	.066	.148	.005	.275	.409	.078	.004
1968	.012	.075	.145	.005	.277	.403	.078	.004
1969	.011	.081	.160	.005	.256	.400	.082	.004
1970	.018	.099	.177	.007	.247	.373	.073	.006
1971	.051	.105	.158	.007	.226	.364	.083	.006
1972	.057	.106	.155	.008	.227	.356	.084	.007
1973	.070	.112	.167	.009	.228	.321	.084	.007
1974	.087	.116	.184	.011	.240	.275	.078	.008
1975	.099	.131	.188	.012	.238	.241	.084	.009
1976	.103	.128	.186	.011	.242	.237	.086	.008
1977	.104	.126	.184	.011	.235	.247	.086	.008

4. TOTAL NEW REGISTRATIONS, SCRAPPAGE, AND NEW REGISTRATIONS BY SIZE-CLASS

4.1 GENERAL

The approach used for new registrations and scrappage is similar to that adopted for the previous model (Schink and Loxley, Section 3.3.4). The discussion will therefore focus primarily on a comparison of results.

First, the data revision to exclude passenger vans should be noted. The models concerned are Plymouth Voyager, Dodge Sportsman, Ford Club Wagon, Chevrolet Sportvan, and Volkswagon Bus. New registrations data for these models (starting in 1965) were tabulated and, for domestics, were previously included as full-size vehicles.

Excluding these new registrations, therefore, reduced the total and reduced the full-size share (raising the others). Less straight-forward was the estimation of a passenger van stock (and hence scrappage) series. This was accomplished by deriving survival probabilities by vintage in a manner analogous in principle to that used for autos[1/] and progressively scrapping the new registrations. This procedure is documented in Appendix A1 of this report.

4.2 ESTIMATION RESULTS

The equation results are presented in Table 4-1. Turning to the aggregate new registrations equation, it can be seen that the coefficient and significance of the desired stock-actual stock ratio are both lower than previously. Similarly, changes in income and prices both have less impact on the new registrations rate (relative to stock) than formerly. The constant term indicates a slightly higher "equilibrium" rate of new registrations.

1/ Schink and Loxley, Section A1.4.8

In our first reestimation of the scrappage equation some significant coefficient changes occurred. Those for the desired stock are slightly lower, but more significant. Age, the unemployment rate, and the rate of growth of miles driven per vehicle have a greater impact. The increased effect of VMT changes and the reduced desired stock impact led to unreasonable responses to VMT changes. Thus, a gas price increase, reducing VMT/K could cut scrappage so much that total stock might increase: an unreasonable result. Therefore, we experimented with different formulations, and found that the VMT/K variables were really picking up income changes. The new version drops the average age and used car prices (they were insignificant).

There are now seven equations for new registrations by size-class. Imported compact and luxury cars are combined. Both have very small shares, and in recent years, the models defining the compact group have virtually all escalated rapidly in price into the luxury bracket. All of the equations have the same philosophy: the new registrations share is a function of the desired share (with the elasticity constrained to unity), and the ratio of the actual stock share to the desired stock share. All the shares are defined in "odds" form, and the actual stock share is defined as last year's class stock less current class scrappage relative to total previous stock less current scrappage.[1/]

The results suggest that domestic subcompacts adjust most rapidly to a change in desired share, closely followed by mid-size and full-size. The foreign shares adjust much less rapidly, which seems a reasonable result. The domestic luxury class adjusts only slightly less rapidly than full-size, but domestic compacts appear to have a slower adjustment to a desired change, more in line with foreign vehicles.

[1/] All shares are reconciled to sum to one.

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS

Definitions:

AVAGEO-20	=	Average age of auto stock.
DUMAUTOS	=	Automobile strike dummy.
KEND*AY	=	Desired stock.
NRUT	=	Unemployment rate.
ODDδ*A	=	SHRδ*A/1-SHRδ*A, where SHRδ*A is the desired share, class δ .
ODDδK-SC	=	TMδK-SC/1-TMδK-SC, where TMδK-SC is the share of actual stock, after current year scrappage, for class δ ; with the sum of shares being reconciled to one.[1/]
ODDδTNR	=	SHRδTNR/1 - SHRδTNR, where SHRδTNR is the new registrations share for class δ .
OMVUANR	=	Total new passenger auto registration.
OPMVUAYEND	=	Actual stock of autos in operations, year-end.
PUOLD	=	Average price of old cars.
PUTOTNR	=	Sales weighted average new car price.
PUTOTNRL	=	Average new car price, weighted by previous year sales mix.
PSCRAPAV	=	Average scrap metal price series.
SCMVAGIV	=	"Given" scrappage, all cars over 20 years.
SCMVUA	=	Total auto scrappage.
VMR/K	=	Miles driven per vehicle.
RDI/FM	=	Real disposable income per family.

[1/] See ODDSDTNR equation comments for a complete algebraic statement.

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975 EQUATION FOR: OMVUANR

$$
\begin{aligned}
\ln(OMVUANR/(OPMVUAYEND(-1)-SCMVUA)) = & -2.64204 \\
& (32.2094) \\
& + 2.45923 \ln(KEND*AY/(OPMVUAYEND(-1)-SCMVUA)) \\
& (5.02245) \\
& + 4.21669 \ln(RDI/FM / RDIP4/FM) \\
& (5.7421) \\
& - 1.06590 \ln(PUTOTNRL/PUTOTNR(-1)) \\
& (2.64462) \\
& -.288736 \; DUMAUTOS \\
& (3.19509)
\end{aligned}
$$

$\bar{R}^2 = .906$ DW = 1.841 SEE = .038985

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975 EQUATION FOR: SCMVUA

$$
\begin{aligned}
\ln(\text{SCMVUA} - \text{SCMVAGIV})/ \\
(\text{OPMVUAYEND}(-1) + \text{OMVUANR})) = & -7.72820 \\
& (8.03122) \\
& -3.22087 \ \ln(\text{KEND*AY} / (\text{OPMVUAYEND}(-1) + \text{OMVUANR})) \\
& (5.3199) \\
& +3.45837 \ \ln(\text{AVAGEO-20}) \\
& (6.03368) \\
& -.143134 \ \ln(\text{PUOLD/PSCRAPAV}) \\
& (1.92125) \\
& -.413961 \ \ln(\text{NRUT}) \\
& (5.2452) \\
& +3.44981 \ \ln(\text{VMT/K} / \text{VMT/K}(-1)) \\
& (3.41749) \\
& +4.43955 \ \ln(\text{VMT/K}(-1) / \text{VMT/K}(-2)) \\
& (5.11976) \\
& +3.28961 \ \ln\ (\text{VMT/K}(-2) / \text{VMT/K}(-3)) \\
& (4.19666)
\end{aligned}
$$

$\bar{R}^2 = .905$ DW = 2.634 SEE = .053941

Comments:

Almon Lag on (VMT/K(-1)) is <2, 3, FAR>

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975

EQUATION FOR: SCMVUA (ALT 1)

ln(SCMVUA - SCMVAGIV)/
(OPMVUAYEND(-1) + OMVUANR)) = -2.17058
(15.9247)

-3.84157 ln(KEND*AY / (OPMVUAYEND(-1) + OMVUANR))
(5.80148)

-.173615 DUMAUTOS
(1.28310)

-.439362 ln(NRUT)
(5.6775)

+2.73125 ln(RDI/FM / RDI/FM(-1))
(4.86269)

+.880028 ln(RDI/FM(-1) / RDI/FM(-2))
(1.28776)

$\bar{R}^2$ = .862 DW = 1.615 SEE = .063382

Comments:

Almon Lag on (RDI/FM / RDI/FM(-1)) is <2, 2, FAR>

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1958-1975 EQUATION FOR: ODDSDTNR

$$
\begin{aligned}
\ln(\text{ODDSDTNR}) = & -.425809 \\
& (3.486) \\
& -.932829 \quad \ln(\text{ODDTMSDK-SC/ODDSD*A}) \\
& (6.19997) \\
& -1.99422 \quad \text{DUM1969} \\
& (4.16) \\
& +\ln(\text{ODDSD*A})
\end{aligned}
$$

$\bar{R}^2 = .837$ DW = 1.194 SEE = .42871

Comments:

SHRSDK - SC = (OPMVUASDYEND(-1) - SCMVUASD) / (OPMVUAYEND(-1) - SCMVUA)

SUMTTK - SC = $\sum_{\delta}$ SHRδK - SC ; δ = SD, CD, MD, FD, LD, SF, CF, LF

TMSDK - SC = SHRSDK - SC / SUMTTK - SC

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975 EQUATION FOR: ODDSFTNR

$$\ln(\text{ODDSFTNR}) = \underset{(6.47562)}{.0830043} \; \underset{(11.7682)}{-.331174} \ln(\text{ODDTMSFK-SC/ODDSF*A}) + \ln(\text{ODDSF*A})$$

$\bar{R}^2 = .896$ DW = 1.158 SEE = .034249

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975

EQUATION FOR: ODDCDTNR

$$\ln(\text{ODDCDTNR}) = \underset{(3.87496)}{.0612474} \; \underset{(14.6598)}{-.340419} \; \ln(\text{ODDTMCDK-SC/ODDSD*A}) + \ln(\text{ODDCD*A})$$

$\bar{R}^2 = .936$ DW = 1.044 SEE = .049227

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975 EQUATION FOR: ODDC+LFTNR

$$\ln(\text{ODDC+LFTNR}) = \underset{(5.65194)}{.0822068}$$

$$-\underset{(10.9929)}{.3704}\ \ln(\text{ODDTMC+LFK-SC/ODDC+LF*A})$$

$$-\underset{(2.71111)}{.116963}\ \text{DUM1965}$$

$$+\ln(\text{ODDC+LF*A})$$

$\bar{R}^2 = .908$ DW = 1.899 SEE = .039927

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975

EQUATION FOR: ODDMDTNR

$$
\begin{aligned}
\ln(\text{ODDMDTNR}) = \; & .00723071 \\
& (1.04808) \\
& -.916888 \; \ln(\text{ODDTMMDK-SC/ODDMD*A}) \\
& (42.5769) \\
& +\ln(\text{ODDMD*A})
\end{aligned}
$$

$\bar{R}^2 = .991$ DW = 1.927 SEE = .015492

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975 EQUATION FOR: ODDFDTNR

$$\ln(\text{ODDFDTNR}) = \underset{(1.77067)}{-.0203659} \;\underset{(20.4792)}{-.898058}\; \ln(\text{ODDTMFDK-SC/ODDFD*A}) + \ln(\text{ODDFD*A})$$

$\bar{R}^2 = .963$ DW = 0.607 SEE = .047227

TABLE 4-1. NEW REGISTRATIONS, SCRAPPAGE AND NEW REGISTRATIONS BY CLASS (continued)

PERIOD: 1959-1975 EQUATION FOR: ODDLDTNR

$$\ln(\text{ODDLDTNR}) = \underset{(.519682)}{.00116789} \; \underset{(21.6122)}{-.698699} \ln(\text{ODDTMLDK-SC/ODDLD*A}) + \ln(\text{ODDLD*A})$$

$\bar{R}^2 = .967$ DW = 1.926 SEE = .0092387

5. REVISED FUEL EFFICIENCY, VEHICLE MILES, AND FUEL CONSUMPTION ESTIMATES

This revision was a very important step in improving the model, especially from a policy analysis viewpoint. New data and procedures have yielded significantly different relationships and historical estimates, representing substantial improvements over the previous versions.

5.1 ACTUAL "ON-ROAD" NEW CAR MPG

5.1.1 Cross-Section Equations

The first important point was the addition of more observations from CONSUMER REPORTS test data. This brought the total number of observations to 829 and updated the ending-period from the 1975 to 1978 models.

As discussed in the draft final report on the Automobile Model,[1/] there was a change in the CONSUMER REPORTS test procedure in 1967, making subsequent tests non-comparable with the 1950-66 period. This caused consistency problems when using the original cross-section results to estimate mpg's over time because a substantial drop was observed in 1967 compared to 1966.

This was compensated for by a dummy variable shift, reducing the 1950-66 results to a level comparable to the later values. The question is whether the test procedure change also changed the significance of the different factors insofar as they affect measured MPG. Since we feel the post-1966 procedure is more representative of driving conditions and thus yields better mpg estimates, we addressed this issue by estimating the cross-section equation from 1967 to 1977 only. This is also important from the point of view of yielding more accurate forecast results, since the modern sample of cars is more complete, and more likely to reflect today's engineering and usage characteristics than the vehicles of the 1950s.

[1/] Schink and Loxley, Vol. III, Appendix A1.

The results of this change in the sample period are dramatic and quite significant. The statistical results are presented in Table 5-1. These can be contrasted with the previous results.[1/] The outstanding change is the increase in the importance of inertial weight. The new city mpg function has a weight elasticity of 0.74 compared to only 0.47 in the original function. Hence the estimated increase in city mpg for a given weight reduction is 50 percent greater. Similarly, the highway mpg weight factor has increased 50 percent, from 0.32 to 0.50. The obvious implication is that a given projected "downsizing" program will now tend to yield higher projected mpg's.

The increased role of weight is accompanied by a reduction in the importance of displacement, from 0.192 to 0.091 for city, and from 0.172 to 0.072 for highway, both reductions of over 50 percent. The effects of automatic transmissions are now estimated to be greater. On the average, the coefficients are almost 50 percent greater. The impacts of the number of cylinders show less dramatic changes, although the mpg gain from a six-cylinder versus an eight-cylinder does increase quite significantly. An overdrive is found to have a much smaller effect and is less statistically significant.

The annual shift-dummies are now also completely revamped. First, there are, of course, no dummies for the pre-1967 period. Secondly, the shifts are expressed relative to the 1978 models. Hence, going backwards for MPGC, we see that unaccounted-for technical and other factors resulted in an improvement of 1.5 percent from 1976 to 1977, with an almost 4 percent gain in 1976 over 1975. Thus, the 1975-77 period reverses the 1970-74 deterioration, which is essentially the same pattern as previously estimated. For MPGH, the previous results implied a deterioration from 1967 to 1972, with no change through 1975. Now we estimate that 1977 is substantially improved over 1976, which, in turn, is slightly improved over 1975.

Finally, we note that the statistical strength of the equations is virtually equivalent to the previous estimates.

1/ Schink and Loxley, Table A1-9.

TABLE 5-1. "ON-ROAD" NEW CAR MPG CROSS-SECTION EQUATIONS

NOTES

1. Sample represents all the automobile test reports from Consumer Reports magazine since 1967, ordered by date.

2. Definitions

USCURB = Curb weight of vehicle, lbs.

USDISP = Engine displacement, cu. inches.

USFAUTO = If transmission is automatic = 1, otherwise 0.

USFOD = If equipped with overdrive (or 5th gear) = 1, otherwise 0.

USF4CYL = If four-cylinder (or less) = 1, otherwise 0.

USF6CYL = If six-cylinder (or 5 or 7) = 1, otherwise 0.

USMPGC = Miles per gallon, city driving.

USMPGH = Miles per gallon, highway driving.

TABLE 5-1. "ON-ROAD" NEW CAR MPG CROSS-SECTION EQUATIONS (continued)

PERIOD: 421 829 (CROSS-SECTION) EQUATION FOR: USMPGC

ln(USMPGC) = 9.04509 (24.51)			
-.740379 (12.30)	ln(USCURB + 300)		
-.0905355 (2.69)	ln(USDISP)		
-.0458839 (2.91)	USFAUTO		
+.0914353 (3.44)	USF4CYL		
+.0688648 (4.34)	USF6CYL		
-.0799698 (3.46)	DUM67	-.0930797 (4.10)	DUM68
-.110071 (5.18)	DUM69	-0.866427 (3.60)	DUM70
-.106055 (4.80)	DUM71	-.105254 (4.43)	DUM72
-.117946 (5.45)	DUM73	-.119611 (5.08)	DUM74
-.0919969 (4.10)	DUM75	-.0552999 (2.46)	DUM76
-.0409391 (1.79)	DUM77		

$\bar{R}^2$ = .910 DW = 1.758 SEE = .09485

TABLE 5-1. "ON-ROAD" NEW CAR MPG CROSS-SECTION EQUATIONS (continued)

PERIOD: 421 784 (CROSS-SECTION) EQUATION FOR: USMPGH

ln(USMPGH) = 7.70345 (21.93)			
-.503006 (8.78)	ln(USCURB + 300)		
-.0715531 (2.24)	ln(USDISP)		
-.0962245 (6.28)	USFAUTO		
+.0494731 (1.72)	USFOD		
+.0872273 (3.45)	USF4CYL		
+.0524127 (3.47)	USF6CYL		
-.104086 (4.68)	DUM67	-.0783148 (3.60)	DUM68
-.0959355 (4.71)	DUM69	-.0811325 (3.51)	DUM70
-.107545 (5.05)	DUM71	-.116785 (5.13)	DUM72
-.134663 (6.49)	DUM73	-.101515 (4.47)	DUM74
-.135781 (6.31)	DUM75	-.119244 (5.56)	DUM76
-.048464 (2.22)	DUM77		

$\bar{R}^2$ = .883 DW = 1.643 SEE = .090299

5.1.2 Time-Series Estimated Values

The new historical estimates for mpg by class are presented in Table 5-2. These were generated using the model-specific characteristics data and the previously developed programs USDOMB and USFORB. These generate the individual model mpg estimates using the parameters from Table 5-1, and generate the sales-weighted mpgs and characteristics by size-class.

Compared to the previous estimates, we note the largest changes in the city estimates; the highway values, in general, show less variation from the "old" values. The most obvious change in the city mpg's is that most are significantly lower than before for the 1958-66 period, then become greater from 1967 on, with some showing lower values for 1974. In addition, the new values now exist through 1976.

5.1.3 Time-Series MPG Equations

The same "stacked" regression technique as described in the earlier report is used to estimate the time-series equations for miles per gallon for city and highway driving.[1/] Our estimates of mpg by class are regressed on the class-average inertial weight, engine displacement, transmission type, and fraction of the class with four- or six-cylinders. The equations are run across all classes over the period 1954-76.[2/] The results are presented in Table 5-3.

[1/] Schink and Loxley, paragraph A2.4.3.

[2/] Except domestic subcompacts, whose period is 1958-76, as none were sold in the earlier period.

TABLE 5-2. MPG ESTIMATES BY CLASS

	USSDMPGC	USSFMPGC	USCDMPGC	USCFMPGC	USMDMPGC	USFDMPGC	USLDMPGC	USLFMPGC
1958	13.5	19.1	11.8	17.1	9.93	8.56	8.11	13.7
1959	13.9	19.6	12.5	16.6	9.78	9.05	7.94	13.7
1960	14.2	19.6	13.3	16.7	9.90	9.14	7.97	13.9
1961	14.2	19.9	13.5	16.6	10.4	9.35	8.06	14.0
1962	14.3	19.8	13.2	16.3	10.8	9.27	8.07	13.5
1963	14.2	19.9	13.4	16.2	10.9	9.33	8.12	13.3
1964	14.2	19.9	12.9	15.8	10.8	9.32	8.01	13.4
1965	14.4	19.8	12.8	16.3	10.9	9.18	7.99	13.2
1966	14.2	18.6	12.4	16.0	10.5	9.05	7.92	13.0
1967	14.1	18.2	11.7	15.5	10.3	8.92	7.96	12.8
1968	13.9	17.5	11.4	14.9	9.86	8.72	7.80	12.7
1969	13.5	17.3	11.1	14.1	9.62	8.39	7.64	12.5
1970	15.7	17.4	11.5	14.3	9.67	8.60	7.77	12.8
1971	15.6	16.8	11.2	14.0	9.29	8.18	7.49	12.4
1972	15.3	16.7	11.0	14.1	9.05	8.08	7.48	11.9
1973	14.5	16.1	10.5	13.9	8.62	7.85	7.28	11.6
1974	13.5	15.7	10.4	13.6	8.39	7.71	7.17	11.5
1975	13.3	15.6	10.6	13.6	8.66	7.86	7.38	11.0
1976	14.2	16.3	10.8	13.9	9.01	8.23	7.68	11.9

	USSDMPGH	USSFMPGH	USCDMPGH	USCFMPGH	USMDMPGH	USFDMPGH	USLDMPGH	USLFMPGH
1958	25.0	32.9	22.6	30.0	19.6	17.2	16.6	25.1
1559	25.3	33.3	23.6	29.2	19.3	18.1	16.4	25.1
1960	25.6	33.2	24.5	29.3	19.5	18.3	16.4	25.3
1961	25.5	33.6	24.6	29.1	20.1	18.6	16.5	25.5
1962	25.7	33.4	24.1	28.6	20.6	18.4	16.5	24.8
1963	25.7	33.5	24.3	28.4	20.9	18.5	16.6	24.5
1964	25.6	33.4	23.6	27.9	20.6	18.4	16.4	24.6
1965	25.7	33.3	23.4	28.6	20.6	18.2	16.4	24.3
1966	25.4	31.7	22.8	28.1	20.1	18.0	16.3	24.0
1967	25.1	31.0	21.8	27.5	19.7	17.7	16.3	23.7
1968	25.7	31.2	22.1	27.6	19.7	18.0	16.7	24.3
1969	25.0	30.7	21.5	26.4	19.2	17.4	16.3	23.9
1970	28.4	30.7	22.1	26.6	19.3	17.7	16.5	24.2
1971	28.2	29.6	21.4	25.7	18.4	16.9	15.8	23.2
1972	27.2	29.1	20.7	25.5	17.9	16.6	15.7	22.4
1973	25.9	28.0	19.9	25.0	17.2	16.1	15.2	21.7
1974	25.5	28.4	20.5	25.5	17.5	16.4	15.6	22.3
1975	23.8	26.9	19.7	24.2	16.9	15.8	15.1	20.6
1976	24.8	27.5	19.7	24.3	17.3	16.2	15.4	21.6

All the coefficients are very close to the cross-section results of Table 5-1 except for the overdrive dummy coefficient for highway mpg, which declines in magnitude. The time dummies are entered somewhat differently from before. First, we had complete new registrations data through 1976, making 1976 the "base year." There is, of course, just one dummy for the 1954-67 period, as 1954-66 was outside the cross-sectional range. The implication is that there may be some mpg variations over the period prior to 1967 which we fail to capture or estimate. This is a less serious error than distorting the recent estimates. First, the effect on cost per mile is very small since gas prices were so low; second, the effect on today's average fleet mpg is small since few of these cars remain in the current fleet.

These new time-series equations for new car mpg will, therefore, be used as inputs for the projection of average fuel economy, fuel consumption, and costs. As discussed in the preceding sections, we feel that these are a significant improvement for forecasting purposes over the previous versions.

The simulation properties of the model with respect to costs will remain virtually unchanged (except for re-estimation of the other model equations), but the implications of "down-sizing" programs will be altered.

TABLE 5-3. "ON-ROAD" NEW CAR MPG TIME-SERIES EQUATIONS

NOTES

1. Time Series data pooled for all classes so that parameter estimates are equal across classes.

2. Definitions:

   Same as Table 5-1, except that values are differentiated by size-class (sc) and the transmission and cylinder variables become class-average fractions as opposed to 0, 1 values.

TABLE 5-3. "ON-ROAD" NEW CAR MPG TIME-SERIES EQUATIONS (continued)

PERIOD: 1804 1983 ("Stacked") EQUATION FOR: USscMPGC

$$
\begin{aligned}
\ln(\text{USscMPGC}) = {} & 8.79422 \\
& (763.72) \\
& -.708042 \ \ln(\text{USscCURB} + 300) \\
& (419.34) \\
& -.104531 \ \ln(\text{USscDISP}) \\
& (84.59) \\
& -.043773 \ \text{USscFAUTO} \\
& (40.19) \\
& +.101089 \ \text{USscF4CYL} \\
& (74.49) \\
& +.077773 \ \text{USscF6CYL} \\
& (100.31) \\
& -.0195994 \ \text{DUM54.67} \\
& (33.10) \\
& -.0341061 \ \text{DUM68} \\
& (44.83) \\
& -.0523216 \ \text{DUM69} \\
& (68.96) \\
& -.0271107 \ \text{DUM70} \\
& (35.65) \\
& -.0497434 \ \text{DUM71} \\
& (65.80) \\
& -.050513 \ \text{DUM72} \\
& (66.80) \\
& -.0616569 \ \text{DUM73} \\
& (82.00) \\
& -.0661044 \ \text{DUM74} \\
& (88.49) \\
& -.0378813 \ \text{DUM75} \\
& (50.86)
\end{aligned}
$$

$\bar{R}^2 = 1.000$ DW = 0.882 SEE = .0014892

TABLE 5-3. "ON-ROAD" NEW CAR MPG TIME-SERIES EQUATIONS (continued)

PERIOD: 1804 1983 ("Stacked") EQUATION FOR: USscMPGH

ln(USscMPGH) =	7.32046	
	(483.77)	
	-.4555344	ln(USscCURB + 300)
	(208.96)	
	-.0960381	ln(USscDISP)
	(66.81)	
	-.0928698	USscFAUTO
	(60.23)	
	+.0265435	USscFOD
	(6.02)	
	+.0902538	USscF4CYL
	(56.96)	
	+.0675721	USscF6CYL
	(71.32)	
	+.0195245	DUM54.67
	(28.35)	
	+.0430605	DUM68
	(48.65)	
	+.02343	DUM69
	(26.54)	
	+.0423952	DUM70
	(47.92)	
	+.0124861	DUM71
	(14.18)	
	-.00252479	DUM72
	(2.86)	
	-.0156823	DUM73
	(17.9)	
	+.162128	DUM74
	(18.65)	
	-.0185684	DUM75
	(21.43)	

$\bar{R}^2 = 1.000$ DW = 0.708 SEE = .0017324

5.2 EPA MPG ESTIMATES

Since fuel economy is a major policy concern, and average fuel economy regulations are stated in terms of the EPA test results, any improvement in the consistency and accuracy with which EPA-based mpg values are projected directly contributes to the model's usefulness for policy analysis. To this end, an initial exploration of a new methodology has been performed.

5.2.1 Cross-Section Equations

In the first version of the model, EPA values were linked to the CONSUMER REPORTS mpg values for that sample for which both data sets were available. This straightforward linkage, based on 50 observations for 1975-76, clearly showed the higher level of the EPA values, but indicated that the rates of change were quite similar, i.e., the elasticities were close to unity.

This approach has some weaknesses. First, the sample is quite small and covers only two years. (In 1975 there was a definite shift in the relationship.) Second, these pooled cross-section results were applied to the time-series domain with no means to adjust them. Third, this is a pure correlation technique with no substantive behavioral basis. It is not at all clear that the EPA values necessarily have any consistent, stable relationship with "on the road" mpg results.

As an initial step in resolving these problems, our substantially increased EPA sample (94 observations) was used to estimate functions equivalent in specification to the mpg equations. Hence, EPA city and highway mpg estimates were expressed as functions of inertial weight, displacement, etc.

Some preliminary results are presented in Table 5-4. The general result is that inertial weight dominates all other factors. The displacement, transmission, and cylinder variables are much less significant. For city EPA-mpg the weight elasticity is quite similar to the "on the road" mpg value: -.718 for the "EPA"-MPGC vs. -.704 for "road"-MPGC. All other factors are much less important and statistically weak except for a combined four- and six-cylinder dummy. Each taken individually was weak.

For highway mpg the displacement and transmission variables are more significant and closer in magnitude to the CONSUMER REPORTS-based results. The inertial weight coefficient, however, is much larger in all versions and greater than the city value. This is, therefore, a somewhat "perverse" result, since previous experimentations with the road-test mpg results always indicated weight as a less significant factor for highway relative to city.

The final statistical result of interest was the presence of a very significant shift from the 1975 EPA test results, far too large to be a random sample characteristic. The inclusion of a 1976 dummy for completeness shows that there was little significant change from 1977. There is a question here of whether the difference between 1975 and 1976-77 is a characteristic of the vehicles or a function of the test. If there were design changes which resulted in a higher EPA rating (without necessarily affecting "on-road" efficiency) these could conceivably occur in the future.

This analysis could fairly readily be extended and developed by cross-classifying all of the models for which we have vehicle characteristics data with their corresponding EPA test results. So far we have operated only with that sub-sample with CONSUMER REPORTS test results.

TABLE 5-4. EPA FUEL ECONOMY CROSS-SECTION EQUATIONS

NOTES

1. Sample of 94 vehicles tested by both Consumer Reports and the EPA with the same physical characteristics (weight, engine, transmission) during 1975-1977.

2. Definitions:

EPAMPGC = EPA City fuel economy rating
EPAMPGH = EPA Highway fuel economy rating

For other variables, see Table 5-1.

TABLE 5-4. EPA FUEL ECONOMY CROSS-SECTION EQUATIONS (continued)

PERIOD: 1 129 (CROSS-SECTION) EQUATION FOR: EPAMPGC

$$
\begin{aligned}
\ln(\text{EPAMPGC}) = {} & 8.87629 \\
& (11.03) \\
& -.672314 \ \ln(\text{USCURB} + 300) \\
& (5.11) \\
& -.0863008 \ \ln(\text{USDISP}) \\
& (1.27) \\
& -.0250634 \ \text{USFAUTO} \\
& (0.72) \\
& -.175748 \ \text{DUM75} \\
& (5.81) \\
& -.0635194 \ \text{DUM76} \\
& (2.12) \\
& -.0436081 \ \text{DUM77} \\
& (1.43) \\
& +.0546627 \ (\text{USF4CYL} + \text{USF6CYL}) \\
& (1.59)
\end{aligned}
$$

$\bar{R}^2 = .818$ DW = 1.979 SEE = .11560

TABLE 5-4. EPA FUEL ECONOMY CROSS-SECTION EQUATIONS (continued)

PERIOD: 1 129 (CROSS-SECTION) EQUATION FOR: EPAMPGH

$$\begin{aligned}\ln(\text{EPAMPGH}) = {} & 9.78247 \\ & (15.40) \\ & -.728616 \ \ln(\text{USCURB} + 300) \\ & (6.89) \\ & -.0946762 \ \ln(\text{USDISP}) \\ & (1.86) \\ & -.0772882 \ \text{USFAUTO} \\ & (2.79) \\ & -.152686 \ \text{DUM75} \\ & (6.30) \\ & -.0647022 \ \text{DUM76} \\ & (2.68) \\ & -.0362308 \ \text{DUM77} \\ & (1.49)\end{aligned}$$

$\bar{R}^2 = .890$ DW = 1.977 SEE = .092939

5.2.2 Time-Series Estimated Values

The EPA values were generated over time in exactly the same manner as the "road-test" mpg's. Thus, these values are consistent aggregates built up from specific model estimates and appropriately sales-weighted. These estimates for 1958-76 are presented in Table 5-5. Note that in performing this "back-casting" we have no historical basis for evaluating time-shift dummies. These are, therefore, excluded from the estimates. The values appear to be consistent with the "road-test" mpg estimates presented in Table 5-2. They are consistently higher throughout, especially for city, and have similar overall trends and fluctuations from year to year.

5.2.3 Time-Series EPA-MPG Equations

Again, we proceeded as in the "road-test" mpg case, performing a "stacked" regression on the EPA-MPG annual class estimates. The only notable feature was that the 4 and 6 cylinder dummy became very weak in the time-series domain. Otherwise, the principal coefficients were robust and changed very little. (See Table 5-6.)

An alternative set of equations was also estimated expressing the time series EPA estimates as a function of the "on-road" estimates individually for each class, city and highway. For the EPA city ratings, the elasticities range from 0.84 (domestic sub-compacts) to 0.66 (domestic compacts), suggesting that city EPA ratings will tend to rise slightly less rapidly than the WEFA "on-road" mpg projections. The converse is true for the highway ratings, where the elasticities range from 0.93 (domestic luxury) to 1.25 (foreign sub-compact), with the foreign classes having noticeably higher elasticities.

TABLE 5-5. EPG-MPG ESTIMATES BY CLASS

	EPASCMPGC	EPASFMPGC	EPACDMPGC	EPACFMPGC	EPAMDMPGC	EPAFDMPGC	EPALDMPGC	EPALFMPGC
1958	19.6	25.6	17.2	23.1	15.5	14.0	13.3	19.3
1959	20.1	26.3	18.2	22.5	15.3	14.4	13.0	19.3
1960	20.4	26.2	19.2	22.6	15.3	14.5	13.1	19.6
1961	20.5	26.6	19.5	22.5	16.1	14.8	13.2	19.8
1962	20.5	26.5	19.2	22.2	16.7	14.8	13.3	19.1
1963	20.4	26.6	19.6	22.1	17.0	14.9	13.3	19.0
1964	20.4	26.6	19.3	22.0	16.9	15.0	13.2	19.1
1965	20.7	26.6	19.3	22.3	17.0	14.8	13.2	18.8
1966	20.5	25.1	18.8	21.9	16.7	14.7	13.1	18.5
1967	20.3	24.8	18.1	21.3	16.4	14.6	13.1	18.4
1968	20.3	24.2	17.8	20.7	16.1	14.5	13.1	18.5
1969	20.1	24.3	17.7	20.1	16.0	14.2	13.1	18.5
1970	22.4	23.8	17.9	19.9	15.8	14.2	13.0	18.6
1971	22.9	23.7	17.7	20.0	15.5	13.8	12.8	18.4
1972	22.2	23.6	17.5	20.1	15.2	13.7	12.8	17.8
1973	21.3	23.0	17.2	20.1	14.7	13.5	12.6	17.6
1974	20.0	22.5	16.8	19.7	14.3	13.3	12.4	17.5
1975	19.4	21.9	16.5	19.3	14.3	13.1	12.4	16.3
1976	19.8	21.9	16.2	18.9	14.3	13.2	12.5	16.9

	EPASCMPGH	EPASFMPGH	EPACDMPGH	EPACFMPGH	EPAMDMPGH	EPAFDMPGH	EPALDMPGH	EPALFMPGH
1958	29.1	40.7	25.2	35.9	22.1	19.3	18.2	28.8
1959	29.9	41.7	26.8	34.7	21.7	20.1	17.8	28.6
1960	30.4	41.6	28.5	34.9	21.8	20.3	17.9	29.1
1961	30.4	42.4	28.9	34.6	22.9	20.8	18.1	29.4
1962	30.6	42.2	28.3	34.0	23.8	20.7	18.1	28.3
1963	30.5	42.3	28.8	33.7	24.3	20.9	18.3	28.1
1964	30.5	42.2	28.2	33.2	24.1	20.9	18.0	28.3
1965	30.9	42.1	28.2	34.0	24.2	20.6	18.0	27.8
1966	30.5	39.3	27.3	33.3	23.7	20.4	17.8	27.3
1967	30.0	38.5	26.1	32.2	23.2	20.1	17.9	27.0
1968	30.0	37.5	25.6	31.2	22.6	20.0	17.8	27.1
1969	29.6	37.7	25.4	30.2	22.5	19.5	17.8	27.2
1970	33.7	36.7	25.6	29.8	22.0	19.5	17.6	27.1
1971	34.6	36.5	25.4	29.7	21.7	19.0	17.4	26.7
1972	33.4	36.2	24.9	29.9	21.1	18.8	17.3	25.8
1973	31.8	35.0	24.3	29.9	20.3	18.4	17.0	25.3
1974	24.7	34.2	23.7	29.2	19.8	18.1	16.8	25.2
1975	28.6	33.1	23.4	28.5	19.8	18.0	16.9	23.4
1976	24.4	33.2	23.0	27.9	19.8	18.1	16.9	24.3

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS

PERIOD: 1804 1983 ("Stacked")   EQUATION FOR: EPAscMPGC

ln(EPAscMPGC)	=	8.9608	
		(1114.11)	
		-.71445	ln(USscCURB + 300)
		(604.53)	
		-.0465158	ln(USscDISP)
		(84.64)	
		-.0256142	USscFAUTO
		(37.43)	
		+.00242464	(USscF4CYL + USscF6CYL)
		(5.09)	

$\bar{R}^2$ = 1.000   DW = 0.529   SEE = .0011622

NOTES

See Table 5-3.

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

PERIOD: 1804 1983 ("Stacked") EQUATION FOR: EPAscMPGH

$$
\begin{aligned}
\ln(\text{EPAscMPGH}) = {} & 9.99235 \\
& (1144.22) \\
& -.764203 \ \ln(\text{USscCURB} + 300) \\
& (552.90) \\
& -.0873399 \ \ln(\text{USscDISP}) \\
& (153.31) \\
& -.0770642 \ \text{USscFAUTO} \\
& (95.12)
\end{aligned}
$$

$\bar{R}^2 = 1.000$ DW = 0.631 SEE = .0013769

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPASDMPGC

$$
\begin{aligned}
\ln(\text{EPASDMPGC}) = \; & .75617 \\
& (14.7075) \\
+ \; & .839965 \quad \ln(\text{USSDMPGC}) \\
& (43.4986) \\
+ \; & .0186308 \quad \text{DUM68.74} \\
& (9.59647) \\
+ \; & .0340384 \quad \text{DUM60.75} \\
& (8.67363)
\end{aligned}
$$

$\bar{R}^2$ = .993 DW = 1.941 SEE = .0037415

PERIOD: 1960 1976 EQUATION FOR: EPASDMPGH

$$
\begin{aligned}
\ln(\text{EPASDMPGH}) = \; & -.0325570 \\
& (-1.86645) \\
+ \; & 1.06312 \quad \ln(\text{USSDMPGH}) \\
& (19.7768) \\
+ \; & .0277984 \quad \text{DUM71.75} \\
& (5.20619)
\end{aligned}
$$

$\bar{R}^2$ = .968 DW = 1.758 SEE = .0091250

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPASFMPGC

$$\ln(\text{EPASFMPGC}) = \underset{(19.6699)}{.867674} + \underset{(50.5836)}{.795257}\ \ln(\text{USFMPGC}) + \underset{(6.89693)}{.0192611}\ \text{DUM68.74} + \underset{(7.36274)}{.0358933}\ \text{DUM60.75}$$

$\bar{R}^2 = .997$ DW = 2.274 SEE = .0040875

PERIOD: 1960 1976 EQUATION FOR: EPASFMPGH

$$\ln(\text{USSFMPGH}) = \underset{(5.56803)}{-.628597} + \underset{(38.155)}{1.2456}\ \ln(\text{USSFMPGH}) + \underset{(5.96271)}{.0345271}\ \text{LUM71.75} - \underset{(4.98289)}{.0212565}\ \text{DUM68.72}$$

$\bar{R}^2 = .992$ DW = 2.515 SEE = .0077535

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPACDMPGC

$$\ln(EPACDMPGC) = \underset{(13.5291)}{1.21933} + \underset{(17.5021)}{.660108}\ \ln(USCDMPGC) + \underset{(2.44753)}{.0172332}\ DUM68.74 + \underset{(3.88565)}{.044506}\ DUM60.75$$

$\bar{R}^2$ = .976 DW = 1.042 SEE = .0095326

PERIOD: 1960 1976 EQUATION FOR: EPACDMPGH

$$\ln(EPACDMPGH) = \underset{(.0423714)}{-.00731691} + \underset{(19.0606)}{1.05483}\ \ln(USCDMPGH) + \underset{(2.40351)}{.0235889}\ DUM71.75$$

$\bar{R}^2$ = .968 DW = 1.292 SEE = .013904

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPACFMPGC

$$
\begin{aligned}
\ln(\text{EPACFMPGC}) = \; & \underset{(10.3579)}{.870576} \\
+ \; & \underset{(24.7031)}{.786504} \; \ln(\text{USCFMPGC}) \\
+ \; & \underset{(3.1703)}{.0154536} \; \text{DUM68.74} \\
+ \; & \underset{(4.32632)}{.0345672} \; \text{DUM60.75}
\end{aligned}
$$

$\bar{R}^2 = .988$ DW = 1.429 SEE = .006492

PERIOD: 1960 1976 EQUATION FOR: EPACFMPGH

$$
\begin{aligned}
\ln(\text{EPACFMPGH}) = \; & \underset{(4.55843)}{-.60291} \\
+ \; & \underset{(30.8666)}{1.23084} \; \ln(\text{USCFMPGH}) \\
+ \; & \underset{(6.32022)}{.036619} \; \text{DUM71.75} \\
- \; & \underset{(7.19302)}{.030901} \; \text{DUM68.72}
\end{aligned}
$$

$\bar{R}^2 = .989$ DW = 2.431 SEE = .0077788

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPAMDMPGC

$$\ln(EPAMDMPGC) = \underset{(10.1195)}{1.01673} + \underset{(16.4476)}{.746457}\ \ln(USMDMPGC) + \underset{(3.81939)}{.0307597}\ DUM68.74 + \underset{(2.14165)}{.029136}\ DUM60.75$$

$\bar{R}^2$ = .965 DW = .738 SEE = .011697

PERIOD: 1960 1976 EQUATION FOR: EPAMDMPGH

$$\ln(EPAMDMPGH) = \underset{(1.13673)}{-.220931} + \underset{(17.1862)}{1.12223}\ \ln(USMDMPGH) + \underset{(2.9774)}{.0319917}\ DUM71.75$$

$\bar{R}^2$ = .963 DW = 1.014 SEE = .014219

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPAFDMPGC

$$\ln(EPAFDMPGC) = \underset{(15.4261)}{1.03422} + \underset{(23.1843)}{.734198}\ \ln(USFDMPGC) + \underset{(23.1843)}{.0212215}\ DUM68.74 + \underset{(4.74227)}{.0305917}\ DUM60.75$$

$\bar{R}^2$ = .983 DW = .898 SEE = .0056937

PERIOD: 1960 1976 EQUATION FOR: EPAFDMPGH

$$\ln(EPAFDMPGH) = \underset{(.83438)}{-.169271} + \underset{(15.5698)}{1.09914}\ \ln(USFDMPGH) + \underset{(2.5277)}{.0207295}\ DUM71.75$$

$\bar{R}^2$ = .96 DW = .010245 SEE = 1.576

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPALDMPGC

$$
\begin{aligned}
\ln(\text{EPALDMPGC}) = \; & 1.13310 \\
& (20.4146) \\
+ \; & .682056 \quad \ln(\text{USLDMPGC}) \\
& (25.0795) \\
+ \; & .0163928 \quad \text{DUM68.74} \\
& (7.45137) \\
+ \; & .0268858 \quad \text{DUM60.75} \\
& (8.38753)
\end{aligned}
$$

$\bar{R}^2$ = .986 DW = 2.13 SEE = .0026944

PERIOD: 1960 1976 EQUATION FOR: EPALDMPGH

$$
\begin{aligned}
\ln(\text{EPALDMPGH}) = \; & .287942 \\
& (.8896) \\
+ \; & .928007 \quad \ln(\text{USLDMPGH}) \\
& (8.0031) \\
+ \; & .0124902 \quad \text{DUM71.75} \\
& (1.48302)
\end{aligned}
$$

$\bar{R}^2$ = .866 DW = 1.683 SEE = .010282

TABLE 5-6. EPA FUEL ECONOMY TIME-SERIES EQUATIONS (continued)

ALTERNATE EQUATIONS

PERIOD: 1960 1976 EQUATION FOR: EPALFMPGC

$$
\begin{aligned}
\ln(\text{EPALFMPGC}) = {} & \underset{(13.8482)}{.9308} \\
& + \underset{(28.3319)}{.76542} \; \ln(\text{USLFMPGC}) \\
& + \underset{(6.47122)}{.0242815} \; \text{DUM68.74} \\
& + \underset{(4.39137)}{.02696931} \; \text{DUM60.75}
\end{aligned}
$$

$\bar{R}^2 = .986$ DW = 1.992 SEE = .0059889

PERIOD: 1960 1976 EQUATION FOR: EPALFMPGH

$$
\begin{aligned}
\ln(\text{EPALFMPGH}) = {} & \underset{(1.5393)}{-.255111} \\
& + \underset{(21.5081)}{1.12078} \; \ln(\text{USLFMPGH}) \\
& + \underset{(3.06599)}{.0221382} \; \text{DUM71.75}
\end{aligned}
$$

$\bar{R}^2 = .977$ DW = 1.876 SEE = .0095359

5.3 VEHICLE MILES

In respecifying the vehicle miles relationships, we decided to view this as a utilization of the automobile stock and to attempt to estimate rural and urban mileage separately, since they are presumed to be for different purposes

The estimation results for urban miles per vehicle and rural miles per vehicle are presented in Table 5-7. Also included for comparison purposes is a total miles per vehicle equation. There is a marked difference in the past trends between urban and rural driving. Urban miles per vehicle have risen continuously since 1963 except for the 1974 decline.[1/] Rural mileage is much more erratic, with an overall downward trend, interrupted by growth from 1967 to 1971, and a 3 percent increase in 1976.

Urban driving is a function of the real gasoline cost per mile in 1972 dollars (using the city fleet average fuel economy); real disposable income per capita (excluding certain transfers) in the form of a weighted sum over three years; and licensed drivers per vehicle, weighted by the percent of the population in metropolitan areas. All variables are highly significant and the fit is very good.[2/] Obviously, one expects that "ceteris paribus" the more drivers per vehicle, the more intensively that vehicle will be used. Since only urban driving is the dependent variable, urban population should also have positive effect. Due to the presence of multicollinearity between income, licensed drivers, and urban population, the latter was used to weight the licensed drivers term.

Rural driving has a very different behavior pattern. The marked similarit is in the real gas cost per mile term (using the highway fleet average mpg), where the price elasticity, allowing for the higher fuel economy, is virtually

---

[1/] The pre-1963 mileage estimates are unrevised, while the FHA substantially revised the 1963 data.

[2/] Interestingly, 1973-74 are estimated very closely, and a dummy variable is neither indicated nor significant.

the same as for urban driving, 0.355 versus 0.371 for the latter. The number of drivers per car has a larger impact upon rural driving. Since the stock per driver has slowly risen, this clearly indicates that rural driving grows less than proportionately to the stock of cars.[1/] Income itself was found to be weak as an explanatory variable. Instead, both income distribution and total interstate road mileage were found to be the appropriate explanatory variables.

[1/] If the auto stock were to rise at the same rate as licensed drivers, rural miles would increase at the same rate; if the stock grows more rapidly, rural miles will increase at a slower rate than licensed drivers.

TABLE 5-7. VEHICLE MILES EQUATIONS

NOTES

1. Definitions:

AVMPGCVINT	=	Average fleet city fuel economy, WEFA estimate
AVMPGHVINT	=	Average fleet highway fuel economy, WEFA estimate
KMID	=	Mid-year stock of cars in operation
LDMV	=	Licensed drivers
NPMET	=	Percent of population in SMSAs
PC	=	Overall consumer price index, 1967=100
PURG	=	Gasoline price in cents per gallon
VMT/K	=	Total vehicle miles per mid-year stock of cars
VMTU*/K	=	Urban vehicle miles per mid-year stock of cars
VMTR*/K	=	Rural vehicle miles per mid-year stock of cars
YPDNET/NPT	=	Real disposable income per capita, less taxes and certain transfer payments[1/]

2. Identities:

(VMTR*/K + VMTU*/K) * KMID = VMTMVA-MC

= Total automobile vehicle miles

[1/] This is a Wharton EFA Annual Model variable.

TABLE 5-7. VEHICLE MILES EQUATIONS (continued)

PERIOD: 1960 1976 EQUATION FOR: VMTU*/K

$$
\begin{aligned}
(VMTU^*/K) = & -1.43792 \\
& (2.30747) \\
& -.371407 \ \ln(PURG/100 \ / \ AVMPGCVINT) \ / \ (PC/125.3) \\
& (7.76729) \\
& +.298117 \ \ln(NPMET * LDMV \ / \ KMID) \\
& (2.32539) \\
& +.61974 \ \ln(.25 * Y + .5 * Y(-1) + .25 * Y(-2)) \\
& (19.9262)
\end{aligned}
$$

$\bar{R}^2 = .988$ DW = 2.618 SEE = .010656

Comments:

Y = YPDNET / NPT

TABLE 5-7. VEHICLE MILES EQUATIONS (continued)

PERIOD: 1960 1976

EQUATION FOR: VMTR*/K

$$\ln(VMTR^*/K) = \underset{(1.73)}{-1.945592}$$

$$\underset{(3.78)}{-.355343} \ \ln(PURG/100 \ / \ AVMPGHVINT) \ / \ (PC/125.3)$$

$$\underset{(3.19)}{+2.05965} \ \ln(LDMV \ / \ KMID)$$

$$\underset{(2.27)}{+.192317} \ \ln(PER+15)$$

$$\underset{(1.95)}{+.216018} \ \ln(RWMMVI \ / \ KMID)$$

$\bar{R}^2 = .851$ DW = 2.789 SEE = .016262

TABLE 5-7. VEHICLE MILES EQUATIONS (continued)

PERIOD: 1960 1976 EQUATION FOR: VMT/K

ln(VMT/K) = -.170944
(.73)

-.456065 ln(PURG/100 / AVMPGVINT) / (PC/125.3)
(11.41)

+1.08055 ln(LDMV / KMID)
(5.88)

+.564765 ln(.25 * Y + .5 * Y(-1) + .25 * Y(-2))
(11.64)

$\bar{R}^2$ = .971 DW = 1.93 SEE = .007338

5.4 FUEL CONSUMPTION

Given the estimation of mpg's by class by year for new automobiles, the elements required for a consistent aggregation to yield an average fuel efficiency for the entire stock of vehicles in operation are:

- stock by class by vintage
- miles per vehicle by vintage
- estimates projected back to 1925 to derive initial stock values and mpg averages for 1954.

The first simplifying assumption is that fuel economy does not change as a given vehicle ages. This is, of course, improbable, but the nature of the likely decay function is unknown and involves many factors. Secondly, we assume equal scrappage rates by vintage across classes. Again, this may not be accurate, but the "true" rates are not known, only an overall estimate.

The initial sequence is unchanged from the previous study. First, we estimate stocks by class by vintage, 1954-1975, using new registrations by class from 1925 on and common year to year survival probabilities. We then compute the average mpg for each vintage as a weighted (harmonic) mean of the class mpg's where the shares by class in the stock are the weights. At the same time, city and highway mpg's are averaged using the urban-highway mileage split appropriate to each time period. This yields variables labeled AVTTMPGi, where i = 00, 01,...,20 for the twenty-year vehicle life assumed.

Theoretically, in order to get total fuel consumption (gallons), we should now compute:

$$\sum_{i=00}^{20} KVi * (\frac{M}{K})i * (\frac{1}{AVTTMPGi})$$

Unfortunately, of course, there is no reason for the above identity to yield values equal to the official FHA fuel consumption by autos statistics. Each of the three terms is strictly unknown and therefore estimated with error. However, both KVi and AVTTMPGi are systematically and consistently derived from model projections given the appropriate identities.

This is not true for miles per vehicle by vintage, $(\frac{M}{K})i$, which clearly should be related to the average miles per vehicle, but for which there is no necessarily deterministic approach. This variable is therefore selected as the factor to force the equality of the gasoline consumption identity.

First, it was divided into two components:

$$(\frac{M}{K})i = (\frac{M}{K}) * mi \qquad (i = 00, \ldots, 20)$$

Here m_i is a distribution factor, reflecting a consistent <u>pattern</u> of miles driven by vintage, thus:

m00 =	0.75	m10 =	0.65
m01 =	1.50	m11 =	0.6
m02 =	1.25	m12 =	0.6
m03 =	1.05	m13 =	0.6
m04 =	1.00	m14 =	0.6
m05 =	0.95	m15 =	0.6
m06 =	0.85	m16 =	0.6
m07 =	0.80	m17 =	0.6
m08 =	0.80	m18 =	0.6
m09 =	0.75	m19 =	0.6
		m20 =	0.6

In other words, if the estimated average miles per vehicle in a given year were 10,000, then all new vehicles would be driven 7,000 miles (by year-end), one-year olds 15,000, and so on. The $(\frac{M}{K})$ term is now constant across vintages, but varies over time.

The identity is computed:

$$\text{WTDMPG} = \sum_{i=00}^{20} \text{KVi} * \text{mi} * (\frac{1}{\text{AVTTMPGi}})$$

$(\frac{M}{K})$ is defined as "that average miles per vehicle which, when multiplied by WTDMPG, yields total actual gasoline consumption," that is:

$$(\frac{M}{K}) = \text{GASAUTOADJ} = \frac{\text{GASAUTO}}{\text{WTDMPG}}$$

where GASAUTO = Autos fuel consumption. These transformations can be seen on the first page of Table 5-8.

We can then define the average fleet mpg, AVMPGVINT, consistent with the official vehicle miles statistics (VMTMVA-MC):

$$\text{AVMPGVINT} = \frac{\text{VMTMVA-MC}}{\text{GASAUTOADJ} * \text{WTDMPG}}$$

The final step is the estimation of GASAUTOADJ $(\frac{M}{K})$ as a function of the actual average VMT/K. Certain "breaks" are observed in the series, most notably 1959-64 and 1974-75. The correlation between the two variables is very strong; when dummy variables are included for the apparent breaks, the elasticity with respect to the actual average miles per vehicle is almost unity. Hence, the two will move in step in the forecast period.

TABLE 5-8. FUEL CONSUMPTION ESTIMATION

NOTES

1. Definitions:

AVMPGVINT	=	Average fleet fuel economy, WEFA estimate reconciled to equal FHA estimate.
AVTTMPGi	=	Average fuel economy, all cars of ith vintage, WEFA estimate.
GASAUTO	=	Fuel consumed by autos.
GASAUTOADJ	=	Fuel consumption adjustment, expressed as miles per vehicle.
KVi	=	Mid-year stock of cars of ith vintage.
mi	=	Ratio of vintage i miles per vehicle to average miles per vehicle.
VMT/K	=	Total miles driven per vehicle.
VMTMVA-MC	=	Total automobile vehicle miles.

2. Identities:

$$1/\mathrm{AVTTMPGi} = \sum_{\delta} \mathrm{SHR}_{\delta}\mathrm{NR}(i-1)/\mathrm{US}_{\delta}\mathrm{MPG}(i-1)$$

δ = ST, CT, MD, FD, LT

$$\mathrm{GASAUTO} = \mathrm{GASAUTOADJ} * \sum_{i=00}^{20} \mathrm{KVi} * \mathrm{mi} * (1/\mathrm{AVTTMPGi})$$

$$\mathrm{AVMPGVINT} = \mathrm{VMTMVA\text{-}MC} / \mathrm{GASAUTO}$$

TABLE 5-8. FUEL CONSUMPTION ESTIMATION (continued)

PERIOD: 1956 1976 EQUATION FOR: GASAUTOADJ

$$
\begin{aligned}
\ln(\text{GASAUTOADJ}) = & \underset{(1.54)}{.172612} \\
& + \underset{(19.53)}{.920927} \ \ln(\text{VMT/K}) \\
& + \underset{(5.88)}{.0228832} \ \text{DUM59.64} \\
& - \underset{(5.18)}{.0258069} \ \text{DUM74.75} \\
& + \underset{(1.99)}{.014727} \ \text{DUM73}
\end{aligned}
$$

$\bar{R}^2 = .966$ DW = 2.099 SEE = .0064762

6. AUTOMOBILE PRICE EQUATIONS

The re-estimated price equations cover base prices, options expenditures, and transportation charges for each class. In general, the specifications are those previously estimated with one significant exception.[1] The specification for foreign base prices now links them directly to the deflator for imported manufactured goods. We have also incorporated into the model the equations used to predict the operating cost component price indexes.

Comparing results (Table 6-1) for the fixed-weighted domestic base and options prices, the cost index has a slightly higher impact on base prices and a slightly lower impact on options prices. Foreign base prices are strongly related to the imported manufactures' index, with subcompacts having an elasticity below one, compacts almost unity, and the luxury class having an elasticity significantly greater than one.

The results for subcompact expenditures on options show greater sensitivity to both price and income terms, higher statistical significance and better fit. The compact class also has a stronger price impact, but a weaker income effect, a result also found in the luxury case. This is also true for mid-size, but the results are very close to previous estimates. The full-size results are also consistent with previous findings, with a slightly lower price impact and a higher income effect.

The transportation cost results are consistent with previous findings, but adding 1975-76 results in higher elasticities with respect to the transportation price index. Once again, luxury has the lowest elasticity, then subcompacts, full-size, mid-size, and compacts. The recent tendency for transportation changes to move closer together would thus be continued in the forecast horizon. Therefore, the model coding is such that the charges for each class may never exceed those for the next larger (more expensive) class within the domestic and foreign groups.

---

[1] Schink and Loxley, Section A2.4.4 and Tables A2-9 to A2-11.

Four price equations have been added to the model to directly predict the indexes for insurance, maintenance and repairs, motor oil, parking and miscellaneous, using Wharton Annual Model price deflators. For insurance and parking, the implicit deflator for consumer expenditures on services was used, while the implicit deflator for all consumer expenditures was used for the others. As can be seen, the elasticities are typically greater than unity, although maintenance and parking have a lagged adjustment to growth rate changes. Insurance is clearly the most rapidly growing component.

Also included in the table is the identity for PINPUTA, which is incorporated into the model. The weights for each industry price index are taken from their 1972 input flows into the motor vehicle industry. Note that these coefficients could be varied to simulate increased inputs of different industries.

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS

Definitions:

ODDδOPT	=	Actual options expenditures as a share of maximum options cost for class δ, expressed as "odds"
PCOIL	=	Motor oil consumer price index, 1967=100
PCREPAIRS	=	Maintenance and repairs consumer price index, 1967=100
PCINSURANCE	=	Insurance consumer price index, 1967=100
PCPARKING	=	Parking and fees consumer price index, 1967=100
PDCE	=	Implicit deflator for consumer expenditures
PDCEST	=	Implicit deflator for consumer expenditures on services
PINPUTA	=	Price index for motor vehicle industry inputs
PTMEGTMF	=	Price deflator for imported manufactured goods
USδPUBASE-2	=	Base purchase price, class δ
USTDPOPTMFW	=	Fixed-weighted average domestic maximum options price
USTDPUBASEFW	=	Fixed-weighted average domestic base purchase price

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1959 1976 EQUATION FOR: USTDPUBASEFW

$$
\begin{aligned}
\ln(\text{USTDPUBASEFW}) = {} & \underset{(12.92)}{3.10777} \\
& + \underset{(20.23)}{1.08658} \ \ln(\text{PINPUTA}) \\
& + \underset{(1.45)}{.312861} \ \Delta\ln(\text{PINPUTA}) \\
& + \underset{(2.93)}{.0170887} \ \text{DUM58.63}
\end{aligned}
$$

$\bar{R}^2 = .984$ DW = 1.644 SEE = .019507

PERIOD: 1958 1976 EQUATION FOR: USTDPOPTMFW

$$
\begin{aligned}
\ln(\text{USTDPOPTMFW}) = {} & \underset{(21.7355)}{3.76115} \\
& + \underset{(18.5655)}{.704192} \ \ln(\text{PINPUTA}) \\
& + \underset{(8.20553)}{.130367} \ \text{DUM58.59}
\end{aligned}
$$

$\bar{R}^2 = .951$ DW = 1.436 SEE = .019865

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1958 1976 EQUATION FOR: USSFPUBASE-2

$$\ln(\text{USSFPUBASE-2}) = \underset{(28.57)}{3.74281} + \underset{(30.12)}{.879238}\ \ln(\text{PTMEGTMF})$$

$\bar{R}^2 = .981$ DW = 1.08 SEE = .035146

PERIOD: 1958 1976 EQUATION FOR: USCFPUBASE-2

$$\ln(\text{USCFPUBASE-2}) = \underset{(20.642)}{3.80505} + \underset{(24.0857)}{.959297}\ \ln(\text{PTMEGTMF}) - \underset{(-4.60188)}{.105466}\ \text{DUM58.65} - \underset{(-2.03693)}{.083732}\ \text{DUM61}$$

$\bar{R}^2 = .985$ DW = 1.528 SEE = .038445

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1958 1976 EQUATION FOR: USLFPUBASE-2

$$\ln(\text{USLFPUBASE-2}) = \underset{(14.7011)}{3.19897} \; \underset{(25.2211)}{+1.22316} \ln(\text{PTMEGTMF})$$

$\bar{R}^2$ = .972 DW = 1.178 SEE = .058384

PERIOD: 1960 1976 EQUATION FOR: ODDSDOPT

$$\ln(\text{ODDSDOPT}) = \underset{(10.03)}{40.3244} \; \underset{(9.82)}{-6.69311} \ln(\text{USTDPOPTMFW/PC/125.3}) \; \underset{(4.76)}{+5.18096} \ln(\text{RDIP4/FM}) \; \underset{(5.10)}{-1.94508} \ln(\text{PER15+}) \; \underset{(11.42)}{+.71503} \text{DUM68.69}$$

$\bar{R}^2$ = .976 DW = 2.215 SEE = .076767

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1960 1976 EQUATION FOR: ODDCDOPT

$$\ln(ODDCDOPT) = \underset{(12.29)}{33.8495} \; \underset{(18.88)}{-5.21438} \ln(USTDPOPTMFW/PC/125.3) \; \underset{(2.01)}{+1.0389} \ln(RDIP4/FM)$$

$\bar{R}^2$ = .974 DW = 1.383 SEE = .11284

PERIOD: 1960 1976 EQUATION FOR: ODDMDOPT

$$\ln(ODDMDOPT) = \underset{(9.80)}{40.7356} \; \underset{(14.75)}{-6.14463} \ln(USTDPOPTMFW/PC/125.3) \; \underset{(1.56)}{+1.22318} \ln(RDIP4/FM)$$

$\bar{R}^2$ = .957 DW = 0.845 SEE = .17022

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1960 1976 EQUATION FOR: ODDFDOPT

$$\ln(\mathrm{ODDFDOPT}) = \underset{(6.32)}{32.8134} \underset{(10.17)}{-5.28811} \ln(\mathrm{USTDPOPTMFW/PC}/125.3) \underset{(2.37)}{+2.31294} \ln(\mathrm{RDIP4/FM})$$

$\bar{R}^2 = .925$ DW = 0.639 SEE = .21254

PERIOD: 1960 1976 EQUATION FOR: ODDLDOPT

$$\ln(\mathrm{ODDLDOPT}) = \underset{(8.93)}{41.2354} \underset{(12.77)}{-5.91298} \ln(\mathrm{USTDPOPTMFW/PC}/125.3) \underset{(1.03)}{+.894137} \ln(\mathrm{RDIP4/FM})$$

$\bar{R}^2 = .942$ DW = 1.321 SEE = .18917

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1939 1976 ("Stacked") EQUATION FOR: USSDPUTRN

$$\ln(USSDPUTRN) = \underset{(20.12)}{-4.46017} \; \underset{(39.25)}{+1.96} \ln(PXRGT) \; \underset{(3.02)}{+.078037} \; DUM59.60 \; \underset{(9.22)}{-.215128} \; DUM72.74$$

$\bar{R}^2$ = .979 DW = 2.248 SEE = .046487

PERIOD: 1939 1976 ("Stacked") EQUATION FOR: USSFPUTRN

$$\ln(USSFPUTRN) = \underset{(20.12)}{-4.46017} \; \underset{(0.38)}{+ .00566954} \; \underset{(39.25)}{+1.96} \ln(PXRGT) \; \underset{(3.02)}{+.078037} \; DUM59.60 \; \underset{(9.22)}{-.215128} \; DUM72.74$$

$\bar{R}^2$ = .979 DW = 2.248 SEE = .046487

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1939 1976 ("Stacked") EQUATION FOR: USCDPUTRN

$$\ln(USCDPUTRN) = \underset{(33.74)}{-5.40656} \; \underset{(61.26)}{+2.20501} \ln(PXRGT) \; \underset{(5.72)}{-.113846} \, DUM73.74 \; \underset{(3.78)}{+.0725213} \, DUM59.60$$

$\bar{R}^2$ = .992 DW = 2.498 SEE = .03449

PERIOD: 1939 1976 ("Stacked") EQUATION FOR: USCFPUTRN

$$\ln(USCFPUTRN) = \underset{(33.74)}{-5.40656} \; \underset{(3.49)}{-.0390938} \; \underset{(61.26)}{+2.20501} \ln(PXRGT) \; \underset{(5.72)}{-.113846} \, DUM73.74 \; \underset{(3.78)}{+.0725213} \, DUM59.60$$

$\bar{R}^2$ = .992 DW = 2.498 SEE = .03449

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1958 1976 EQUATION FOR: USMDPUTRN

$$\begin{aligned}\ln(\text{USMDPUTRN}) = & -4.54575 \\ & (17.66) \\ & +2.0353 \quad \ln(\text{PXRGT}) \\ & (35.48) \\ & +.0799527 \ \text{DUM59.60} \\ & (2.67) \\ & -.043902 \quad \text{DUM64.67} \\ & (1.93) \\ & -.103003 \quad \text{DUM73.74} \\ & (3.48)\end{aligned}$$

$\bar{R}^2$ = .990 DW = 1.791 SEE = .036172

PERIOD: 1958 1976 EQUATION FOR: USFDPUTRN

$$\begin{aligned}\ln(\text{USFDPUTRN}) = & -4.0867 \\ & (15.70) \\ & +1.96692 \quad \ln(\text{PXRGT}) \\ & (34.05) \\ & +.114412 \quad \text{DUM58.60} \\ & (4.43) \\ & -.0624909 \ \text{DUM64.67} \\ & (2.78) \\ & -.0086486 \quad \text{DUM73.74} \\ & (3.07)\end{aligned}$$

$\bar{R}^2$ = .99 DW = 2.168 SEE = .034441

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1939 1976 ("Stacked") EQUATION FOR: USLDPUTRN

$$\ln(\text{USLDPUTRN}) = \underset{(9.14)}{-1.57211} \; \underset{(37.42)}{+1.44173} \ln(\text{PXRGT}) \; \underset{(3.78)}{+.0792536} \text{ DUM59.60} \; \underset{(3.97)}{-.0605194} \text{ DUM67.70} \; \underset{(4.70)}{-.100686} \text{ DUM73.74}$$

$\bar{R}^2$ = .978 DW = 1.221 SEE = .036681

PERIOD: 1939 1976 ("Stacked") EQUATION FOR: USLFPUTRN

$$\ln(\text{USLFPUTRN}) = \underset{(9.14)}{-1.57211} \; \underset{(4.05)}{-.0482333} \; \underset{(37.42)}{+1.44173} \ln(\text{PXRGT}) \; \underset{(3.78)}{+.0792536} \text{ DUM59.60} \; \underset{(3.97)}{-.0605194} \text{ DUM67.70} \; \underset{(4.70)}{-.100686} \text{ DUM73.74}$$

$\bar{R}^2$ = .978 DW = 1.221 SEE = .036681

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1960 1976 EQUATION FOR: PCINSURANCE

ln(PCINSURANCE)	=	-2.02873 (6.0859)	
	+	1.48049 (20.1498)	ln(PDCEST)
	+	.549752 (1.49733)	ln(PDCEST/PDCEST(-1))
	+	.201332 (5.22561)	DUMINS60.73
	-	.0609356 (1.28994)	DUMINS72
	-	.0895137 (1.77074)	DUMINS73

$\bar{R}^2$ = .988 DW = .763 SEE = .035953

PERIOD: 1960 1976 EQUATION FOR: PCREPAIRS

ln(PCREPAIRS)	=	-1.00297 (7.89057)	
	+	1.30408 (39.6549)	ln(PDCE)
	-	.499379 (1.8885)	ln(PDCE/PDCE(-1))

$\bar{R}^2$ = .997 DW = .563 SEE = .013669

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

PERIOD: 1960 1976 EQUATION FOR: PCOIL

$$\ln(PCOIL) = \underset{(.359865)}{-.0440088} + \underset{(39.8026)}{1.05301} \ln(PDCE)$$

$\bar{R}^2 = .99$ DW = .613 SEE = .021122

PERIOD: 1960 1976 EQUATION FOR: PCPARKING

$$\ln(PCPARKING) = \underset{(4.23667)}{-.476829} + \underset{(44.9408)}{1.19065} \ln(PDCEST) - \underset{(3.32827)}{.569233} \ln(PDCEST/PDCEST(-1))$$

$\bar{R}^2 = .995$ DW = 1.334 SEE = .017943

TABLE 6-1. AUTOMOBILE PRICE EQUATIONS (continued)

<u>PINPUTA Identity</u>

PINPUTA = .00007 * PXAG + .00054 * PXMG

+ .09611 * PXCO + .00107 * PXMFN20

+ .00006 * PXMFN21 + .00525 * PXMFN22

+ .02103 * PXMFN23 + .00362 * PXMFN26

+ .00045 * PXMFN27 + .00821 * PXMFN28

+ .00248 * PXMFN29 + .03369 * PXMFN30

+ .00004 * PXMFN31 + .00168 * PXMFD24

+ .0015 * PXMFD25 + .01597 * PXMFD32

+ .13449 * PXMFD33 + .14972 * PXMFD34

+ .05976 * PXMFD35 + .03831 * PXMFD36

+ .00243 * PXMFD37SP1 + .37880 * PXMFD371

+ .00552 * PXMFD38 + .00065 * PXMFD39

+ .02599 * PXRGT + .00273 * PXRGC48

+ .00682 * PXRGU49 + .00149 * PXGVFE

+ .00015 * PXGVSE + .00137 * PTMB

7. LINKAGES TO THE WHARTON ANNUAL MODEL

7.1 GENERAL

There are three points of direct contact between the two models: final demand prices, expenditures on autos, and expenditures on gasoline. From prices and expenditures, effects pass to the consumer price index and to output, employment, wages, and investment in the motor vehicles sector, and hence (via multiplier effects) to the economy at large.

The key relationships that have been incorporated into the Motor Vehicle Model are shown in Table 7-1. The implicit deflator for new auto expenditures is a function of the average base purchase price and the average maximum options price (USTTPUBASE-2, USTTPOPTM). The unit purchase price, which is a "real value" index defined as constant dollar expenditures divided by retail sales, is a function of the ratio between the average total purchase cost and the implicit deflator.

Expenditures are derived by first estimating retail sales for foreign and domestic vehicles as a function of new registrations. Then, constant dollar consumer expenditures on new autos are an identity, depending upon the real unit value, sales, and the share of sales allocated to consumer spending versus business investment and government expenditures (RACEDAVN). RACEDAVN is an exogenous variable. The historical split is estimated by the Department of Commerce for purposes of national income accounting. In a forecast it would normally be left constant (which it virtually is historically).

Constant dollar gasoline consumption (CENG) is estimated very straightforwardly, taking the gallons consumed forecast (GASAUTO) and multiplying by RACENGAUTO. This is the ratio between the two historically. Again, the constant dollar value is the result of a distribution process performed by the Department of Commerce. Hence, just as for CEDAVN, the other fraction of expenditures comprises business investment and government spending.

7.2 EQUATION ESTIMATES

The correlations between the various price concepts and between sales and registrations are very significant, as would be expected. The implicit deflator, PDCEDAVN, has an elasticity of 0.7 with respect to the average price variable. This is an expected deviation from unity, because implicit deflators rise less rapidly than pure price measures.

Two significant shifts in the relationship occur that are evident in the data: the 1960-64 period and 1970-72. In both cases the dummy variable coefficients indicate that the rate of change of PDCEDAVN was greater than would be expected given the Motor Vehicle Model price measures.

For PUCEDAVN the elasticity with respect to the price ratio is close to unity (1.04) as expected. Again, shifts in the relationship appear to be observed for 1964-67 and 1972-74. In the retail sales equation, despite the fact that new registrations lag retail sales (both in fact and in recording of the data) by about two months, the tracking on an annual basis is very good. The elasticity is unity for domestics and slightly higher for foreign (after adjustments for passenger vans).

Also included in Table 7-1 are the equations for the variables driven directly by the Wharton Annual Model values: the consumer installment rate for new autos (FRMCICR) and the percent of families with incomes over $15,000 (PER15+) in 1970$. FRMCICR is linked to Moody's Corporate Bond Rate and is less volatile. PER15+ is regarded as a "cumulative" kind of variable; movements are likely to reflect income changes over a period of years. This is shown by a distributed lag on real disposable income per family unit excluding transfers, the estimated weights declining over time.

TABLE 7-1. LINKAGES TO THE WHARTON ANNUAL MODEL

Identities:

$$USTTPUBASE\text{-}2 = \sum_{sc} US\ sc\ PUBASE\text{-}2 * SHR\ sc\ NR$$

sc = SD, CD, MD, FD, LD, SF, CF, LF

$$USTTPOPTM = \sum_{sc} US\ sc\ POPTM * SHR\ sc\ NR$$

sc = ST, CT, MD, FD, LT

(for US sc POPTM, ST = SD,
CT = CD,
LT = LD)

CEDAVN = PUCEDAVN * SAWRRDAV * RACEDAVN

CENG = GASAUTO * RACENGAUTO

TABLE 7-1. LINKAGES TO THE WHARTON ANNUAL MODEL (continued)

Definitions:

CEDAVN	=	Consumer expenditures for new autos, 1972$
CENG	=	Consumer expenditures for motor fuel, 1972$
FRMCICR	=	Consumer installment credit interest rate, new autos
FRMCS	=	Moody's corporate bond rate
OMVUANR	=	Total new automobile registrations
OMVUATDNR	=	Total domestic new automobile registrations
OMVUATFNR	=	Total foreign new automobile registrations
PERI5+	=	Percent of families with incomes of $15,000 or more in 1970$
PDCEDAVN	=	Implicit deflator, consumer expenditures for new autos
PUCEDAVN	=	Unit price in 1972$
PUTOTNR	=	Sales-weighted average purchase price
RACEDAVN	=	Fraction of new car expenditures allocated to personal consumption
RACENGAUTO	=	Fraction of fuel expenditures allocated to personal consumption
SAWRRDAVD-V	=	Domestic retail auto sales, excluding passenger vans
SAWRRDAVF-V	=	Foreign retail auto sales, excluding passenger vans
USTTPUBASE-2	=	Sales-weighted new autos base price
USTTPOPTM	=	Sales-weighted maximum options price
YPDNET	=	Real disposable income excluding transfers

TABLE 7-1. LINKAGES TO THE WHARTON ANNUAL MODEL (continued)

PERIOD: 1960 1976 EQUATION FOR: PDCEDAVN

$$
\begin{aligned}
\ln(\text{PDCEDAVN}) = & -1.32207 \\
& (8.00759) \\
& +.706011 \quad \ln(\text{USTTPUBASE-2} + \text{USTTPOPTM}) \\
& (35.8687) \\
& +.059698 \quad \text{DUM60.64} \\
& (9.88919) \\
& +.0204057 \quad \text{DUM70.72} \\
& (3.36705)
\end{aligned}
$$

$\bar{R}^2$ = .99 DW = 2.284 SEE = .0087693

PERIOD: 1956 1976 EQUATION FOR: PUCEDAVN

$$
\begin{aligned}
\ln(\text{PUCEDAVN}) = & -2.55396 \\
& (32.5246) \\
& +1.04492 \quad \ln(\text{PUTOTNR/PDCEDAVN}) \\
& (48.2125) \\
& -.0130219 \quad \text{DUM64.67} \\
& (2.27656) \\
& +.0265797 \quad \text{DUM72.74} \\
& (3.79193)
\end{aligned}
$$

$\bar{R}^2$ = .993 DW = 2.135 SEE = .010082

PUCEDAVN = CEDAVN / (RACEDAVN * SAWRRDAV-V)

TABLE 7-1. LINKAGES TO THE WHARTON ANNUAL MODEL (continued)

PERIOD: 1958 1976 EQUATION FOR: SAWRRDAVD-V

ln(SAWRRDAVD-V) = .0196347
(.69)

+.996473 ln(OMVUATDNR)
(69.35)

$\bar{R}^2$ = .996 DW = 1.794 SEE = .012512

PERIOD: 1958 1976 EQUATION FOR: SAWRRDAVF-V

ln(SAWRRDAVF-V) = .024777
(5.76)

+1.02402 ln(OMVUATFNR)
(143.45)

$\bar{R}^2$ = .999 DW = 1.774 SEE = .017038

TABLE 7-1. LINKAGES TO THE WHARTON ANNUAL MODEL (continued)

PERIOD: 1958 1976 EQUATION FOR: FRMCICR

$$
\begin{aligned}
FRMCICR = \; & 5.90435 \\
& (116.049) \\
& +.667223 \quad FRMCS \\
& (86.9268)
\end{aligned}
$$

$\bar{R}^2$ = .998 DW = 1.63 SEE = .061201

PERIOD: 1960 1976 EQUATION FOR: PER15+

$$
\begin{aligned}
\ln(PER15+ \, / \, (100-PER15+)) = \; & -11.4759 \\
& (21.77) \\
& +.364119 \quad \ln(RDI/FM) \\
& (1.10) \\
& +.969885 \quad \ln(RDI/FM(-1)) \\
& (9.77) \\
& +.1.23635 \quad \ln(RDI/FM(-2)) \\
& (14.15) \\
& +1.16353 \quad \ln(RDI/FM(-3)) \\
& (8.14) \\
& +.751413 \quad \ln(RDI/FM(-4)) \\
& (6.49)
\end{aligned}
$$

$\bar{R}^2$ = .967 DW = 1.008 SEE = .076002

RDI/FM = (YP$ - TXCP$ - TRTOP$) / (PC/125.3)/(NCF + NCU)

RDI/FM is Almon Lag <2,5,FAR>

8. THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL, AUGUST 1979 FORECAST

8.1 EXECUTIVE SUMMARY

A progressive slowdown in real economic growth and accelerating inflation have combined with a chaotic gasoline supply situation to produce a significant deterioration in the near term outlook for motor vehicle demand. Not only has our estimate of the 1979 decline increased, this forecast reflects a significant probability of little real recovery occuring until the 1982 model year. Calendar year 1979 sales are forecast to be 10.5 million units, down almost 6 percent from 1978, with a further slight decline expected in 1980.

The huge surge in gas prices, up 30 percent year to year, together with supply problems, has also drastically shifted the sales mix. Small car new registrations are forecast to end 1979 up over 15 percent, with a better than 56 percent market share. Imports are breaking almost all sales records, and should end the year with a 22 percent share, with new registrations up over 13 percent. In contrast domestic fullsize will finish with only a 13 percent share for the year, with new registrations down 30 percent. Combined with a 25 percent decline for midsize, the result is a forecast 10 percent decline for 1979 domestic sales--the third worst drop since 1960.

While the immediate panic response to the gas "mini-crisis" already appears to have moderated, we see little immediate prospects of a strong rebound in sales as occurred following 1974-75. This is a conservative outlook, but the key uncertainties appear to favor the downside risk, with a weaker 1980-81 economy being entirely possible, and the chance of further fuel price and supply disruptions. The key auto market forces originate with our expectations of a substantial scrappage downturn and high rates of price and operating cost increases.

The major factors responsible for this outlook are continued rapid price and cost increases, and a severe drop in consumers' real incomes and purchasing power. The average new car price will increase nearly 8 percent this year, jump 9.5 percent in 1980, and rise over 8 percent in both 1981 and 1982. Gas price increases are put at near 30 percent for both 1979 and 1980, with annual increases of 18 percent and 10 percent following in 1981-82. The results are an increase in the average cost per mile of 14 percent for this year (higher even than 1974), followed by increases of 12 percent, 10 percent, and 8 percent, for 1980 through 1982. Despite this year's modest tax cut and further relief assumed in 1980, real disposable income per family falls 2.4 percent this year, followed by a 3.4 percent drop in 1980. Even worse, 1981 sees a further 1.2 percent decline with only a slight recovery in 1982.

Along with falling sales, scrappage drops sharply in 1979-80, following three years of rapid growth. A strong corrective rebound is expected for 1981-83. As a result, the year-end operating fleet grows by more than 2 percent annually in 1979-80, falling to a 1.6 percent rate in 1981.

With the widespread informal gas rationing during the peak summer travel period, a 2 percent decline in vehicle miles travelled is forecast--almost as large as in 1974. Very low growth is projected for 1980-81. Together with the strong fuel efficiency improvements, fuel consumption should drop by over 4 percent in both 1979 and 1980.

The longer term outlook projected for the 1980s has changed relatively little, and still shows a moderate growth path. Sales hit 12 million units by 1985 and reach 12.6 million by 1987, with compact vans adding another 200,000 units. A falling-off in the small car share towards 50 percent would be expected, if and only if further gas supply shocks can be avoided. While this affects the imports share, increasingly competitive domestic models and pricing, together with some additional deterioration in the dollar in 1982-83, are projected to trim the foreign share to 20 percent by 1984.

As a result of the increasing safety, emissions, and fuel economy requirements, average new car prices and cost per mile grow by around 7 percent annually throughout the 1980s, exceeding the rate of general inflation of consumer prices. The long-term growth of cars in operation is near 2 percent

TABLE 8-1. AUGUST CONTROL FORECAST SUMMARY TABLE

		1970		1975		1978		1980		1985		1990
RETAIL SALES, TOTAL	(mills)	8.4		8.6		11.3		10.4		12.2		13.7
average annual growth rate			0.5		9.9		-4.5		3.2.		2.3	
COMPACT VANS	(mills)	0.115		0.124		0.161		0.155		0.200		0.230
average annual growth rate			1.5		9.1		-1.9		5.2		2.8	
NEW CAR SALES	(mills)	8.3		8.5		11.2		10.2		12.0		13.5
average annual growth rate			0.5		9.4		-4.6		3.3		2.4	
IMPORTS SHARE	(%)	14.2		18.2		17.9		21.2		20.4		21.7
AVERAGE NEW CAR PRICE	($)	3,833		5,427		6,730		7,952		11,675		15,939
average annual growth rate			7.2		7.4		8.7		8.0		6.4	
COST PER MILE	(¢)	13.9		20.3		23.5		30.1		43.2		59.1
average annual growth rate			7.9		5.0		13.2		7.5		6.5	
CONSUMER PRICE INDEX	(1967=100))	116.3		161.2		195.4		243.9		344.8		460.0
average annual growth rate			6.7		6.6		11.7		7.2		5.9	
DISP. FAMILY INCOME	(1972$)	9,810		9,420		9,750		9,190		9,460		10,030
average annual growth rate			0.8		1.2		-2.9		0.6		1.2	
SALES RATE		0.105		0.088		0.109		0.095		0.102		0.106
SCRAPPAGE RATE		0.077		0.062		0.888		0.070		0.084		0.093
CARS IN OPERATION YEAR END	(mills)	81.4		95.6		102.4		107.2		117.1		126.8
average annual growth rate			3.3		2.3		2.3		1.8		1.6	
TOTAL POPULATION	(mills)	204.9		213.5		218.5		222.2		233.0		243.6
average annual growth rate			0.8		0.8		0.8		1.0		0.9	
LICENSED DRIVERS	(mills)	111.5		129.8		141.2		147.2		159.5		169.7
average annual growth rate			3.1		2.8		2.1		1.6		1.2	
VEHICLE MILES	(bills)	891		1,028		1,187		1,158		1,319		1,556
average annual growth rate			2.9		4.9		-1.2		2.6		3.4	
AVERAGE TOTAL FLEET MPG		13.6		13.5		14.2		15.2		18.5		21.9
average annual growth rate			-0.1		1.6		3.4		4.0		3.5	
FUEL CONSUMPTION	(bills)	65.7		76.0		83.6		76.3		71.4		71.0
average annual growth rate			3.0		3.2		4.5		-1.3		-0.1	
GASOLINE PRICE, REGULAR	(¢)	35.7		57.2		65.9		109.2		174.1		235.1
average annual growth rate			9.9		4.8		28.7		9.8		6.2	

annually, while miles travelled grows at a 3 percent rate. Fuel consumption continues to fall throughout the forecast period, dropping to 71 billion gallons by 1987, a 12.5 billion gallon reduction from 1978.

8.2 ASSUMPTIONS

The primary assumptions and inputs into the Motor Vehicle Demand Model are consistently generated by, and taken from, the Wharton Annual Model Control Forecast of July, 1979. These inputs are shown in detail in Tables 16.00 and 17.00 of the forecast output. Primary underlying assumptions are discussed below. The July, 1979 Wharton Annual Model Control Forecast predicts a mild recession in the second half of 1979 with very slow real growth through 1980, accompanied by double-digit inflation in consumer prices. During the 1980's real GNP growth is expected to average 2.9 percent annually, with slower productivity increases only gradually moderating the inflation rate towards 6 percent. The unemployment rate exceeds 8 percent by 1981.

8.2.1 Economic

Key fiscal and monetary policy assumptions include a further tax cut of $22 billion in 1980, and a one-year postponement of the 1981 social security tax rate increase. These are, perhaps, optimistic assumptions, but without such actions the 1980-81 economic outlook is significantly worse. Fiscal conservatism is expected to continue to hold down federal spending growth, to 1 percent per year in real terms through 1981, and to 1.7 percent during the 1980's. A balanced budget is projected for 1983-84, with the share of real federal spending in GNP falling from over 20 percent towards 18 percent. Similarly, state and local government spending growth is assumed to slow during the early 1980's. Monetary policy has been fairly restrictive of late, with an increased emphasis on maintaining the dollar's value. As the U.S. trade deficit and high domestic inflation are expected to persist through 1983, the discount rate is set at between 7.5 percent and 8 percent, falling towards 6 percent by the end of the decade.

8.2.2 Energy

Given previous and expected OPEC price hikes, the price of imported crude is assumed to rise almost 44 percent in 1979, and a further 20 percent in 1980. After 1980 increases of 7 percent per year are assumed. Again, these assumptions could well be on the optimistic side. Domestic prices are decontrolled over the 1979-81 period, during which time the upper tier oil price achieves parity. Natural gas price controls are scheduled to be further relaxed in 1985. Despite increased Alaskan output, and modest increases from new discoveries, etc., domestic crude production is assumed to peak at 9.3 mbd (million barrels per day) in 1981, and fall steadily thereafter. Natural gas production is assumed to fall by 1.5 percent per year. A 50 percent crude oil "windfall" profits tax is assumed to be passed. The tax rate is applied to the difference between inflated current prices and the parity prices for decontrolled oil, and upper tier, and also to the difference between lower and upper tier prices for oil which is reclassified. This is expected to generate revenues of from $12 billion to nearly $14 billion during the early 1980s.

8.2.3 Demographic

The demographic inputs are taken from Current Population Reports, P-20, Bureau of the Census, July 1978. The population projections are based on the Series II fertility assumption. This yields an average annual population growth of 0.9 percent. The household and family formation patterns are based on the Series B projection. The average family size continues to fall slightly throughout the forecast period, hence the growth in families averages a 1.5 percent annual rate. The number of unrelated individuals ("single-person" families) continues to grow more rapidly still, at 2.0 percent per annum.

The metropolitan population as a percent of total has leveled off in recent years after very rapid growth. It is assumed to be stable at just over 73 percent. The Pacific, Mountain, and West South Central regions are projected to continue to gain population from the rest of the nation, with East South Central experiencing the most rapid outmigration.

8.2.4 Vehicle Design

The auto characteristics projections are shown in detail in Table 8-2, subtables 18.00 and 19.00. In 1977 the domestic luxury and full size average total curb weight dropped 10 percent, while midsize were shrunk almost 11 percent in 1978. This year G.M.'s redesign has slightly less impact due to it's smaller share of the compact segment. Hence the curb weight decline is estimated at 8 percent. Full size and luxury should average a 6 percent to 7 percent reduction due to consumer demand and some further, less radical, weight reductions, particularly by Ford.

The 1982-83 period is expected to be the next significant downsizing period, although this second-round achieves less dramatic weight reductions. The larger vehicles have the greatest proportional reductions. By 1985 the domestic luxury at 3500 lbs and the full size at 3200 lbs are both lighter than the average 1978 midsize and equal to the 1978 foreign luxury car average. These projections imply reductions of over 20 percent. The midsize 1985 curb weight, at 3000 lbs, and the domestic compacts at 2700, represent near 20 percent reductions from 1978 averages. In contrast, the average weight of domestic subcompacts is projected to fall only 11 percent, to 2300 lbs - slightly below the 1978 foreign subcompact average. Imports, with much less need, incentive, or ability to reduce curb weights, are projected to reduce weight by from 1 percent to 2 percent per year.

The domestic manufacturers are expected to continue to rapidly reduce engine sizes, both with respect to total displacement and number of cylinders. The most popular domestic engine by 1985 will probably be close to a 225 cu. in. 6 cylinder. We have assumed that in 1985 up to 50 percent of domestic luxury cars will still be sold with V8's, of about 300 cu.in., although this is possibly a high estimate. The same V8, as an option, would account for between 15 percent and 20 percent of compact, midsize, and full size sales.

The proportions of domestics sold with automatic transmissions are assumed to decline somewhat from their current high levels. However, we note that the negative effects of automatics on fuel economy are largely being offset by new improved designs and the provisions of an overdrive gear (the main mpg reduction occurs in highway driving). Hence, the lower automatic sales, while consistent with the smaller engines, may not be required.

Technological improvements, reflected in the efficiency factors as multiplicative percentages (Table 20.00), are still expected to make major contributions to better domestic fuel economy, adding up to 16 percent to actual on road mpg, and 21 percent for EPA drive-cycle results, by 1985. The two major sources of improvement (emissions standards permitting) are dieselization, and electronic sensing, metering and control. Diesels have of course been selling extremely well--out of all proportion to their fuel cost advantages. Their outlook is currently clouded by future particulate and NOx emissions regulations. Should these prevent a minimum 10-20 percent of larger domestic's being diesels, the 1982-83 CAFE requirements become more difficult to meet. The application of electronics is already well underway, and is likely to be a major growth area. The use of "on-board" computers is also likely to become the center for sophisticated options packages.

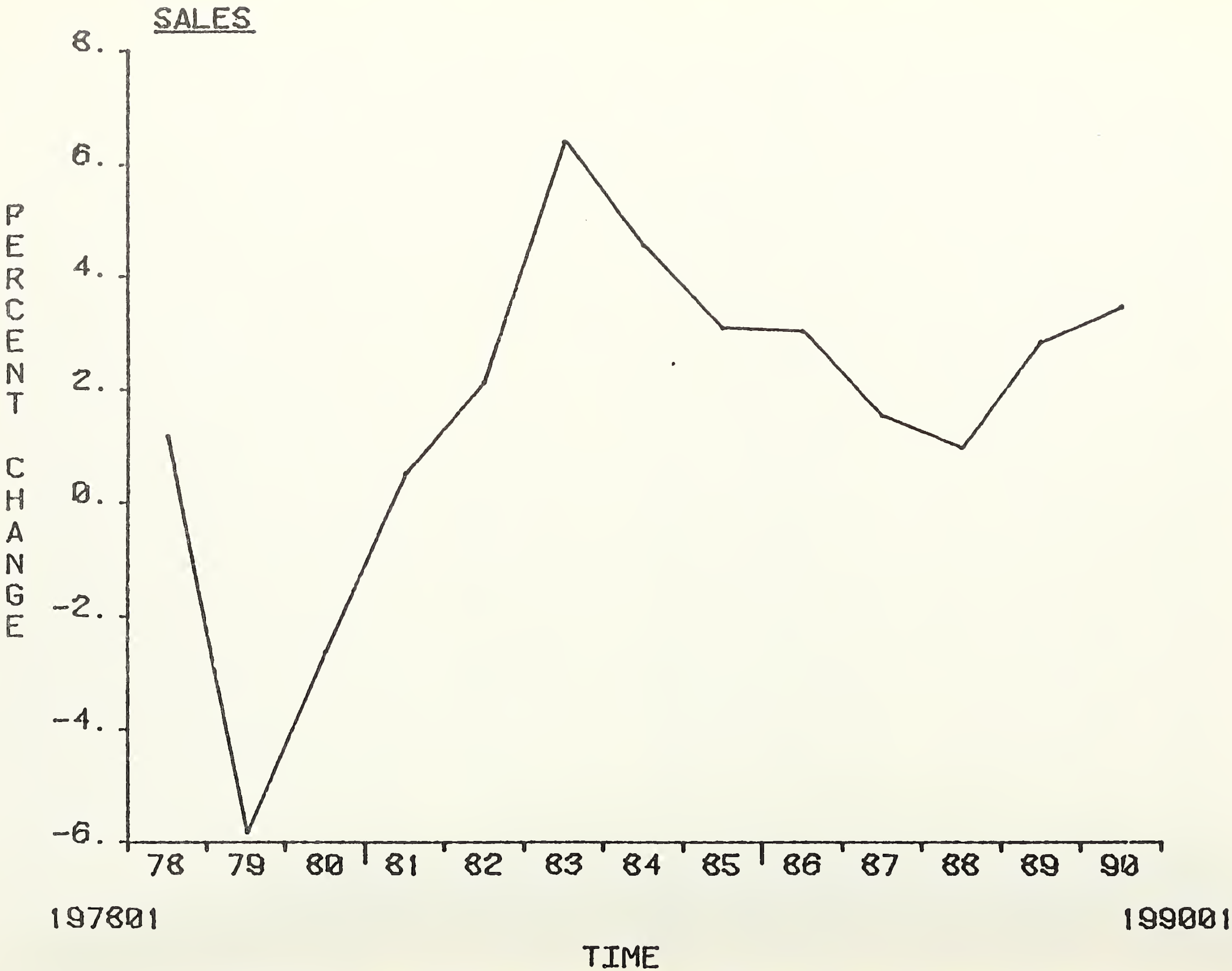


FIGURE 8-1. AUGUST CONTROL FORECAST NEW CAR RETAIL SALES---PERCENT CHANGE

8.3 FORECAST REVIEW

8.3.1 New Car Sales and Registrations

Year-to-date sales at the end of August stand at 7.5 million units, down almost 4 percent from 7.8 million in 1978. Despite the most strenuous marketing efforts--and substantial discounting--August sales were down 4.5 percent, notwithstanding Chrysler's relatively strong showing. Domestic sales are down 8 percent so far this year, versus a 15 percent rise for imports. Sales leaders are GM, down less than 5 percent, and, of course VWoA, whose domestic sales are over 110,000 units so far with VW imports down only 55,000. Toyota, Datsun, and Honda all set records for August, with the former two companies in close competition for leading importer. Major sales increases for the year have also been registered by Mazda (up over 100 percent) and Subaru (up one-third).

Our 1979 forecast shows a domestic decline of over 10 percent, and a total sales fall of nearly 6 percent. To the extent that imports can and do pick up the slack, total sales will fall slightly less and imports will gain more than the predicted 13.4 percent.

As is clearly shown by the sales growth rate chart, the strong sales rebound (of 6.4 percent) is delayed until 1983. With an almost 9 percent drop for 1979-80, and less than 3 percent recovery for 1981-82, sales do not recover to 1978 levels until 1983. Following a 4.5 percent increase in 1984, sales rise 3 percent annually in 1985-86, with the next down cycle occuring in 1987-88.

Given our success in forecasting 1977's strong growth and the continued expansion in 1978 (against the conventional wisdom of the Wall St. pundits) the model's results for the current downturn are viewed with cautious confidence. Beyond 1980, the slow recovery is the result of several strong negative factors, which are felt to have a significant probability. Key factors --discussed in detail below--are a sharp drop in scrappage in both 1979 and 1980, and rapid price and operating cost increases in 1981-82. Of course, these negative effects may not materalize in their entirety. However, the

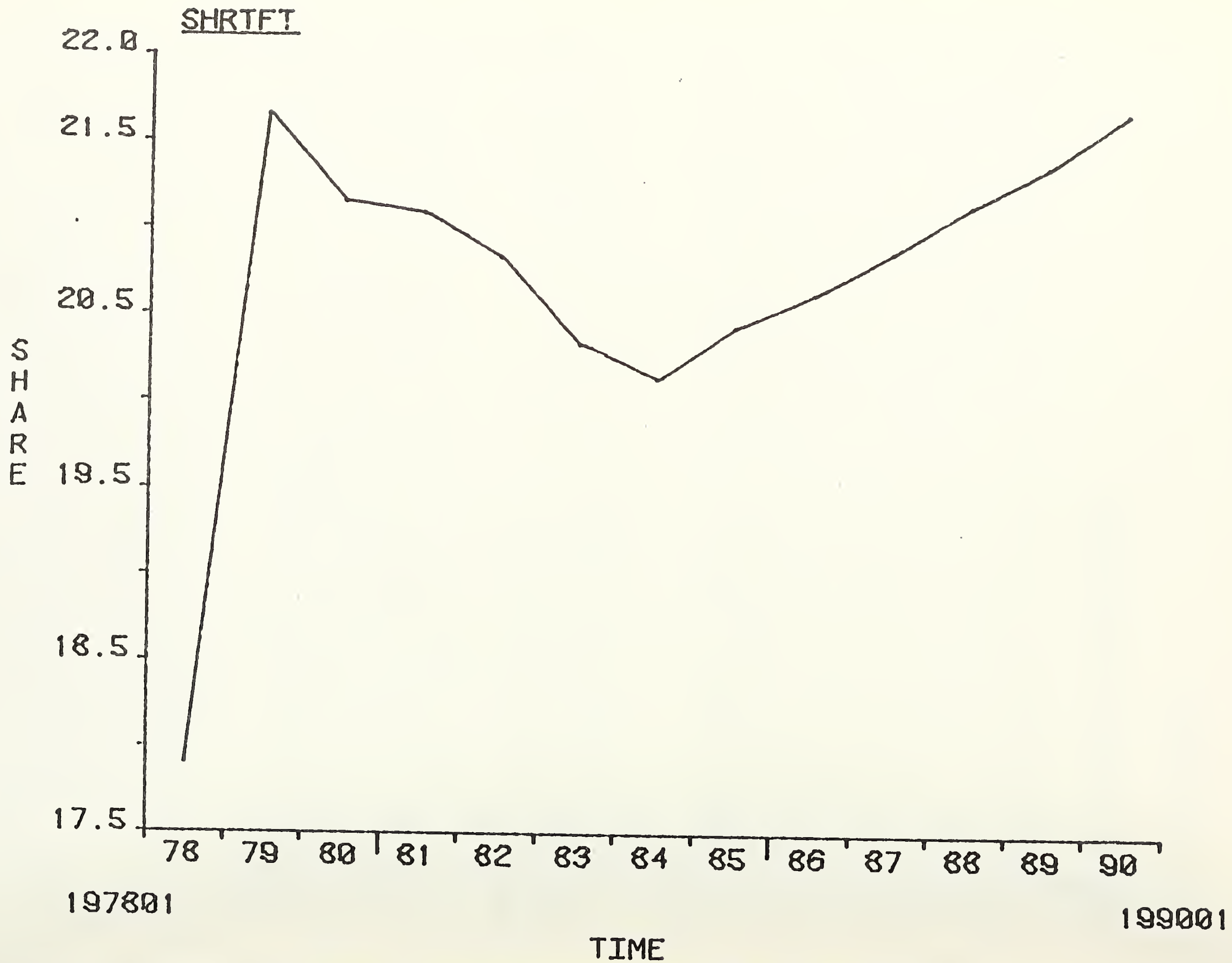


FIGURE 8-2. AUGUST CONTROL FORECAST IMPORTS MARKET SHARE

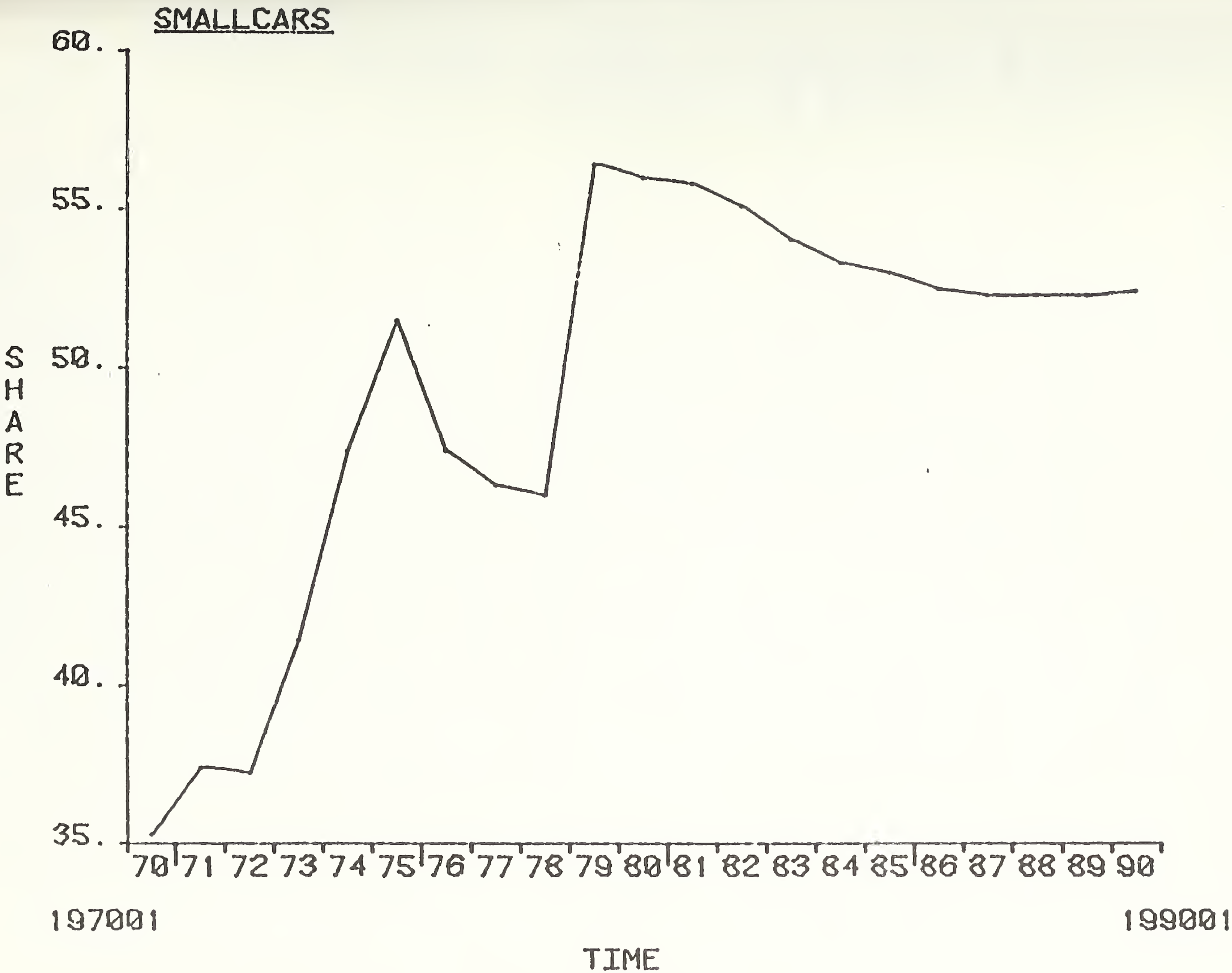


FIGURE 8-3. AUGUST CONTROL FORECAST SMALL CARS MARKET SHARE

economy could well fare worse in 1980-81 than assumed here, and future energy prices and supply will continue to be subject to international crises.

8.3.2 Imports and Small Cars

The imports share is expected to fall slightly from this year's peak of 21.7 percent, if interest rates decline in 1980 and the dollar ceases to climb against the yen. Strong domestic competition is a major factor reducing imports to 20 percent by 1984, together with a slackening of gas price increases. In particular, we assume that growth in domestic subcompact base prices will be restrained over this period in order to compete with imports and ensure compliance with CAFE regulations. After 1984 the imports share again rises back towards 22 percent, due to rates of inflation for imported manufacturers below U.S. rates, and less severe price competition--assuming no increase in CAFE requirements beyond 1985.

Undoubtedly, exchange rate fluctuations will occur and produce more significant shifts than shown here. For instance, if U.S. oil imports were to be held flat or reduced, and/or interest rates are kept very high, the dollar could strengthen appreciably, giving imports substantial impetus and pushing their market share up to 25 percent.

The overall small cars' share is expected to recede slightly from this year's high water mark in the absence of "artificial" gas supply constraints. Domestic subcompact and compact cars maintain their overall share of total sales, falling slightly from 46 percent of domestic sales in 1979 to 43 percent by 1984. Domestic compacts are forecast to continue to gain market share. From 22 percent of domestics in 1978 their share rises to 25.5 percent in 1982. This gain occurs at the expense of subcompacts. Both midsize and full size are projected to increase market share slightly compared to their current depressed levels, as they go through further downsizing and experience substantial mpg improvements.

The long-term trends in small-car shares and domestic and foreign subcompact sales are shown in the enclosed figures from 1970 to 1990. There we can clearly see the dramatic increase in the small car segment since 1970,

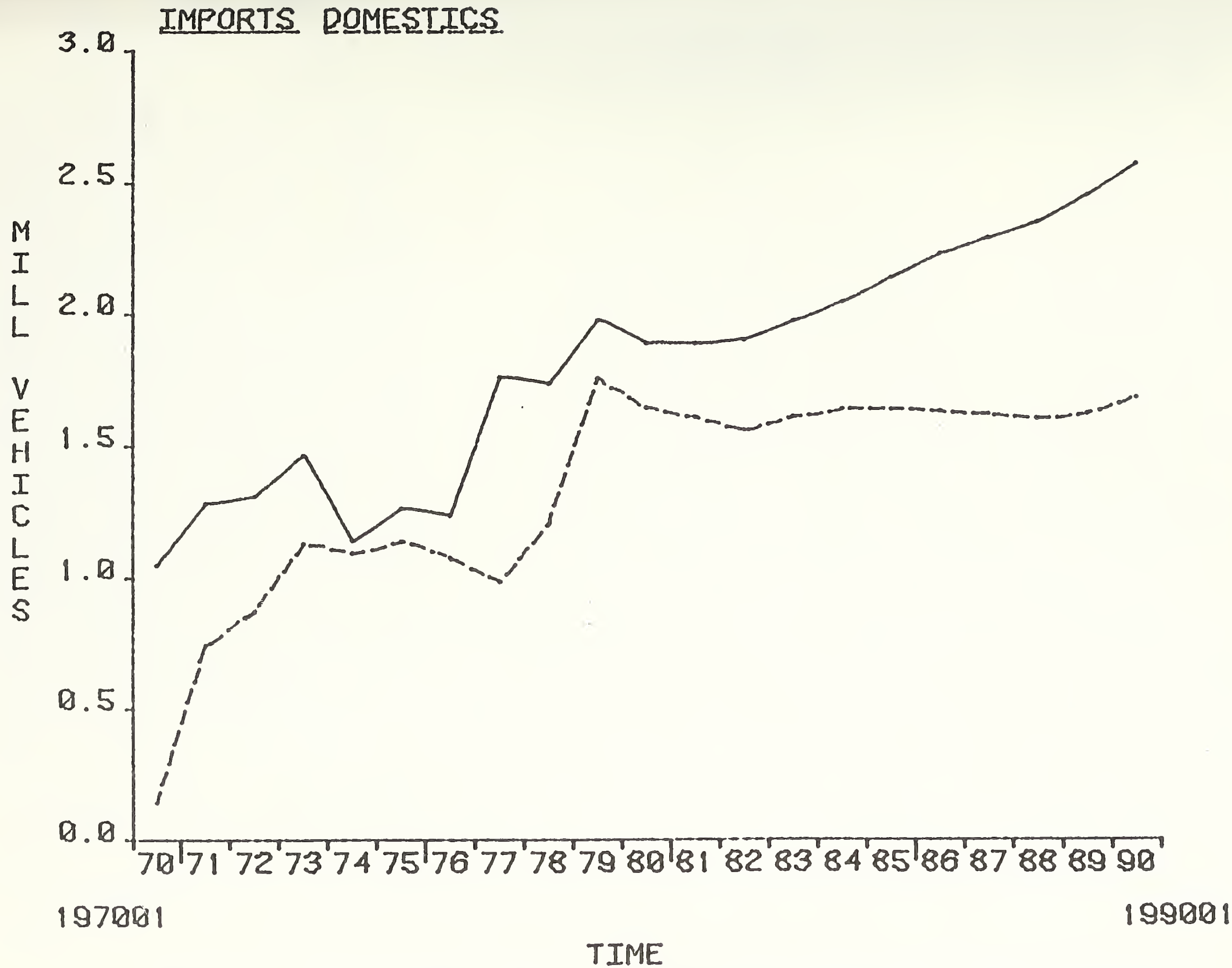


FIGURE 8-4. AUGUST CONTROL FORECAST SUBCOMPACT NEW REGISTRATIONS--IMPORTS VS DOMESTICS

when a market share of 35 percent was attained. After peaking at 51.5 percent in 1974, the share fell sharply, reaching 46 percent in 1978. Major contributing factors in the 1976-78 reductions were strongly rising real incomes, declining real gas prices, and higher price and operating cost increases. Surprisingly, small cars experienced an increase in cost per mile of 18 percent from 1975 to 1978, versus a full size increase of less than 15 percent.

Also of interest is the comparative performance of domestics and imports in the subcompact segment. Figure 8-4 shows unit sales in millions for the 1970 to 1990 period. Obviously the domestic competition increased dramatically until 1974, when the domestic share of subcompacts reached 49 percent (compared to only 37 percent in 1971). By 1977, however, while total subcompact new registrations reached 2.75 million, domestics accounted for only 36 percent. This year, despite being constrained by capacity, the domestic share has grown to an estimated 47 percent. Hence domestic subcompacts have shown a marked improvement in competitiveness. This is probably the joint result of the high imports' price increases in late 1978 - early 1979, and the attraction of new buyers away from their larger domestic cars, who have not previously purchased a foreign car.

8.3.3 Prices and Costs

Figure 8-5 shows changes in gas prices versus all consumer prices, and dramatically compares the current situation with the 1973-74 upheaval. While the 35 percent increase in gas prices was a major shock to the economy and the industry, a return to the consistent historical experience--declining real gas prices and abundant supplies--obviously encouraged consumers to view it as a 'one-time' extraordinary occurence. As can be seen, the current gas price increase is almost as severe, while the overall increase in consumer prices is greater than before. The other, and most important distinction, is that the forecast does not show an abrupt return to "normality" -- on the contrary, the 1980 gas price increase is estimated to be higher than 1979 (annual average), and the 1981 increase is still very high. In fact, gas prices continue to rise in real terms throughout the forecast.

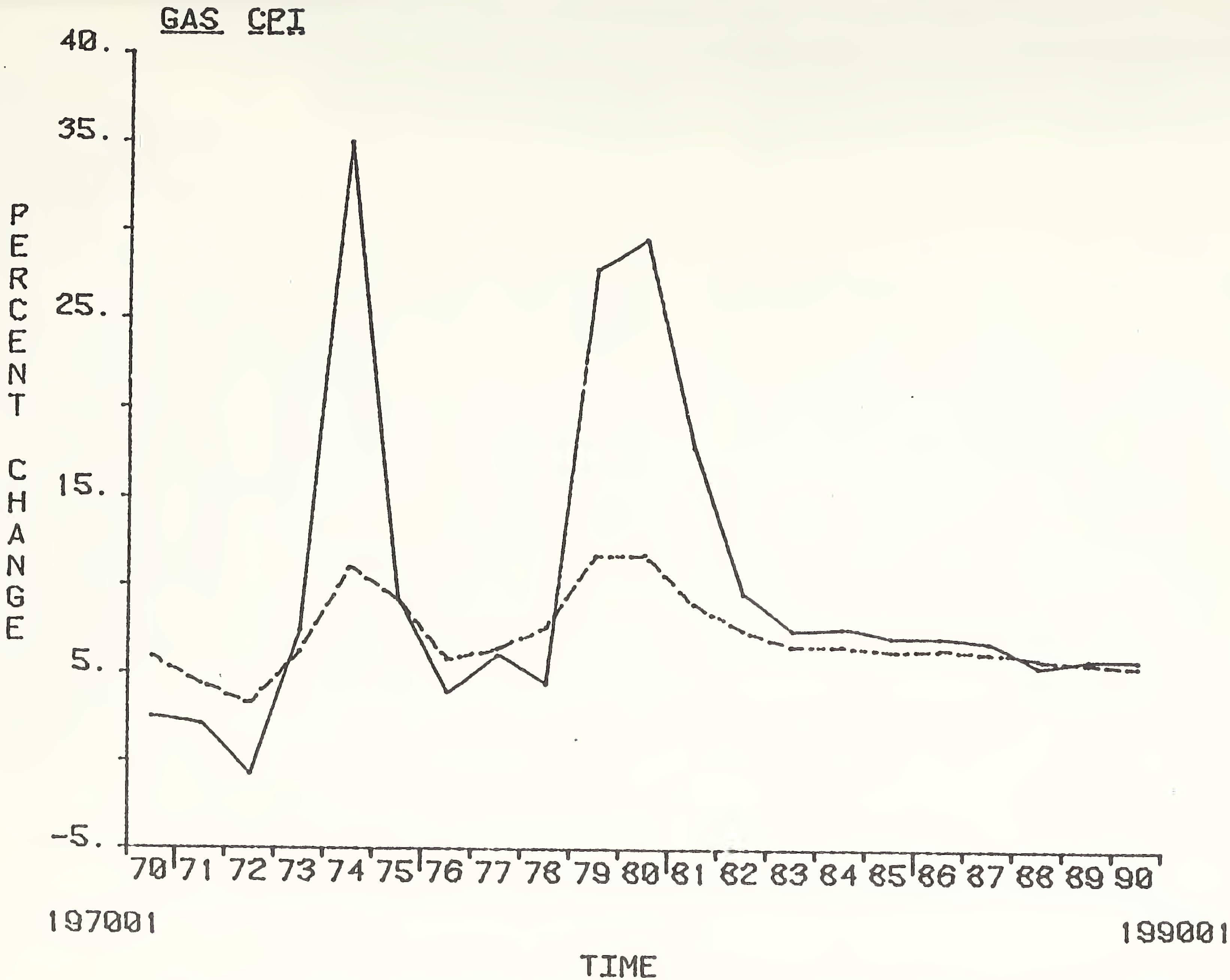


FIGURE 8-5. AUGUST CONTROL FORECAST GAS PRICE AND CONSUMER PRICE INDEX--PERCENT CHANGE

Higher gas prices contribute significantly to the inflationary environment facing new car buyers. Also having a powerful impact are sharp increases in purchase costs. After the devastating price hikes in 1975, domestic base list prices rose at only moderate rates in the 1976-78 period, below the general cost of living increase. This year, however, the average price increase has reached 11 percent for domestics. Imports prices have risen at a slower rate, having jumped over 14 percent last year.

Price increases are expected to range from 7 percent to 10 percent for the 1980-82 period, with foreign and domestic subcompact price hikes at the lower end of the scale. Together with rising options prices and installations, inevitable severe jumps in transportation fees, and a steady upward creep in the average sales tax rate, the result is an average new car purchase cost which rises 7.9 percent this year, despite the relatively huge sales mix shift towards cheaper cars. The projected increases are then 9.5 percent, 8.5 percent, and 8.5 percent, respectively, for 1980, 1981, and 1982.

Compounding these effects are sharp increases in other operating costs. After having been temporarily restrained in 1978, average insurance premium costs are forecast to increase by over 60 percent by 1982 compared to 1978! Major factors here are the repeal of no-fault laws and escalating labor costs. It is possible that reduced travel, stricter speed limit enforcement, and the mandated improvements in vehicle safety, could lead to significantly lower premium hikes. (High interest rates would also keep premiums down.) Repairs are another rapidly increasing cost component, due to higher wages and more complex engineering. Front-wheel drive and emissions equipment, for instance, both tend to add significantly to maintenance costs. The auto repairs index is projected to rise 50 percent by 1982 compared to 1978.

All of the above leads to rapid increases in capitalized costs per mile for every market segment, ranging from 12 percent to 15 percent for 1979-80, and 8 percent to 10 percent for 1981-82. The average increase exceeds the overall rate of inflation in consumer prices for the entire 1979-82 period. The cumulative increase in the average real cost per mile through 1982 is 4 percent, compared to a decline of over 4 percent for the 1976-78 period. As Figure 8-6 shows, cost per mile rises more rapidly than

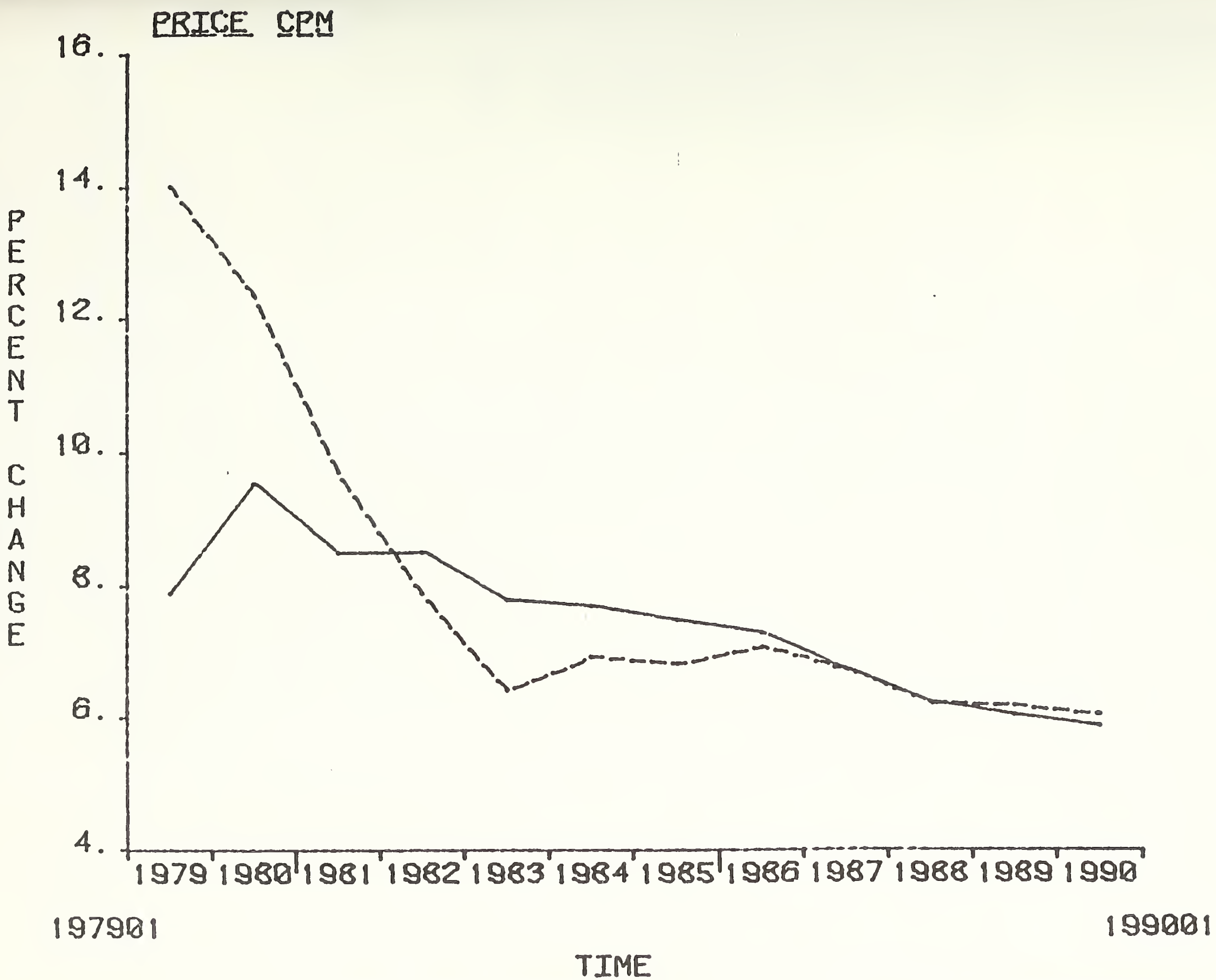


FIGURE 8-6. AUGUST CONTROL FORECAST NEW CAR PRICE AND COST PER MILE--PERCENT CHANGE

purchase costs until 1982, primarily due to the high gas price increases. From 1982 through 1986, the average cost per mile rises less rapidly than purchase costs, averaging a 7 percent annual rate, primarily aided by substantial fuel economy improvements.

8.3.4 Scrappage and Vehicles in Operation

As expected in a sales recession, scrappage is forecast to drop sharply this year, and again in 1980. This is consistent with historical behavior. Scrappage usually drops significantly faster than the sales decline, and in the 1974-75 recession (the only other two-year sales downturn was the mild 1966-67 recession) scrappage fell 27.5 percent and 5.4 percent, respectively. Since the 1975 trough scrappage has risen over 50 percent. Despite this recovery, the average age of the fleet is estimated to have risen to a new high of almost 5.8 years in 1978.

The low scrappage projection yields an average age projection reaching 6.2 years by 1984. Thereafter it slowly declines. The following factors are believed to be at work. First, the declines in, and slow recovery of, real family income. Secondly, the rapid jump in unemployment, which has a strong cyclical effect on whether to maintain an old car or not. Thirdly, high purchase costs and interest rates have already inspired a substantial increase in longer-term financing, and the number of 48 to 60 month contracts has increased sharply. Obviously this will encourage longer first-ownership periods, reducing the supply of good condition used cars. Fourthly, 1978 saw an extreme shortage of used cars and a sharp increase in average price, and finally, some retention of now-vanished "gas-guzzlers" may occur, especially given the forecast of reduced miles travelled per car.

Historically the "normal" ratio of scrappage to beginning of year vehicle fleet has ranged from 8.5 percent to 9.0 percent. Since 1975's abysmally low 6.2 percent it has recovered to 8.8 percent in 1978. In the forecast period it falls to 7 percent in 1980, and grows only slowly, reaching 8.6 percent.

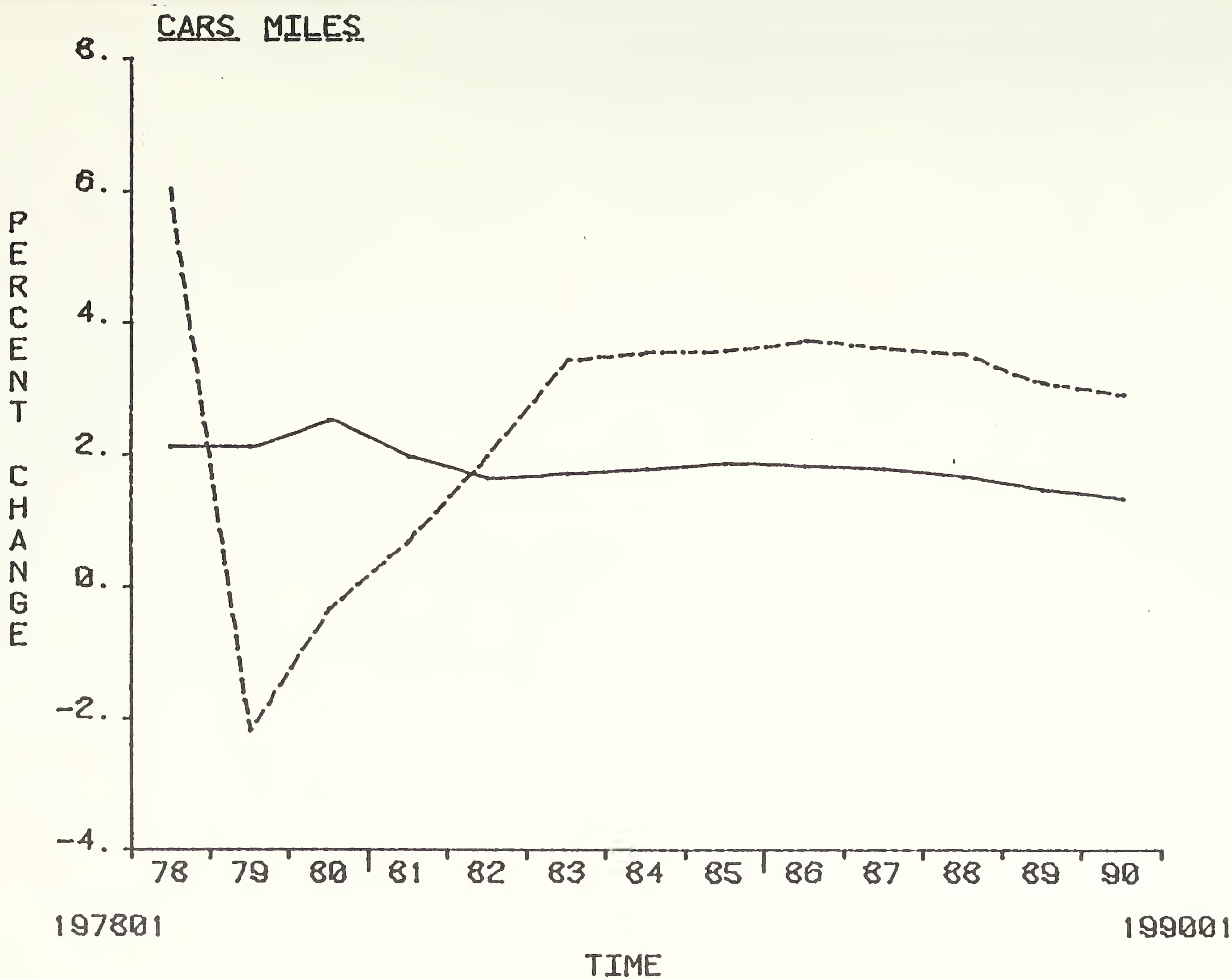


FIGURE 8-7. AUGUST CONTROL FORECAST CARS IN OPERATION AND VEHICLE MILES--PERCENT CHANGE

The year-end stock of vehicles in operation is estimated at 102.4 million for 1978. Due to the scrappage decline the total fleet maintains its recent growth path, at over 2 percent annually, in 1979-80. Thereafter growth fluctuates only slightly between 1.6 percent and 1.9 percent per year. The changes in stock by size-class are quite dramatic, reflecting the fundamental shifts in the sales mix. Currently, we estimate that 20.6 percent of the fleet are subcompacts, 19.2 percent are compacts, 24.2 percent are midsize, 26.8 percent are fullsize, and 9.2 percent are luxury cars. By 1985 the subcompact share hits 30 percent, while the full size fleet falls below 17 percent of the total. Foreign vehicles are estimated to possess a 14.5 percent share, which steadily rises towards 20 percent.

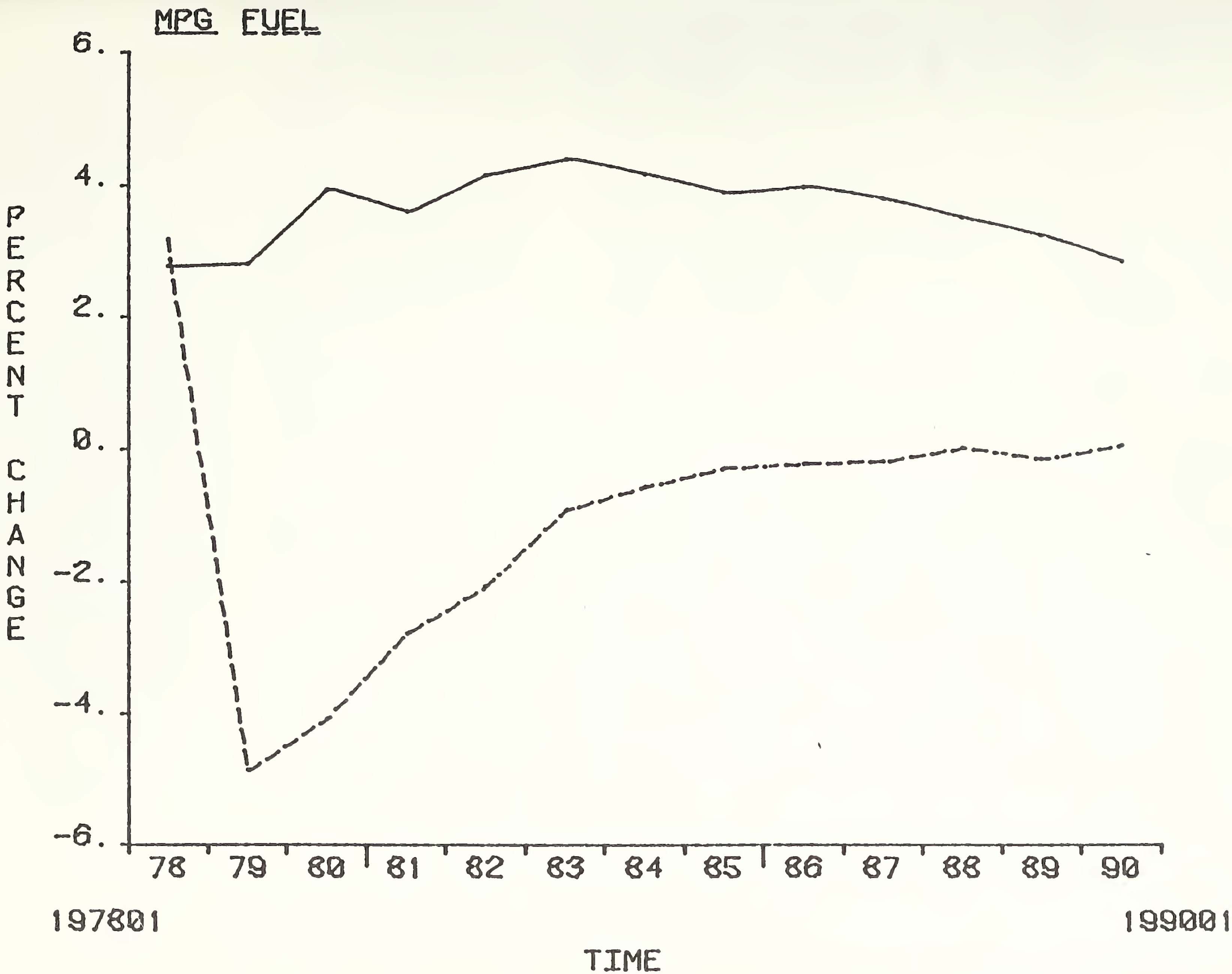


FIGURE 8-8. AUGUST CONTROL FORECAST FLEET AVG FUEL ECONOMY AND FUEL CONSUMPTION--PERCENT CHANGE

8.3.5 Vehicle Miles, MPG, and Fuel Consumption

The FHA data suggest that vehicle miles travelled (VMT) rose strongly in 1977-78 but this year's supply problems are forecast to cut VMT by over 2 percent with low income and continuing gas price increases resulting in zero growth in 1980. The two major travel purposes are commuting and social-recreational. Obviously both tend to slacken when unemployment rises and real income falls.

VMT growth recovers to historical trend in the 1980's, averaging 3.5 percent annually for 1983-87. The projected fuel economy improvements during this period are sufficiently rapid to substantially offset higher gas prices. On a per-vehicle basis, miles per auto rise rather strongly during the 1983-87 period, at 1.8 percent per year. Some of this is undoubtedly a rebound from the over 8 percent cumulative decline in usage during the 1979-81 period. Overall, rural-highway travel per car is forecast to show the strongest declines, over 6 percent in 1979, with another 5 percent in 1980-82, and very slow growth thereafter. Urban travel per car drops equally in 1979 and 1980, by 2.9 percent in each year. However, growth is very strong from 1983 on, averaging 2.7 percent per year. Some of this growth could perhaps be reduced by substantially improved mass transit facilities.

The overall fleet fuel economy appears to have risen by between 2.5 percent and 3.0 percent recently. As the higher mpg new cars enter the fleet, together with some changes in utilization patterns, the average mpg will rise by 4 percent annually. This more than offsets the longer term VMT growth, and thus fuel consumption falls throughout the forecast. This year should see a near 5 percent drop, with a further 4 percent fall in 1980. Total consumption is forecast to fall to 71 billion gallons, a 15 percent decline from 1978's estimated level.

Due to the improvements in individual mpg's as well as the favorable mix shift, the average new car "on road" mpg is predicted to increase by 10 percent this year, after an 8 percent jump in 1978. These estimated improvements have exceeded expectations. In 1980 the average increase may fall off somewhat, to 4 percent, however, it then begins to climb, peaking at a 5.5

percent efficiency gain in 1983. Domestics, naturally, set the pace, registering a 6.5 percent improvement in 1983.

In EPA "drive-cycle" terms, the 1979 domestic CAFE is estimated to have already reached the 1980 minimum of 20 mpg. Given the high fuel costs and proven consumer acceptance of smaller vehicles, we do not anticipate major problems in meeting the CAFE requirements through 1985. The intermediate standards in 1982-83 are very demanding, however, and attaining the 26 mpg level for 1983 is particularly difficult.

TABLE 8-2. THE WHARTON E.F.A. MOTOR VEHICLE DEMAND MODEL
AUGUST 1979 CONTROL SOLUTION

INDEX OF TABLES

Subtable	Page	Table Title
1.00	8-25	Selected Market Indicators
2.00	8-26	New Registrations (Mill Autos)
3.00	8-27	Growth Rates, New Registrations
4.00	8-28	Passenger Cars in Operation: Year-End
5.00	8-29	Growth Rates, Cars in Operation: Year-End
6.00	8-30	Cars in Operation
7.00	8-31	Growth Rates, Cars in Operation
8.00	8-32	Scrappage and Used Cars Market
9.00	8-33	Growth Rates, Scrappage and Used Car Market
10.00	8-34	Auto Prices (Dollars)
11.00	8-35	Growth Rates, Auto Prices
12.00	8-36	Miscellaneous Market Variables
13.00	8-37	Growth Rates, Miscellaneous Market Variables
14.00	8-38	Miles Per Gallon
15.00	8-39	Growth Rates, Miles Per Gallon
16.00	8-40	Economic and Demographic Variables
17.00	8-41	Growth Rates, Economic and Demographic Variables
18.00	8-42	Auto Characteristics
19.00	8-43	Growth Rates, Auto Characteristics
20.00	8-44	Micellaneous Assumptions
21.00	8-45 - 8-47	Constant Adjustments
22.00	8-48 - 8-50	Exogenous Assumptions

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 1.00 SELECTED MARKET INDICATORS

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	CARS IN OPERATION: YR-END	MILL AUTOS	102.4	104.6	107.2	109.3	111.1	113.0	115.0	117.1	119.2	121.3
2		%GROWTH	2.1	2.1	2.5	1.9	1.6	1.7	1.8	1.9	1.8	1.8
3												
4	NEW CAR RETAIL SALES	MILL AUTOS	11.15	10.50	10.23	10.28	10.50	11.17	11.68	12.04	12.41	12.60
5		%GROWTH	1.2	-5.8	-2.6	0.5	2.2	6.4	4.5	3.1	3.0	1.5
6												
7	TOTAL NEW CAR REGISTRATIONS	MILL AUTOS	10.93	10.25	9.99	10.04	10.26	10.92	11.42	11.77	12.13	12.31
8		%GROWTH	1.3	-6.2	-2.6	0.5	2.2	6.5	4.6	3.1	3.0	1.5
9												
10	DOMESTIC	MILL AUTOS	8.97	8.03	7.87	7.92	8.12	8.70	9.12	9.37	9.63	9.74
11		%GROWTH	1.8	-10.5	-2.0	0.6	2.5	7.1	4.8	2.7	2.8	1.2
12	FOREIGN	MILL AUTOS	1.96	2.22	2.11	2.12	2.14	2.22	2.30	2.41	2.50	2.57
13		%GROWTH	-1.0	13.4	-4.9	0.2	0.9	3.9	3.6	4.6	4.0	2.7
14												
15	% FOREIGN		17.9	21.7	21.2	21.1	20.8	20.3	20.1	20.4	20.6	20.9
16		%GROWTH	-2.2	21.0	-2.3	-0.3	-1.2	-2.4	-1.0	1.5	1.0	1.2
17	% SMALL CARS (SUB + COMP)		46.0	56.4	56.0	55.8	55.0	54.0	53.3	52.9	52.4	52.3
18		%GROWTH	-0.6	22.7	-0.8	-0.3	-1.3	-1.9	-1.3	-0.7	-0.9	-0.3
19												
20	TOTAL AUTOS SCRAPPED	MILL AUTOS	8.8	8.1	7.4	8.0	8.5	9.0	9.4	9.6	10.0	10.2
21		%GROWTH	6.1	-7.9	-9.2	8.1	6.7	6.2	4.5	2.3	4.1	1.8
22												
23	VEHICLE MILES TRAVELLED	BILL MILES	1187.	1161.	1158.	1166.	1189.	1230.	1273.	1319.	1368.	1417.
24		%GROWTH	6.0	-2.2	-0.3	0.7	2.0	3.4	3.5	3.6	3.7	3.6
25												
26	TOTAL FLEET MPG (WEFA EST.)		14.20	14.60	15.17	15.71	16.36	17.08	17.79	18.47	19.21	19.93
27		%GROWTH	2.8	2.8	3.9	3.6	4.1	4.4	4.1	3.9	4.0	3.8
28												
29	AUTO MOTOR FUEL CONSUMPTION	BILL GAL	83.64	79.57	76.32	74.19	72.65	71.99	71.57	71.38	71.22	71.09
30		%GROWTH	3.2	-4.9	-4.1	-2.8	-2.1	-0.9	-0.6	-0.3	-0.2	-0.2
31	CONSUMPTION EXPEND,GAS AND OIL,	BILL 72$	27.48	26.74	26.27	26.14	25.75	25.66	25.65	25.72	25.81	25.90
32		%GROWTH	4.2	-2.7	-1.8	-0.5	-1.5	-0.4	-0.0	0.3	0.3	0.4
33												
34	NEW CAR FLEET MPG (EPA EST.)		20.02	21.65	22.48	23.59	25.02	26.60	27.71	28.27	28.46	28.90
35		%GROWTH	6.7	8.2	3.8	4.9	6.1	6.3	4.2	2.0	0.7	1.6
36												
37	DOMESTIC		18.97	20.46	21.34	22.50	24.06	25.81	27.00	27.53	27.69	28.10
38		%GROWTH	7.8	7.9	4.3	5.5	6.9	7.3	4.6	2.0	0.6	1.5
39	FOREIGN		26.79	27.45	28.06	28.76	29.49	30.22	30.97	31.58	31.85	32.41
40		%GROWTH	0.6	2.4	2.2	2.5	2.5	2.5	2.5	2.0	0.9	1.7
41												
42	AVERAGE NEW CAR PURCHASE COST	DOLLARS	6730.	7260.	7952.	8626.	9358.	10087.	10863.	11675.	12524.	13366.
43		%GROWTH	7.6	7.9	9.5	8.5	8.5	7.8	7.7	7.5	7.3	6.7
44	CONSUMPTION EXPEND ON NEW CARS,	BILL 72$	35.61	32.52	31.42	32.98	34.19	37.06	39.35	41.26	43.14	44.22
45		%GROWTH	-0.1	-8.7	-3.4	5.0	3.7	8.4	6.2	4.8	4.5	2.5
46												
47	AVG CAP. COST PER MILE	CENTS/MILE	23.46	26.75	30.07	32.98	35.57	37.86	40.47	43.23	46.29	49.41
48		%GROWTH	4.9	14.0	12.4	9.7	7.9	6.4	6.9	6.8	7.1	6.7
49												
50	AVG USED CAR WHOLESALE PRICE	DOLLARS	3195.	3558.	3943.	4298.	4683.	5074.	5509.	5993.	6502.	7021.
51		%GROWTH	17.2	11.4	10.8	9.0	9.0	8.3	8.6	8.8	8.5	8.0
52	TOTAL USED CAR PURCHASES	MILL AUTOS	14.88	16.05	17.73	18.18	18.00	18.10	17.88	18.16	18.72	19.09
53		%GROWTH	-1.9	7.9	10.4	2.5	-1.0	0.6	-1.2	1.5	3.1	2.0

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 2.00 NEW REGISTRATIONS (MILL AUTOS)

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL NEW REGISTRATIONS		10.93	10.25	9.99	10.04	10.26	10.92	11.42	11.77	12.13	12.31
2												
3	SUBCOMPACT		2.94	3.74	3.53	3.50	3.47	3.59	3.70	3.78	3.86	3.91
4		%SHARE	26.9	36.5	35.3	34.8	33.8	32.9	32.4	32.2	31.9	31.8
5	COMPACT		2.09	2.05	2.06	2.10	2.18	2.30	2.39	2.45	2.50	2.53
6		%SHARE	19.1	20.0	20.6	20.9	21.2	21.1	20.9	20.8	20.6	20.5
7	MID-SIZE		2.99	2.22	2.17	2.20	2.31	2.50	2.63	2.71	2.80	2.86
8		%SHARE	27.3	21.6	21.7	21.9	22.5	22.9	23.0	23.1	23.1	23.2
9	FULL SIZE		1.87	1.30	1.28	1.28	1.34	1.51	1.64	1.70	1.79	1.81
10		%SHARE	17.1	12.7	12.8	12.7	13.1	13.8	14.4	14.5	14.8	14.7
11	LUXURY .		1.05	0.94	0.94	0.96	0.96	1.01	1.07	1.12	1.18	1.21
12		%SHARE	9.6	9.2	9.5	9.5	9.4	9.3	9.3	9.5	9.7	9.8
13												
14												
15	TOTAL DOMESTIC NEW REGISTRATIONS		8.97	8.03	7.87	7.92	8.12	8.70	9.12	9.37	9.63	9.74
16												
17	SUBCOMPACTS		1.20	1.76	1.64	1.61	1.56	1.61	1.64	1.64	1.63	1.62
18		%SHARE	13.4	21.9	20.8	20.3	19.2	18.5	18.0	17.5	17.0	16.6
19	COMPACT		1.98	1.94	1.95	1.99	2.07	2.19	2.28	2.34	2.39	2.42
20		%SHARE	22.0	24.1	24.7	25.2	25.5	25.2	25.0	24.9	24.8	24.8
21	MID-SIZE		2.99	2.22	2.17	2.20	2.31	2.50	2.63	2.71	2.80	2.86
22		%SHARE	33.3	27.6	27.6	27.8	28.5	28.8	28.8	29.0	29.1	29.3
23	FULL SIZE		1.87	1.30	1.28	1.28	1.34	1.51	1.64	1.70	1.79	1.81
24		%SHARE	20.8	16.2	16.3	16.1	16.5	17.3	18.0	18.2	18.6	18.6
25	LUXURY		0.94	0.81	0.83	0.84	0.84	0.88	0.93	0.97	1.01	1.04
26		%SHARE	10.5	10.1	10.6	10.6	10.4	10.1	10.2	10.4	10.5	10.7
27												
28												
29	TOTAL FOREIGN NEW REGISTRATIONS		1.96	2.22	2.11	2.12	2.14	2.22	2.30	2.41	2.50	2.57
30												
31	SUBCOMPACT		1.74	1.98	1.89	1.89	1.91	1.98	2.05	2.14	2.23	2.29
32		%SHARE	88.7	89.2	89.4	89.3	89.3	89.3	89.3	89.1	89.2	89.3
33	COMPACT		0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
34		%SHARE	5.6	5.0	5.2	5.2	5.1	5.0	4.8	4.6	4.4	4.3
35	LUXURY		0.11	0.13	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.17
36		%SHARE	5.6	5.8	5.3	5.5	5.6	5.8	5.9	6.3	6.4	6.5
37												
38	FOREIGN MARKET SHARES:	% OF TOTAL	17.9	21.7	21.2	21.1	20.8	20.3	20.1	20.4	20.6	20.9
39		% OF SUBCOMPACT	59.1	53.0	53.5	54.0	55.0	55.1	55.5	56.6	57.7	58.6
40		% OF COMPACT	5.3	5.4	5.3	5.2	5.0	4.8	4.6	4.5	4.4	4.4
41		% OF LUXURY	10.5	13.7	12.0	12.3	12.4	12.7	12.8	13.5	13.7	13.7

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 3.00 GROWTH RATES, NEW REGISTRATIONS

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL NEW REGISTRATIONS	1.3	-6.2	-2.6	0.5	2.2	6.5	4.6	3.1	3.0	1.5
3	SUBCOMPACT	7.0	27.2	-5.6	-0.9	-0.9	3.7	2.8	2.4	2.1	1.2
5	COMPACT	-7.1	-1.9	0.6	2.2	3.6	5.6	3.7	2.5	2.1	1.2
7	MID-SIZE	2.7	-25.8	-2.1	1.4	4.9	8.4	4.9	3.3	3.2	2.0
9	FULL SIZE	2.3	-30.2	-1.7	-0.2	4.8	12.5	8.8	3.9	5.1	0.9
11	LUXURY	-1.3	-9.9	-0.0	1.5	0.4	5.1	5.5	5.2	4.8	3.0
14	TOTAL DOMESTIC NEW REGISTRATIONS	1.8	-10.5	-2.0	0.6	2.5	7.1	4.8	2.7	2.8	1.2
16	SUBCOMPACTS	22.2	46.2	-6.7	-2.0	-3.0	3.4	1.9	-0.2	-0.5	-1.0
18	COMPACT	-7.8	-2.0	0.6	2.3	3.8	5.9	3.9	2.6	2.2	1.3
20	MID-SIZE	2.7	-25.8	-2.1	1.4	4.9	8.4	4.9	3.3	3.2	2.0
22	FULL SIZE	2.3	-30.2	-1.7	-0.2	4.8	12.5	8.8	3.9	5.1	0.9
24	LUXURY	-1.5	-13.1	2.0	1.1	0.2	4.8	5.4	4.3	4.6	2.9
27	TOTAL FOREIGN NEW REGISTRATIONS	-1.0	13.4	-4.9	0.2	0.9	3.9	3.6	4.6	4.0	2.7
29	SUBCOMPACT	-1.5	14.0	-4.6	0.0	1.0	3.9	3.6	4.4	4.1	2.8
31	COMPACT	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	LUXURY	0.2	17.5	-12.9	4.0	1.5	7.7	6.3	11.2	6.2	3.0

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 4.00 PASSENGER CARS IN OPERATION: YEAR-END (MILL AUTOS)

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL CARS IN OPERATION YEAR-END		102.4	104.6	107.2	109.3	111.1	113.0	115.0	117.1	119.2	121.3
2												
3	SUBCOMPACT		21.06	23.69	26.08	28.21	30.07	31.82	33.45	34.98	36.38	37.64
4		%SHARE	20.6	22.6	24.3	25.8	27.1	28.2	29.1	29.9	30.5	31.0
5	COMPACT		19.70	20.34	21.09	21.74	22.35	22.94	23.51	24.06	24.55	25.01
6		%SHARE	19.2	19.4	19.7	19.9	20.1	20.3	20.4	20.5	20.6	20.6
7	MID-SIZE		24.80	25.10	25.55	25.92	26.28	26.69	27.10	27.52	27.91	28.30
8		%SHARE	24.2	24.0	23.8	23.7	23.7	23.6	23.6	23.5	23.4	23.3
9	FULL SIZE		27.42	25.76	24.50	23.19	21.95	20.92	20.12	19.53	19.11	18.85
10		%SHARE	26.8	24.6	22.9	21.2	19.8	18.5	17.5	16.7	16.0	15.5
11	LUXURY		9.44	9.68	9.97	10.22	10.41	10.60	10.80	11.03	11.27	11.52
12		%SHARE	9.2	9.3	9.3	9.4	9.4	9.4	9.4	9.4	9.4	9.5
13												
14												
15	DOMESTIC CARS IN OPERATION		87.62	88.46	89.87	90.86	91.65	92.63	93.74	94.97	96.20	97.47
16												
17	SUBCOMPACTS		8.10	9.55	10.84	11.98	12.95	13.84	14.64	15.35	15.94	16.43
18		%SHARE	9.2	10.8	12.1	13.2	14.1	14.9	15.6	16.2	16.6	16.9
19	COMPACTS		18.70	19.29	19.99	20.60	21.17	21.75	22.30	22.84	23.32	23.79
20		%SHARE	21.3	21.8	22.2	22.7	23.1	23.5	23.8	24.0	24.2	24.4
21	MID-SIZE		24.80	25.10	25.55	25.92	26.28	26.69	27.10	27.52	27.91	28.30
22		%SHARE	28.3	28.4	28.4	28.5	28.7	28.8	28.9	29.0	29.0	29.0
23	FULL SIZE		27.42	25.76	24.50	23.19	21.95	20.92	20.12	19.53	19.11	18.85
24		%SHARE	31.3	29.1	27.3	25.5	24.0	22.6	21.5	20.6	19.9	19.3
25	LUXURY		8.58	8.74	8.97	9.16	9.30	9.43	9.57	9.74	9.91	10.10
26		%SHARE	9.8	9.9	10.0	10.1	10.1	10.2	10.2	10.3	10.3	10.4
27												
28												
29	FOREIGN CARS IN OPERATION		14.81	16.12	17.34	18.43	19.41	20.35	21.24	22.14	23.02	23.85
30												
31	SUBCOMPACTS		12.96	14.14	15.24	16.23	17.12	17.98	18.81	19.64	20.44	21.21
32		%SHARE	87.5	87.7	87.9	88.1	88.2	88.4	88.5	88.7	88.8	88.9
33	COMPACTS		1.00	1.05	1.10	1.14	1.17	1.20	1.21	1.22	1.22	1.23
34		%SHARE	6.7	6.5	6.3	6.2	6.0	5.9	5.7	5.5	5.3	5.1
35	LUXURY		0.85	0.94	1.00	1.06	1.11	1.17	1.22	1.29	1.35	1.42
36		%SHARE	5.8	5.8	5.8	5.8	5.7	5.7	5.8	5.8	5.9	5.9
37												
38	FOREIGN SHARES: % OF TOTAL		14.5	15.4	16.2	16.9	17.5	18.0	18.5	18.9	19.3	19.7
39	% OF SUBCOMPACT		61.5	59.7	58.4	57.5	56.9	56.5	56.2	56.1	56.2	56.3
40	% OF COMPACT		5.1	5.2	5.2	5.2	5.2	5.2	5.1	5.1	5.0	4.9
41	% OF LUXURY		9.1	9.7	10.0	10.4	10.7	11.0	11.3	11.7	12.0	12.3

A PRODUCT OF WHARTON EFA, 3624 SCIENCE CENTER, PHILA, PA 19104   WRITTEN PERMISSION MUST BE OBTAINED FOR SECONDARY DISTRIBUTION

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 5.00 GROWTH RATES, CARS IN OPERATION: YEAR-END

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL CARS IN OPERATION YEAR-END	2.1	2.1	2.5	1.9	1.6	1.7	1.8	1.9	1.8	1.8
2											
3	SUBCOMPACT	9.7	12.5	10.1	8.2	6.6	5.8	5.1	4.6	4.0	3.5
4											
5	COMPACT	3.2	3.2	3.7	3.1	2.8	2.7	2.5	2.3	2.0	1.9
6											
7	MID-SIZE	3.6	1.2	1.8	1.4	1.4	1.6	1.5	1.6	1.4	1.4
8											
9	FULL SIZE	-5.2	-6.1	-4.9	-5.3	-5.3	-4.7	-3.9	-2.9	-2.1	-1.4
10											
11	LUXURY	3.3	2.5	3.1	2.5	1.9	1.8	1.9	2.1	2.2	2.2
12											
13											
14	DOMESTIC CARS IN OPERATION	1.2	1.0	1.6	1.1	0.9	1.1	1.2	1.3	1.3	1.3
15											
16	SUBCOMPACTS	12.9	17.9	13.5	10.5	8.0	6.9	5.8	4.8	3.8	3.1
17											
18	COMPACTS	3.0	3.1	3.6	3.1	2.8	2.7	2.6	2.4	2.1	2.0
19											
20	MID-SIZE	3.6	1.2	1.8	1.4	1.4	1.6	1.5	1.6	1.4	1.4
21											
22	FULL SIZE	-5.2	-6.1	-4.9	-5.3	-5.3	-4.7	-3.9	-2.9	-2.1	-1.4
23											
24	LUXURY	2.8	1.8	2.6	2.1	1.5	1.4	1.5	1.7	1.8	1.9
25											
26											
27	FOREIGN CARS IN OPERATION	7.7	8.9	7.6	6.3	5.3	4.8	4.4	4.2	3.9	3.6
28											
29	SUBCOMPACTS	7.8	9.1	7.8	6.5	5.5	5.0	4.6	4.4	4.1	3.8
30											
31	COMPACTS	5.5	5.1	4.9	3.8	2.8	1.9	1.2	0.7	0.4	0.2
32											
33	LUXURY	7.9	9.5	6.9	6.1	5.1	4.9	4.7	5.2	5.1	4.8

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 6.00 CARS IN OPERATION

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	CARS IN OPERATION: ALL VINTAGES	101.3	103.4	105.8	108.2	110.1	111.9	113.8	115.9	118.0	120.1
2											
3	BY AGE, MID YEAR(MILL AUTOS)										
4											
5	LESS THAN 1 YEAR OLD	5.46	5.12	4.99	5.01	5.12	5.45	5.70	5.88	6.06	6.15
6	AGE: 1 YEAR OLD	10.74	10.89	10.21	9.95	10.00	10.22	10.88	11.38	11.73	12.08
7	AGE: 2 YEARS OLD	9.60	10.67	10.82	10.15	9.89	9.94	10.16	10.81	11.30	11.65
8	AGE: 3 YEARS OLD	8.04	9.48	10.56	10.71	10.05	9.79	9.84	10.05	10.69	11.18
9	AGE: 4 YEARS OLD	8.32	7.89	9.33	10.40	10.55	9.89	9.63	9.68	9.88	10.51
10	AGE: 5 YEARS OLD	10.59	8.10	7.70	9.12	10.16	10.30	9.65	9.39	9.43	9.63
11	AGE: 6 YEARS OLD	9.39	10.17	7.81	7.44	8.81	9.80	9.93	9.30	9.04	9.08
12	AGE: 7 YEARS OLD	8.25	8.81	9.62	7.41	7.05	8.33	9.26	9.37	8.77	8.53
13	AGE: 8 YEARS OLD	6.39	7.55	8.15	8.94	6.88	6.54	7.71	8.56	8.65	8.08
14	AGE: 9 YEARS OLD	6.38	5.65	6.78	7.36	8.06	6.18	5.86	6.90	7.64	7.71
15	AGE: 10 YEARS OLD	5.22	5.32	4.82	5.83	6.31	6.89	5.26	4.98	5.84	6.45
16	AGE: 11 YEARS OLD	3.62	4.10	4.31	3.96	4.77	5.14	5.58	4.25	4.00	4.68
17	AGE: 12 YEARS OLD	2.95	2.76	3.24	3.46	3.17	3.80	4.07	4.39	3.33	3.12
18	AGE: 13 YEARS OLD	2.30	2.23	2.16	2.58	2.75	2.50	2.98	3.18	3.41	2.58
19	AGE: 14 YEARS OLD	1.47	1.73	1.74	1.72	2.05	2.17	1.96	2.33	2.47	2.64
20	AGE: 15 YEARS OLD	0.98	1.11	1.36	1.39	1.37	1.62	1.70	1.53	1.81	1.91
21	AGE: 16 YEARS OLD	0.63	0.74	0.87	1.08	1.10	1.08	1.27	1.33	1.19	1.40
22	AGE: 17 YEARS OLD	0.38	0.48	0.58	0.69	0.86	0.87	0.85	0.99	1.03	0.92
23	AGE: 18 YEARS OLD	0.30	0.29	0.37	0.46	0.55	0.68	0.68	0.66	0.77	0.80
24	AGE: 19 YEARS OLD	0.20	0.23	0.22	0.30	0.37	0.43	0.53	0.53	0.51	0.60
25	AGE: 20 YEARS OLD	0.11	0.15	0.18	0.18	0.24	0.29	0.34	0.42	0.42	0.40
26											
27	SHARES BY AGE(PERCENT)										
28											
29	LESS THAN 1 YEAR OLD	5.4	4.9	4.7	4.6	4.7	4.9	5.0	5.1	5.1	5.1
30	AGE: 1 YEAR OLD	10.6	10.5	9.7	9.2	9.1	9.1	9.6	9.8	9.9	10.1
31	AGE: 2 YEARS OLD	9.5	10.3	10.2	9.4	9.0	8.9	8.9	9.3	9.6	9.7
32	AGE: 3 YEARS OLD	7.9	9.2	10.0	9.9	9.1	8.7	8.6	8.7	9.1	9.3
33	AGE: 4 YEARS OLD	8.2	7.6	8.8	9.6	9.6	8.8	8.5	8.3	8.4	8.8
34	AGE: 5 YEARS OLD	10.5	7.8	7.3	8.4	9.2	9.2	8.5	8.1	8.0	8.0
35	AGE: 6 YEARS OLD	9.3	9.8	7.4	6.9	8.0	8.8	8.7	8.0	7.7	7.6
36	AGE: 7 YEARS OLD	8.1	8.5	9.1	6.9	6.4	7.4	8.1	8.1	7.4	7.1
37	AGE: 8 YEARS OLD	6.3	7.3	7.7	8.3	6.2	5.8	6.8	7.4	7.3	6.7
38	AGE: 9 YEARS OLD	6.3	5.5	6.4	6.8	7.3	5.5	5.1	6.0	6.5	6.4
39	AGE: 10 YEARS OLD	5.2	5.1	4.6	5.4	5.7	6.2	4.6	4.3	4.9	5.4
40	AGE: 11 YEARS OLD	3.6	4.0	4.1	3.7	4.3	4.6	4.9	3.7	3.4	3.9
41	AGE: 12 YEARS OLD	2.9	2.7	3.1	3.2	2.9	3.4	3.6	3.8	2.8	2.6
42	AGE: 13 YEARS OLD	2.3	2.2	2.0	2.4	2.5	2.2	2.6	2.7	2.9	2.1
43	AGE: 14 YEARS OLD	1.4	1.7	1.6	1.6	1.9	1.9	1.7	2.0	2.1	2.2
44	AGE: 15 YEARS OLD	1.0	1.1	1.3	1.3	1.2	1.4	1.5	1.3	1.5	1.6
45	AGE: 16 YEARS OLD	0.6	0.7	0.8	1.0	1.0	1.0	1.1	1.1	1.0	1.2
46	AGE: 17 YEARS OLD	0.4	0.5	0.5	0.6	0.8	0.8	0.7	0.9	0.9	0.8
47	AGE: 18 YEARS OLD	0.3	0.3	0.4	0.4	0.5	0.6	0.6	0.6	0.7	0.7
48	AGE: 19 YEARS OLD	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.4	0.5
49	AGE: 20 YEARS OLD	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.3

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 7.00 GROWTH RATES, CARS IN OPERATION

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	CARS IN OPERATION: ALL VINTAGES	2.3	2.1	2.3	2.2	1.8	1.7	1.7	1.8	1.8	1.8
2											
3	BY AGE,MID YEAR(MILL AUTOS)										
4											
5	LESS THAN 1 YEAR OLD	1.3	-6.2	-2.6	0.5	2.2	6.4	4.6	3.1	3.0	1.5
6	AGE: 1 YEAR OLD	11.1	1.3	-6.2	-2.6	0.5	2.2	6.4	4.6	3.1	3.0
7	AGE: 2 YEARS OLD	17.9	11.2	1.4	-6.1	-2.6	0.5	2.2	6.4	4.5	3.1
8	AGE: 3 YEARS OLD	-5.3	18.0	11.3	1.5	-6.2	-2.6	0.5	2.1	6.4	4.5
9	AGE: 4 YEARS OLD	-23.7	-5.2	18.2	11.4	1.4	-6.2	-2.7	0.5	2.1	6.4
10	AGE: 5 YEARS OLD	8.1	-23.5	-4.9	18.4	11.4	1.4	-6.2	-2.7	0.4	2.1
11	AGE: 6 YEARS OLD	6.5	8.3	-23.2	-4.7	18.3	11.3	1.3	-6.3	-2.8	0.4
12	AGE: 7 YEARS OLD	17.7	6.8	9.2	-23.0	-4.8	18.2	11.1	1.2	-6.4	-2.8
13	AGE: 8 YEARS OLD	-12.0	18.2	8.0	9.6	-23.1	-4.9	17.9	11.0	1.0	-6.5
14	AGE: 9 YEARS OLD	0.9	-11.4	20.0	8.6	9.4	-23.3	-5.2	17.7	10.8	0.9
15	AGE: 10 YEARS OLD	12.3	1.9	-9.4	21.1	8.2	9.0	-23.6	-5.5	17.4	10.5
16	AGE: 11 YEARS OLD	-7.5	13.4	5.0	-8.1	20.6	7.7	8.5	-23.9	-5.8	16.9
17	AGE: 12 YEARS OLD	-4.1	-6.6	17.4	6.9	-8.5	20.0	7.1	8.0	-24.2	-6.2
18	AGE: 13 YEARS OLD	16.9	-3.1	-3.1	19.7	6.4	-9.0	19.2	6.6	7.5	-24.5
19	AGE: 14 YEARS OLD	11.8	18.1	0.5	-1.2	19.1	5.9	-9.6	18.6	6.1	7.0
20	AGE: 15 YEARS OLD	15.6	12.9	22.4	2.4	-1.7	18.5	5.2	-10.0	18.1	5.6
21	AGE: 16 YEARS OLD	25.3	16.7	17.1	24.8	1.9	-2.2	17.8	4.7	-10.4	17.6
22	AGE: 17 YEARS OLD	-6.3	26.6	21.0	19.4	24.2	1.4	-2.8	17.2	4.2	-10.8
23	AGE: 18 YEARS OLD	15.4	-5.4	31.2	23.4	18.8	23.5	0.8	-3.3	16.7	3.7
24	AGE: 19 YEARS OLD	37.1	16.5	-1.9	33.8	22.8	18.2	22.8	0.3	-3.7	16.1
25	AGE: 20 YEARS OLD	-18.5	38.4	20.8	0.0	33.1	22.1	17.5	22.2	-0.2	-4.2
26											
27	SHARES BY AGE(PERCENT)										
28											
29	LESS THAN 1 YEAR OLD	-1.0	-8.1	-4.8	-1.6	0.4	4.7	2.8	1.3	1.2	-0.3
30	AGE: 1 YEAR OLD	8.6	-0.8	-8.3	-4.7	-1.2	0.5	4.6	2.7	1.3	1.2
31	AGE: 2 YEARS OLD	15.2	8.9	-0.9	-8.2	-4.3	-1.1	0.4	4.5	2.7	1.3
32	AGE: 3 YEARS OLD	-7.4	15.5	8.8	-0.7	-7.8	-4.2	-1.2	0.3	4.5	2.7
33	AGE: 4 YEARS OLD	-25.4	-7.1	15.6	9.0	-0.4	-7.7	-4.3	-1.3	0.3	4.5
34	AGE: 5 YEARS OLD	5.6	-25.1	-7.0	15.8	9.4	-0.3	-7.8	-4.4	-1.3	0.3
35	AGE: 6 YEARS OLD	4.0	6.1	-24.9	-6.8	16.2	9.5	-0.4	-8.0	-4.5	-1.4
36	AGE: 7 YEARS OLD	15.1	4.6	6.7	-24.6	-6.5	16.2	9.3	-0.6	-8.1	-4.5
37	AGE: 8 YEARS OLD	-14.0	15.8	5.5	7.3	-24.4	-6.5	15.9	9.0	-0.7	-8.2
38	AGE: 9 YEARS OLD	-1.4	-13.3	17.3	6.2	7.5	-24.5	-6.8	15.6	8.8	-0.9
39	AGE: 10 YEARS OLD	9.7	-0.2	-11.4	18.5	6.3	7.3	-24.9	-7.1	15.3	8.6
40	AGE: 11 YEARS OLD	-9.6	11.1	2.7	-10.1	18.5	6.0	6.6	-25.2	-7.5	14.9
41	AGE: 12 YEARS OLD	-6.3	-8.5	14.8	4.6	-10.1	18.0	5.3	6.1	-25.5	-7.9
42	AGE: 13 YEARS OLD	14.2	-5.1	-5.3	17.1	4.5	-10.5	17.2	4.7	5.6	-25.9
43	AGE: 14 YEARS OLD	9.3	15.6	-1.8	-3.3	17.0	4.1	-11.1	16.5	4.2	5.1
44	AGE: 15 YEARS OLD	12.9	10.6	19.7	0.2	-3.4	16.6	3.4	-11.6	16.0	3.8
45	AGE: 16 YEARS OLD	22.5	14.3	14.5	22.1	0.1	-3.8	15.8	2.8	-12.0	15.5
46	AGE: 17 YEARS OLD	-8.4	23.9	18.3	16.8	22.0	-0.2	-4.5	15.1	2.4	-12.4
47	AGE: 18 YEARS OLD	12.8	-7.3	28.3	20.7	16.7	21.5	-0.9	-5.0	14.6	1.9
48	AGE: 19 YEARS OLD	33.9	14.1	-4.1	30.9	20.6	16.3	20.7	-1.5	-5.4	14.1
49	AGE: 20 YEARS OLD	-20.4	35.6	18.1	-2.1	30.8	20.2	15.5	20.0	-1.9	-5.9

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 8.00 SCRAPPAGE AND USED CAR MARKET

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL SCRAPPAGE DOMESTIC AND FOREIGN		8.80	8.10	7.36	7.95	8.48	9.01	9.42	9.63	10.03	10.21
2												
3	SUBCOMPACT DOMESTIC		0.28	0.31	0.35	0.47	0.59	0.72	0.84	0.94	1.04	1.12
4	SUBCOMPACT FOREIGN		0.79	0.80	0.79	0.90	1.01	1.12	1.23	1.31	1.43	1.53
5	SUBCOMPACT TOTAL		1.07	1.11	1.14	1.37	1.61	1.84	2.07	2.25	2.47	2.65
6												
7	COMPACT DOMESTIC		1.42	1.35	1.25	1.38	1.49	1.62	1.72	1.80	1.90	1.95
8	COMPACT FOREIGN		0.06	0.06	0.06	0.07	0.08	0.09	0.10	0.10	0.11	0.11
9	COMPACT TOTAL		1.48	1.41	1.31	1.45	1.57	1.71	1.82	1.90	2.01	2.06
10												
11	MID-SIZE		2.12	1.92	1.72	1.84	1.95	2.09	2.22	2.29	2.41	2.47
12												
13	FULL SIZE		3.37	2.96	2.54	2.59	2.58	2.54	2.45	2.29	2.21	2.07
14												
15	LUXURY DOMESTIC		0.70	0.66	0.60	0.65	0.71	0.75	0.79	0.80	0.84	0.86
16	LUXURY FOREIGN		0.05	0.05	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.10
17	LUXURY TOTAL		0.75	0.71	0.65	0.71	0.77	0.83	0.87	0.89	0.94	0.96
18												
19												
20	USED CAR MARKET											
21												
22	AVERAGE WHOLESALE PRICE	DOLLARS	3195.	3558.	3943.	4298.	4683.	5074.	5509.	5993.	6502.	7021.
23												
24	PRICE OF 1 YR OLD CAR/NEW CAR (%):											
25	SUBCOMPACT		68.4	70.8	70.2	70.4	70.1	69.6	69.2	69.2	69.1	69.2
26	COMPACT		77.5	81.7	82.2	82.1	81.8	80.8	80.2	80.1	80.0	80.0
27	MID-SIZE		69.1	68.2	70.8	71.2	71.1	70.7	70.1	70.0	70.1	70.2
28	FULL SIZE		74.2	75.4	80.5	82.1	81.1	80.0	78.4	78.6	78.8	79.2
29	LUXURY		77.5	78.5	82.8	83.0	82.4	81.6	80.7	80.5	80.8	81.1
30												
31	TOTAL USED CARS PURCHASED	MILL AUTOS	14.88	16.05	17.73	18.18	18.00	18.10	17.88	18.16	18.72	19.09

A PRODUCT OF WHARTON EFA, 3624 SCIENCE CENTER,PHILA,PA 19104 WRITTEN PERMISSION MUST BE OBTAINED FOR SECONDARY DISTRIBUTION

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 9.00 GROWTH RATES, SCRAPPAGE AND USED CAR MARKET

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL SCRAPPAGE DOMESTIC AND FOREIGN	6.1	-7.9	-9.2	8.1	6.7	6.2	4.5	2.3	4.1	1.8
2											
3	SUBCOMPACT DOMESTIC	21.1	11.2	12.9	33.7	27.3	21.2	16.6	11.4	11.5	7.6
4	SUBCOMPACT FOREIGN	16.5	0.8	-1.9	14.6	12.4	10.7	9.5	7.0	8.7	6.9
5	SUBCOMPACT TOTAL	17.7	3.5	2.2	20.5	17.5	14.6	12.3	8.8	9.9	7.2
6											
7	COMPACT DOMESTIC	8.6	-5.4	-7.2	10.4	8.1	8.4	6.3	4.7	5.6	2.7
8	COMPACT FOREIGN	17.2	1.7	-0.2	16.4	14.1	12.0	9.6	5.3	4.3	1.7
9	COMPACT TOTAL	8.9	-5.1	-6.9	10.6	8.4	8.6	6.4	4.8	5.5	2.7
10											
11	MID-SIZE	3.6	-9.8	-10.1	6.6	6.4	7.2	5.9	3.4	4.9	2.8
12											
13	FULL SIZE	2.6	-12.1	-14.3	1.9	-0.3	-1.6	-3.6	-6.3	-3.8	-6.3
14											
15	LUXURY DOMESTIC	8.4	-6.5	-8.6	9.0	7.9	6.5	4.5	2.4	4.4	2.2
16	LUXURY FOREIGN	17.3	2.4	-0.7	17.0	14.8	12.8	11.0	7.9	8.6	5.9
17	LUXURY TOTAL	8.9	-6.0	-8.0	9.6	8.4	7.1	5.1	2.9	4.9	2.5
18											
19											
20	USED CAR MARKET										
21											
22	AVERAGE WHOLESALE PRICE DOLLARS	17.2	11.4	10.8	9.0	9.0	8.3	8.6	8.8	8.5	8.0
23											
24	PRICE OF 1 YR OLD CAR/NEW CAR (%):										
25	SUBCOMPACT	-5.7	3.5	-0.9	0.3	-0.5	-0.6	-0.6	-0.1	-0.0	0.1
26	COMPACT	13.7	5.4	0.7	-0.1	-0.5	-1.2	-0.7	-0.2	-0.1	0.0
27	MID-SIZE	8.7	-1.2	3.8	0.5	-0.2	-0.6	-0.8	-0.1	0.0	0.2
28	FULL SIZE	5.5	1.7	6.7	2.0	-1.2	-1.4	-2.1	0.2	0.3	0.6
29	LUXURY	1.6	1.3	5.4	0.3	-0.7	-1.0	-1.2	-0.2	0.3	0.4
30											
31	TOTAL USED CARS PURCHASED MILL AUTOS	-1.9	7.9	10.4	2.5	-1.0	0.6	-1.2	1.5	3.1	2.0

A PRODUCT OF WHARTON EFA, 3624 SCIENCE CENTER,PHILA,PA 19104 WRITTEN PERMISSION MUST BE OBTAINED FOR SECONDARY DISTRIBUTION

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 10.00 AUTO PRICES (DOLLARS)

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL AUTO PRICES:										
2	SUBCOMPACT DOMESTIC	4673.	5178.	5630.	6064.	6550.	7010.	7491.	8070.	8700.	9345.
3	SUBCOMPACT FOREIGN	5472.	6055.	6503.	6976.	7480.	7976.	8484.	9023.	9603.	10197.
4	COMPACT DOMESTIC	5686.	6353.	6918.	7490.	8099.	8694.	9333.	10020.	10740.	11467.
5	COMPACT FOREIGN	8352.	9113.	9866.	10693.	11539.	12389.	13274.	14172.	15097.	16033.
6	MID-SIZE	6828.	7617.	8391.	9098.	9866.	10616.	11412.	12224.	13067.	13915.
7	FULL SIZE	7226.	8058.	8873.	9650.	10501.	11339.	12225.	13079.	13964.	14852.
8	LUXURY DOMESTIC	11000.	12252.	13473.	14639.	15931.	17197.	18528.	19801.	21114.	22433.
9	LUXURY FOREIGN	18648.	20392.	22413.	24543.	26874.	29253.	31733.	34270.	36886.	39565.
10											
11	BASE PRICE: DOM.FXD.WTD.AVG.	5272.	5855.	6400.	6918.	7508.	8078.	8676.	9277.	9897.	10516.
12	SUBCOMPACT DOMESTIC	3737.	4099.	4430.	4736.	5088.	5420.	5767.	6177.	6600.	7022.
13	SUBCOMPACT FOREIGN	4498.	4933.	5258.	5600.	5967.	6333.	6703.	7074.	7447.	7821.
14	COMPACT DOMESTIC	4286.	4756.	5166.	5552.	5996.	6423.	6873.	7360.	7861.	8363.
15	COMPACT FOREIGN	6834.	7381.	7962.	8578.	9244.	9909.	10589.	11271.	11961.	12656.
16	MID-SIZE	5108.	5669.	6193.	6689.	7254.	7799.	8371.	8951.	9548.	10146.
17	FULL SIZE	5288.	5905.	6492.	7052.	7685.	8301.	8947.	9555.	10181.	10808.
18	LUXURY DOMESTIC	8651.	9648.	10605.	11520.	12554.	13558.	14611.	15604.	16627.	17651.
19	LUXURY FOREIGN	15956.	17406.	19089.	20908.	22913.	24957.	27081.	29250.	31481.	33764.
20											
21	MAX OPTIONS PRICE: DOM.FXD.WTD.AVG.	1525.	1658.	1788.	1912.	2042.	2168.	2296.	2422.	2548.	2673.
22	SUBCOMPACT	1368.	1487.	1604.	1715.	1832.	1945.	2059.	2173.	2286.	2398.
23	COMPACT	1456.	1583.	1708.	1826.	1950.	2071.	2193.	2313.	2434.	2553.
24	MID-SIZE	1491.	1622.	1749.	1870.	1997.	2121.	2245.	2369.	2493.	2615.
25	FULL SIZE	1583.	1721.	1856.	1985.	2120.	2251.	2383.	2514.	2646.	2775.
26	LUXURY	1644.	1787.	1928.	2062.	2201.	2338.	2475.	2611.	2747.	2882.
27	VALUE OF OPTIONS INSTALLED:										
28	SUBCOMPACT	534.	611.	664.	722.	783.	831.	876.	944.	1043.	1149.
29	COMPACT	904.	1012.	1078.	1182.	1270.	1357.	1455.	1558.	1675.	1794.
30	MID-SIZE	1155.	1292.	1445.	1571.	1687.	1800.	1922.	2047.	2180.	2313.
31	FULL SIZE	1327.	1460.	1604.	1733.	1857.	1982.	2115.	2250.	2392.	2533.
32	LUXURY	1562.	1711.	1863.	2000.	2137.	2270.	2406.	2543.	2683.	2821.
33											
34	AVERAGE SALES TAX: RATE	4.86	5.02	5.18	5.34	5.50	5.66	5.82	5.98	6.14	6.30
35	SUBCOMPACT DOMESTIC	208.	236.	264.	291.	323.	354.	387.	426.	469.	515.
36	SUBCOMPACT FOREIGN	245.	278.	307.	337.	371.	405.	441.	479.	521.	566.
37	COMPACT DOMESTIC	252.	290.	323.	359.	399.	440.	485.	533.	586.	640.
38	COMPACT FOREIGN	376.	421.	468.	521.	578.	637.	701.	767.	837.	911.
39	MID-SIZE	305.	349.	395.	441.	491.	543.	599.	658.	720.	786.
40	FULL SIZE	322.	370.	419.	469.	524.	582.	644.	706.	772.	841.
41	LUXURY DOMESTIC	497.	570.	646.	722.	807.	895.	990.	1085.	1186.	1291.
42	LUXURY FOREIGN	852.	960.	1085.	1223.	1377.	1540.	1716.	1901.	2098.	2307.
43	TRANSPORTATION CHARGES:										
44	SUBCOMPACT DOMESTIC	193.	232.	272.	315.	357.	405.	461.	523.	589.	658.
45	SUBCOMPACT FOREIGN	194.	233.	274.	317.	359.	408.	464.	526.	592.	662.
46	COMPACT DOMESTIC	244.	296.	352.	397.	434.	474.	520.	569.	619.	670.
47	COMPACT FOREIGN	239.	298.	358.	412.	447.	486.	529.	576.	624.	672.
48	MID-SIZE	260.	307.	358.	397.	434.	474.	520.	569.	619.	670.
49	FULL SIZE	290.	323.	358.	397.	434.	474.	520.	569.	619.	670.
50	LUXURY DOMESTIC	290.	323.	358.	397.	434.	474.	520.	569.	619.	670.
51	LUXURY FOREIGN	277.	315.	375.	412.	447.	486.	529.	576.	624.	672.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 11.00 GROWTH RATES, AUTO PRICES

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	TOTAL AUTO PRICES:										
2	SUBCOMPACT DOMESTIC	6.4	10.8	8.7	7.7	8.0	7.0	6.9	7.7	7.8	7.4
3	SUBCOMPACT FOREIGN	13.7	10.7	7.4	7.3	7.2	6.6	6.4	6.4	6.4	6.2
4	COMPACT DOMESTIC	5.6	11.7	8.9	8.3	8.1	7.3	7.3	7.4	7.2	6.8
5	COMPACT FOREIGN	1.9	9.1	8.3	8.4	7.9	7.4	7.1	6.8	6.5	6.2
6	MID-SIZE	7.4	11.6	10.2	8.4	8.4	7.6	7.5	7.1	6.9	6.5
7	FULL SIZE	7.5	11.5	10.1	8.8	8.8	8.0	7.8	7.0	6.8	6.4
8	LUXURY DOMESTIC	7.5	11.4	10.0	8.7	8.8	7.9	7.7	6.9	6.6	6.2
9	LUXURY FOREIGN	15.5	9.4	9.9	9.5	9.5	8.9	8.5	8.0	7.6	7.3
10											
11	BASE PRICE: DOM.FXD.WTD.AVG.	6.8	11.1	9.3	8.1	8.5	7.6	7.4	6.9	6.7	6.3
12	SUBCOMPACT DOMESTIC	5.6	9.7	8.1	6.9	7.4	6.5	6.4	7.1	6.8	6.4
13	SUBCOMPACT FOREIGN	14.2	9.7	6.6	6.5	6.6	6.1	5.9	5.5	5.3	5.0
14	COMPACT DOMESTIC	4.4	11.0	8.6	7.5	8.0	7.1	7.0	7.1	6.8	6.4
15	COMPACT FOREIGN	0.6	8.0	7.9	7.7	7.8	7.2	6.9	6.4	6.1	5.8
16	MID-SIZE	8.4	11.0	9.2	8.0	8.4	7.5	7.3	6.9	6.7	6.3
17	FULL SIZE	6.6	11.7	9.9	8.6	9.0	8.0	7.8	6.8	6.6	6.2
18	LUXURY DOMESTIC	7.6	11.5	9.9	8.6	9.0	8.0	7.8	6.8	6.6	6.2
19	LUXURY FOREIGN	16.4	9.1	9.7	9.5	9.6	8.9	8.5	8.0	7.6	7.3
20											
21	MAX OPTIONS PRICE: DOM.FXD.WTD.AVG.	6.8	8.7	7.9	6.9	6.8	6.2	5.9	5.5	5.2	4.9
22	SUBCOMPACT	5.8	8.7	7.9	6.9	6.8	6.2	5.9	5.5	5.2	4.9
23	COMPACT	7.9	8.7	7.9	6.9	6.8	6.2	5.9	5.5	5.2	4.9
24	MID-SIZE	3.8	8.7	7.9	6.9	6.8	6.2	5.9	5.5	5.2	4.9
25	FULL SIZE	8.7	8.7	7.9	6.9	6.8	6.2	5.9	5.5	5.2	4.9
26	LUXURY	6.0	8.7	7.9	6.9	6.8	6.2	5.9	5.5	5.2	4.9
27	VALUE OF OPTIONS INSTALLED:										
28	SUBCOMPACT	9.6	14.3	8.8	8.6	8.4	6.1	5.4	7.8	10.4	10.2
29	COMPACT	9.3	12.0	6.5	9.7	7.5	6.8	7.3	7.1	7.5	7.1
30	MID-SIZE	1.6	11.8	11.8	8.8	7.4	6.7	6.8	6.5	6.5	6.1
31	FULL SIZE	9.8	10.1	9.8	8.0	7.2	6.7	6.7	6.4	6.3	5.9
32	LUXURY	5.6	9.5	8.9	7.3	6.8	6.2	6.0	5.7	5.5	5.2
33											
34	AVERAGE SALES TAX: RATE	3.3	3.2	3.1	3.1	3.0	2.9	2.9	2.7	2.7	2.7
35	SUBCOMPACT DOMESTIC	9.6	13.8	11.6	10.4	10.8	9.6	9.3	10.1	10.2	9.8
36	SUBCOMPACT FOREIGN	17.4	13.7	10.2	10.0	10.0	9.2	8.9	8.7	8.8	8.5
37	COMPACT DOMESTIC	8.7	14.7	11.6	11.2	11.1	10.2	10.1	10.0	9.8	9.3
38	COMPACT FOREIGN	4.9	12.0	11.1	11.3	10.9	10.3	10.0	9.4	9.2	8.8
39	MID-SIZE	10.6	14.7	13.2	11.5	11.5	10.5	10.3	9.8	9.5	9.1
40	FULL SIZE	10.8	15.0	13.4	11.8	11.9	10.9	10.7	9.6	9.4	8.9
41	LUXURY DOMESTIC	10.8	14.8	13.2	11.8	11.9	10.9	10.6	9.6	9.3	8.8
42	LUXURY FOREIGN	19.2	12.7	13.0	12.7	12.6	11.9	11.4	10.8	10.4	9.9
43	TRANSPORTATION CHARGES:										
44	SUBCOMPACT DOMESTIC	9.0	20.0	17.6	15.7	13.4	13.5	13.8	13.5	12.5	11.8
45	SUBCOMPACT FOREIGN	9.7	19.9	17.6	15.7	13.4	13.5	13.8	13.5	12.5	11.8
46	COMPACT DOMESTIC	10.7	21.0	19.1	12.8	9.3	9.4	9.6	9.4	8.8	8.3
47	COMPACT FOREIGN	9.1	24.8	19.9	15.2	8.5	8.7	8.9	8.8	8.3	7.8
48	MID-SIZE	11.6	17.9	16.8	10.8	9.3	9.4	9.6	9.4	8.8	8.3
49	FULL SIZE	9.6	11.3	11.0	10.8	9.3	9.4	9.6	9.4	8.8	8.3
50	LUXURY DOMESTIC	9.6	11.3	11.0	10.8	9.3	9.4	9.6	9.4	8.8	8.3
51	LUXURY FOREIGN	14.0	13.8	19.1	9.8	8.5	8.7	8.9	8.8	8.3	7.8

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 12.00 MISCELLANEOUS MARKET VARIABLES

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	LONG-RUN EQUILIBRIUM ('DESIRED') VALUES											
2	DESIRED STOCK	MILL AUTOS	102.125	102.957	103.933	105.725	108.036	110.769	113.241	115.954	118.471	121.025
3	DESIRED STOCK PER DRIVER	AUTOS	0.723	0.713	0.706	0.705	0.709	0.715	0.721	0.727	0.732	0.737
4												
5	DESIRED SHARE BY SIZE-CLASS (PERCENT)											
6	TOTAL DOMESTIC		85.05	84.99	84.74	84.52	84.48	84.60	84.53	83.99	83.58	83.16
7	SUBCOMPACT		11.54	11.57	15.16	15.34	15.39	15.53	15.61	15.43	15.21	15.00
8	COMPACT		18.32	19.29	19.61	19.91	20.16	20.17	20.15	20.12	20.05	20.05
9	MID-SIZE		25.27	25.30	23.26	23.29	23.52	23.71	23.74	23.72	23.71	23.73
10	FULL SIZE		21.60	20.55	18.28	17.51	17.04	16.89	16.70	16.34	16.16	15.87
11	LUXURY		8.31	8.27	8.43	8.47	8.37	8.29	8.33	8.37	8.45	8.52
12												
13	TOTAL FOREIGN		14.95	15.01	15.26	15.48	15.52	15.40	15.47	16.01	16.42	16.84
14	SUBCOMPACT		13.04	12.99	13.27	13.45	13.49	13.39	13.47	13.96	14.35	14.76
15	COMPACT AND LUXURY		1.92	2.03	2.00	2.04	2.03	2.01	2.00	2.05	2.07	2.08
16												
17	AVG AGE OF AUTO STOCK	YEARS	5.757	5.802	5.909	6.032	6.131	6.184	6.191	6.172	6.135	6.093
18												
19	YEAR-END STOCK PER FAMILY	AUTOS	1.271	1.272	1.279	1.280	1.277	1.276	1.277	1.280	1.284	1.287
20	TOTAL MILES PER AUTO:	THOUS MILES	11.71	11.22	10.93	10.77	10.79	10.98	11.17	11.36	11.58	11.78
21	RURAL	THOUS MILES	4.80	4.51	4.41	4.29	4.28	4.31	4.33	4.33	4.35	4.36
22	URBAN	THOUS MILES	6.92	6.72	6.52	6.48	6.51	6.67	6.84	7.03	7.23	7.42
23	NEW REGIS. TO BEGINNING STOCK	RATIO	0.109	0.100	0.095	0.094	0.094	0.098	0.101	0.102	0.104	0.103
24	SCRAPPAGE TO BEGINNING STOCK	RATIO	0.088	0.079	0.070	0.074	0.078	0.081	0.083	0.084	0.086	0.086
25												
26	CAPITALIZED COST PER MILE BY SIZE:											
27	SUBCOMPACTS		0.1890	0.2153	0.2437	0.2681	0.2908	0.3109	0.3328	0.3561	0.3818	0.4082
28	COMPACTS		0.2158	0.2445	0.2781	0.3058	0.3299	0.3509	0.3750	0.4010	0.4297	0.4592
29	MID-SIZE		0.2402	0.2749	0.3130	0.3437	0.3697	0.3924	0.4194	0.4482	0.4797	0.5120
30	FULL SIZE		0.2551	0.2922	0.3324	0.3649	0.3934	0.4177	0.4465	0.4764	0.5095	0.5434
31	LUXURY		0.3352	0.3861	0.4344	0.4764	0.5165	0.5525	0.5919	0.6334	0.6777	0.7225
32												
33	CAP. COST PER MILE BY FOR/DOM:											
34	TOTAL DOMESTIC		0.239	0.265	0.303	0.333	0.359	0.383	0.410	0.439	0.471	0.504
35	SUBCOMPACT		0.1832	0.2091	0.2375	0.2610	0.2828	0.3014	0.3223	0.3460	0.3719	0.3986
36	COMPACT		0.2141	0.2425	0.2760	0.3035	0.3274	0.3481	0.3721	0.3979	0.4266	0.4560
37	LUXURY		0.3241	0.3706	0.4197	0.4595	0.4970	0.5300	0.5668	0.6042	0.6454	0.6874
38												
39	TOTAL FOREIGN		0.209	0.239	0.268	0.296	0.321	0.345	0.371	0.397	0.426	0.454
40	SUBCOMPACT		0.1930	0.2207	0.2491	0.2741	0.2974	0.3187	0.3411	0.3639	0.3890	0.4150
41	COMPACT		0.2469	0.2800	0.3155	0.3478	0.3782	0.4061	0.4357	0.4654	0.4972	0.5297
42	LUXURY		0.4294	0.4835	0.5426	0.5973	0.6542	0.7072	0.7633	0.8204	0.8809	0.9431

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 13.00 GROWTH RATES, MISCELLANEOUS MARKET VARIABLES

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	LONG-RUN EQUILIBRIUM ('DESIRED') VALUES											
2	DESIRED STOCK	MILL AUTOS	3.3	0.8	0.9	1.7	2.2	2.5	2.2	2.4	2.2	2.2
3	DESIRED STOCK PER DRIVER	AUTOS	0.9	-1.4	-1.0	-0.1	0.5	0.9	0.7	0.9	0.7	0.7
4												
5	DESIRED SHARE BY SIZE-CLASS (PERCENT)											
6	TOTAL DOMESTIC		2.6	-0.1	-0.3	-0.3	-0.0	0.1	-0.1	-0.6	-0.5	-0.5
7	SUBCOMPACT		10.1	0.2	31.1	1.2	0.3	0.9	0.5	-1.2	-1.4	-1.4
8	COMPACT		2.0	5.3	1.6	1.5	1.3	0.1	-0.1	-0.2	-0.4	-0.0
9	MID-SIZE		4.6	0.1	-8.1	0.2	1.0	0.8	0.1	-0.1	-0.0	0.1
10	FULL SIZE		-0.9	-4.9	-11.0	-4.2	-2.7	-0.9	-1.2	-2.1	-1.1	-1.8
11	LUXURY		-2.3	-0.4	1.9	0.4	-1.2	-0.9	0.4	0.6	0.9	0.8
12												
13	TOTAL FOREIGN		-12.5	0.4	1.7	1.4	0.2	-0.8	0.5	3.5	2.5	2.6
14	SUBCOMPACT		-14.6	-0.4	2.1	1.4	0.3	-0.7	0.6	3.6	2.8	2.9
15	COMPACT AND LUXURY		4.7	5.6	-1.3	2.0	-0.4	-1.0	-0.3	2.5	0.8	0.5
16												
17	AVG AGE OF AUTO STOCK	YEARS	0.2	0.8	1.8	2.1	1.6	0.9	0.1	-0.3	-0.6	-0.7
18												
19	YEAR-END STOCK PER FAMILY	AUTOS	-0.6	0.1	0.6	0.0	-0.2	-0.1	0.1	0.2	0.3	0.3
20	VEHICLE MILES PER AUTO: TOTAL	MILES	3.6	-4.2	-2.6	-1.5	0.2	1.7	1.8	1.7	1.9	1.8
21	URBAN	MILES	4.8	-2.9	-2.9	-0.7	0.4	2.5	2.6	2.8	2.8	2.6
22	RURAL	MILES	1.9	-6.1	-2.1	-2.8	-0.2	0.6	0.5	0.1	0.3	0.4
23	NEW REGIS. TO BEGINNING STOCK	RATIO		-8.2	-4.6	-1.9	0.2	4.7	2.8	1.3	1.2	-0.3
24	SCRAPPAGE TO BEGINNING STOCK	RATIO		-9.8	-11.1	5.5	4.6	4.5	2.8	0.5	2.2	0.0
25												
26	CAPITALIZED COST PER MILE($/MILE)											
27												
28	AVG NOMINAL CAP. COST PER MILE		4.9	14.0	12.4	9.7	7.9	6.4	6.9	6.8	7.1	6.7
29												
30	AVG REAL CAP. COST PER MILE		-2.6	2.1	0.5	0.7	0.4	-0.1	0.2	0.5	0.5	0.5
31												
32	CAPITALIZED COST PER MILE BY SIZE:											
33	SUBCOMPACTS		6.6	13.9	13.2	10.0	8.5	6.9	7.0	7.0	7.2	6.9
34	COMPACTS		3.7	13.3	13.7	10.0	7.9	6.4	6.9	6.9	7.2	6.9
35	MID-SIZE		3.1	14.4	13.8	9.8	7.6	6.1	6.9	6.9	7.0	6.7
36	FULL SIZE		4.9	14.5	13.7	9.8	7.8	6.2	6.9	6.7	7.0	6.7
37	LUXURY		6.4	15.2	12.5	9.7	8.4	7.0	7.1	7.0	7.0	6.6
38												
39	CAP. COST PER MILE BY FOR/DOM:											
40	TOTAL DOMESTIC		3.6	11.1	14.1	9.9	8.1	6.5	7.1	7.1	7.3	6.9
41	SUBCOMPACT		3.8	14.2	13.6	9.9	8.3	6.6	6.9	7.3	7.5	7.2
42	COMPACT		3.7	13.3	13.8	10.0	7.9	6.3	6.9	6.9	7.2	6.9
43	LUXURY		5.5	14.3	13.3	9.5	8.2	6.6	6.9	6.6	6.8	6.5
44												
45	TOTAL FOREIGN		8.7	14.2	12.2	10.3	8.7	7.5	7.3	7.2	7.1	6.7
46	SUBCOMPACT		8.5	14.3	12.9	10.0	8.5	7.1	7.0	6.7	6.9	6.7
47	COMPACT		2.5	13.4	12.7	10.2	8.7	7.4	7.3	6.8	6.8	6.5
48	LUXURY		12.0	12.6	12.2	10.1	9.5	8.1	7.9	7.5	7.4	7.1

TABLE . 14.00 MILES PER GALLON

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	OVERALL FLEET MILES PER GALLON	14.20	14.60	15.17	15.71	16.36	17.08	17.79	18.47	19.21	19.93
2											
3	NEW AUTO MILES PER GALLON(WEFA)										
4	TOTAL DOMESTIC AND FOREIGN	14.54	16.04	16.65	17.36	18.27	19.28	19.96	20.50	20.74	21.00
5	SUBCOMPACT	20.34	20.82	21.43	22.05	22.70	23.44	24.03	24.59	24.91	25.25
6	COMPACT	14.81	16.39	16.94	17.65	18.65	19.75	20.52	21.13	21.40	21.68
7	MID-SIZE	13.37	14.13	14.86	15.60	16.76	18.02	18.77	19.29	19.53	19.78
8	FULL SIZE	12.18	12.84	13.58	14.35	15.34	16.53	17.29	17.84	18.07	18.31
9	LUXURY	11.69	12.40	12.94	13.64	14.43	15.26	15.89	16.43	16.64	16.86
10											
11	TOTAL DOMESTIC	13.66	15.06	15.71	16.46	17.45	18.58	19.31	19.83	20.04	20.27
12	SUBCOMPACT	19.32	20.11	20.87	21.72	22.61	23.77	24.61	25.12	25.45	25.78
13	COMPACT	14.64	16.27	16.82	17.55	18.58	19.73	20.52	21.14	21.41	21.69
14	LUXURY	11.33	11.94	12.55	13.26	14.07	14.93	15.58	16.10	16.30	16.51
15											
16	TOTAL FOREIGN	20.59	20.98	21.45	21.82	22.24	22.63	23.03	23.60	23.94	24.29
17	SUBCOMPACT	21.12	21.49	21.95	22.34	22.77	23.18	23.58	24.19	24.54	24.90
18	COMPACT	18.73	18.96	19.27	19.55	19.87	20.17	20.45	20.92	21.22	21.52
19	LUXURY	15.92	16.44	16.85	17.21	17.61	17.99	18.38	18.90	19.17	19.44
20											
21											
22	NEW AUTO MILES PER GALLON (EPA)										
23	TOTAL DOMESTIC AND FOREIGN	20.02	21.65	22.48	23.59	25.02	26.60	27.71	28.27	28.46	28.90
24	SUBCOMPACT	26.82	27.28	28.12	29.20	30.34	31.56	32.60	33.16	33.42	33.96
25	COMPACT	20.54	21.82	22.62	23.75	25.33	27.12	28.43	29.10	29.34	29.80
26	MID-SIZE	18.63	19.28	20.21	21.25	22.92	24.84	26.04	26.64	26.85	27.28
27	FULL SIZE	17.03	18.03	18.96	20.13	21.67	23.43	24.55	25.07	25.27	25.68
28	LUXURY	16.18	17.11	17.91	19.10	20.43	21.74	22.72	23.21	23.40	23.79
29											
30	TOTAL DOMESTIC	18.97	20.46	21.34	22.50	24.06	25.81	27.00	27.53	27.69	28.10
31	SUBCOMPACT	25.90	26.34	27.41	28.86	30.45	32.27	33.70	34.18	34.45	34.98
32	COMPACT	20.36	21.67	22.49	23.65	25.28	27.13	28.48	29.16	29.39	29.85
33	LUXURY	15.79	16.61	17.51	18.73	20.12	21.49	22.51	22.97	23.16	23.53
34											
35	TOTAL FOREIGN	26.79	27.45	28.06	28.76	29.49	30.22	30.97	31.58	31.85	32.41
36	SUBCOMPACT	27.50	28.17	28.76	29.50	30.24	31.00	31.77	32.42	32.70	33.27
37	COMPACT	24.43	24.76	25.19	25.75	26.32	26.89	27.47	27.94	28.19	28.68
38	LUXURY	20.48	21.07	21.60	22.25	22.90	23.58	24.26	24.86	25.08	25.52

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 15.00 GROWTH RATES, MILES PER GALLON

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	OVERALL FLEET MILES PER GALLON	2.77	2.82	3.92	3.58	4.14	4.38	4.14	3.87	3.96	3.79
2											
3	NEW AUTO MILES PER GALLON(WEFA)										
4	TOTAL DOMESTIC AND FOREIGN	8.0	10.3	3.8	4.3	5.2	5.5	3.5	2.7	1.2	1.3
5	SUBCOMPACT	3.3	2.4	2.9	2.9	3.0	3.3	2.5	2.3	1.3	1.4
6	COMPACT	6.9	10.7	3.3	4.2	5.6	5.9	3.9	3.0	1.3	1.3
7	MID-SIZE	13.9	5.7	5.2	5.0	7.4	7.5	4.1	2.8	1.3	1.3
8	FULL SIZE	5.2	5.4	5.8	5.7	6.9	7.8	4.6	3.2	1.3	1.3
9	LUXURY	4.4	6.1	4.3	5.4	5.7	5.8	4.2	3.4	1.3	1.3
10											
11	TOTAL DOMESTIC	9.2	10.2	4.3	4.8	6.0	6.5	3.9	2.7	1.1	1.2
12	SUBCOMPACT	8.4	4.1	3.7	4.1	4.1	5.1	3.5	2.1	1.3	1.3
13	COMPACT	6.8	11.1	3.4	4.4	5.9	6.2	4.0	3.0	1.3	1.3
14	LUXURY	4.5	5.3	5.1	5.7	6.1	6.1	4.4	3.3	1.3	1.3
15											
16	TOTAL FOREIGN	1.2	1.9	2.2	1.7	2.0	1.8	1.7	2.5	1.4	1.5
17	SUBCOMPACT	1.0	1.8	2.1	1.8	1.9	1.8	1.7	2.6	1.4	1.5
18	COMPACT	5.4	1.3	1.6	1.4	1.6	1.5	1.4	2.3	1.4	1.4
19	LUXURY	2.1	3.2	2.5	2.1	2.3	2.2	2.1	2.8	1.4	1.4
20											
21											
22	NEW AUTO MILES PER GALLON (EPA)										
23	TOTAL DOMESTIC AND FOREIGN	6.7	8.2	3.8	4.9	6.1	6.3	4.2	2.0	0.7	1.6
24	SUBCOMPACT	2.2	1.7	3.1	3.9	3.9	4.0	3.3	1.7	0.8	1.6
25	COMPACT	6.4	6.2	3.7	5.0	6.7	7.0	4.8	2.4	0.8	1.6
26	MID-SIZE	12.3	3.5	4.8	5.1	7.9	8.3	4.8	2.3	0.8	1.6
27	FULL SIZE	3.9	5.8	5.2	6.2	7.6	8.1	4.8	2.1	0.8	1.6
28	LUXURY	2.9	5.7	4.7	6.6	7.0	6.4	4.5	2.2	0.8	1.6
29											
30	TOTAL DOMESTIC	7.8	7.9	4.3	5.5	6.9	7.3	4.6	2.0	0.6	1.5
31	SUBCOMPACT	6.2	1.7	4.1	5.3	5.5	6.0	4.4	1.4	0.8	1.6
32	COMPACT	6.2	6.4	3.8	5.2	6.9	7.3	5.0	2.4	0.8	1.6
33	LUXURY	3.0	5.2	5.4	7.0	7.5	6.8	4.7	2.1	0.8	1.6
34											
35	TOTAL FOREIGN	0.6	2.4	2.2	2.5	2.5	2.5	2.5	2.0	0.9	1.7
36	SUBCOMPACT	0.3	2.4	2.1	2.5	2.5	2.5	2.5	2.0	0.9	1.7
37	COMPACT	5.9	1.3	1.8	2.2	2.2	2.2	2.2	1.7	0.9	1.7
38	LUXURY	0.9	2.9	2.5	3.0	3.0	2.9	2.9	2.4	0.9	1.8

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 16.00 ECONOMIC AND DEMOGRAPHIC VARIABLES

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	GENERAL:											
2	PERSONAL INCOME	BILL CURR $	1708.2	1904.3	2106.4	2330.3	2560.6	2816.1	3092.6	3385.2	3690.1	4014.6
3	PERSONAL INCOME TAXES	BILL CURR $	256.2	288.2	314.9	360.5	399.7	442.7	483.4	527.9	560.4	606.7
4	TRANSFER PAYMENTS	BILL CURR $	226.0	253.8	292.0	326.3	361.6	396.9	435.1	475.6	520.0	567.1
5												
6	REAL DISP. INCOME/FAMILY	THOU 72 $	9.75	9.52	9.19	9.08	9.09	9.20	9.33	9.46	9.59	9.69
7	REAL DISP. INCOME/LIC.DR.	THOU 72 $	5.57	5.42	5.23	5.17	5.18	5.26	5.34	5.43	5.50	5.56
8	FAMILIES WITH INCOME OVER $15,000											
9	IN 1970 $	PERCENT	24.5	23.6	22.7	22.4	22.3	22.5	23.0	23.4	24.0	24.5
10												
11	UNEMPLOYMENT RATE		6.0	6.2	7.6	8.2	8.2	8.0	7.6	7.3	6.9	6.5
12	NEW AUTOS INSTALL. CREDIT RATE	%	11.02	12.03	11.97	11.70	11.87	11.62	11.44	11.34	11.22	11.12
13												
14	CONSUMER PRICE INDICES (1967=100):											
15	TOTAL		195.4	218.2	243.9	265.6	285.3	304.1	324.3	344.8	367.2	390.0
16	AUTO REPAIRS		220.9	246.1	278.8	309.7	338.6	367.4	397.4	428.9	462.8	498.6
17	AUTO INSURANCE PREMIUMS		216.7	244.7	282.0	312.2	350.8	385.4	424.9	465.4	509.3	554.7
18	TIRES		142.1	154.7	164.0	173.8	184.3	195.3	207.0	219.5	232.6	246.6
19	MOTOR OIL		170.8	190.0	212.2	229.7	247.7	264.8	283.2	301.8	322.2	342.8
20	PARKING FEES		201.6	223.9	250.1	277.8	305.8	334.9	364.0	394.5	426.1	459.1
21												
22	OTHER COSTS AND PRICES:											
23	NEW AUTO UNIT PRICE	THOU 72 $	4.598	4.572	4.582	4.659	4.738	4.832	4.916	5.011	5.095	5.159
24	NEW AUTOS PRICE INDEX	1972=100	138.4	150.1	164.1	175.1	186.8	197.6	209.2	220.7	232.9	245.6
25	DOM. AUTO INPUT PRICE INDEX	1972=100	148.8	163.2	177.6	191.4	206.3	221.1	236.3	251.7	267.3	283.0
26	IMPORTED GOODS PRICE INDEX	1972=100	197.7	214.4	231.2	249.0	268.4	287.8	307.7	327.7	348.0	368.5
27	TRANSPORTATION PRICE INDEX	1972=100	147.2	159.0	170.1	183.2	195.3	208.3	222.5	237.3	252.1	266.8
28												
29	AVG RETAIL PRICE OF GASOLINE	CENTS	65.9	84.2	109.2	128.5	140.7	151.1	162.7	174.1	186.3	199.0
30	EXCUDING TAXES	CENTS	53.3	71.4	96.1	115.3	127.3	137.5	148.9	160.1	172.1	184.6
31	STATE AND LOCAL TAX	CENTS	8.6	8.9	9.1	9.2	9.4	9.6	9.8	10.0	10.2	10.4
32	FEDERAL TAX	CENTS	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
33												
34	NUMBER OF FAMILIES	MILL FAMILIES	57.21	58.21	59.18	60.18	61.21	62.22	63.19	64.10	65.00	65.87
35	NUMBER OF UNREL. INDIVIDUALS	MILL PERS	23.40	24.00	24.61	25.22	25.76	26.30	26.84	27.38	27.88	28.37
36	PERCENT OF FAMILIES WITH 3 OR 4 PERS.		30.8	30.9	31.2	31.3	31.5	31.6	31.6	31.8	31.8	31.8
37	PERCENT OF FAMILIES WITH 5+ PERSONS		13.6	13.0	12.2	11.7	11.1	10.6	10.2	9.6	9.4	9.0
38												
39	PERSONS 20 TO 29 PER FAMILY		0.474	0.473	0.472	0.470	0.466	0.461	0.454	0.446	0.435	0.422
40	NUMBER OF LICENSED DRIVERS	MILL PERS	141.2	144.3	147.2	149.9	152.5	154.9	157.2	159.4	161.8	164.1
41												
42	PERCENT OF POPULATION:											
43	IN METROPOLITAN AREAS		73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3	73.3
44	IN NEW ENGLAND REGION		5.7	5.7	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.5
45	IN SOUTH ATLANTIC REGION		15.7	15.7	15.6	15.6	15.6	15.5	15.5	15.4	15.4	15.4
46	IN EAST NORTH CENTRAL REGION		19.2	19.3	19.3	19.4	19.5	19.5	19.6	19.7	19.7	19.8
47	IN EAST SOUTH CENTRAL REGION		6.2	6.1	6.0	5.9	5.9	5.8	5.7	5.7	5.6	5.5
48	IN MOUNTAIN REGION		4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7
49	IN PACIFIC REGION		13.6	13.7	13.8	13.9	14.0	14.1	14.2	14.3	14.4	14.5
50	IN WEST NORTH CENTRAL REGION		7.7	7.7	7.7	7.6	7.6	7.6	7.6	7.5	7.5	7.5
51	IN WEST SOUTH CENTRAL REGION		10.0	10.1	10.1	10.2	10.3	10.3	10.4	10.4	10.5	10.6

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 17.00 GROWTH RATES, ECONOMIC AND DEMOGRAPHIC VARIABLES

LINE	ITEM		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	GENERAL:											
2	PERSONAL INCOME	BILL CURR $	11.7	11.5	10.6	10.6	9.9	10.0	9.8	9.5	9.0	8.8
3	PERSONAL INCOME TAXES	BILL CURR $	13.4	12.5	9.3	14.5	10.9	10.7	9.2	9.2	6.2	8.3
4	TRANSFER PAYMENTS	BILL CURR $	8.2	12.3	15.0	11.8	10.8	9.8	9.6	9.3	9.3	9.1
5												
6	REAL DISP. INCOME/FAMILY	THOU 72 $	1.3	-2.4	-3.4	-1.2	0.1	1.3	1.4	1.4	1.3	1.0
7	REAL DISP. INCOME/LIC.DR.	THOU 72 $	1.6	-2.6	-3.5	-1.2	0.2	1.5	1.6	1.6	1.4	1.0
8	FAMILIES WITH INCOME OVER $15,000											
9	IN 1970 $	PERCENT	0.0	-3.6	-4.2	-1.0	-0.7	0.8	2.6	1.6	2.4	2.2
10												
11	UNEMPLOYMENT RATE		-14.2	3.4	22.9	7.8	-0.7	-2.6	-4.1	-4.1	-5.7	-5.8
12	NEW AUTOS INSTALL. CREDIT RATE	%	1.2	9.2	-0.5	-2.3	1.4	-2.1	-1.6	-0.9	-1.0	-1.0
13												
14	CONSUMER PRICE INDICES (1967=100):											
15	TOTAL		7.7	11.7	11.8	8.9	7.4	6.6	6.7	6.3	6.5	6.2
16	AUTO REPAIRS		8.5	11.4	13.3	11.1	9.3	8.5	8.1	7.9	7.9	7.8
17	AUTO INSURANCE PREMIUMS		2.9	12.9	15.2	10.7	12.4	9.9	10.3	9.5	9.4	8.9
18	TIRES		3.2	8.9	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
19	MOTOR OIL		2.7	11.2	11.7	8.3	7.9	6.9	6.9	6.6	6.7	6.4
20	PARKING FEES		3.1	11.0	11.7	11.1	10.1	9.5	8.7	8.4	8.0	7.7
21												
22	OTHER COSTS AND PRICES:											
23	NEW AUTO UNIT PRICE	THOU 72 $	1.4	-0.6	0.2	1.7	1.7	2.0	1.7	1.9	1.7	1.2
24	NEW AUTOS PRICE INDEX	1972=100	8.5	8.5	9.3	6.7	6.7	5.7	5.9	5.5	5.5	5.4
25	DOM. AUTO INPUT PRICE INDEX	1972=100	8.2	9.7	8.8	7.7	7.8	7.2	6.9	6.5	6.2	5.9
26	IMPORTED GOODS PRICE INDEX	1972=100	14.6	8.4	7.8	7.7	7.8	7.2	6.9	6.5	6.2	5.9
27	TRANSPORTATION PRICE INDEX	1972=100	8.1	8.0	7.0	7.7	6.6	6.7	6.8	6.7	6.2	5.8
28												
29	AVG RETAIL PRICE OF GASOLINE	CENTS	4.4	27.9	29.6	17.7	9.5	7.4	7.6	7.0	7.0	6.8
30	EXCUDING TAXES	CENTS	5.0	34.0	34.6	20.1	10.4	8.0	8.2	7.5	7.5	7.2
31	FEDERAL TAX	CENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	STATE AND LOCAL TAX	CENTS	2.7	2.9	2.8	1.1	2.2	2.1	2.1	2.0	2.0	2.0
33												
34	NUMBER OF FAMILIES	MILL FAMILIES	0.9	1.7	1.7	1.7	1.7	1.6	1.6	1.4	1.4	1.3
35	NUMBER OF UNREL. INDIVIDUALS	MILL PERS	7.7	2.6	2.5	2.5	2.1	2.1	2.0	2.0	1.8	1.8
36												
37	PERCENT OF FAMILIES WITH 3 OR 4 PERS.		0.8	0.4	0.8	0.4	0.5	0.4	0.1	0.4	0.0	0.1
38	PERCENT OF FAMILIES WITH 5+ PERSONS		-5.4	-4.1	-5.9	-4.6	-4.8	-5.0	-3.3	-5.5	-2.9	-3.7
39												
40	PERSONS 20 TO 29 PER FAMILY		-1.0	-0.2	-0.2	-0.4	-0.8	-1.1	-1.4	-1.9	-2.5	-3.0
41	NUMBER OF LICENSED DRIVERS	MILL PERS	2.40	2.20	2.00	1.87	1.69	1.58	1.48	1.44	1.46	1.45
42												
43	PERCENT OF POPULATION:											
44	IN METROPOLITAN AREAS		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	IN NEW ENGLAND REGION		-0.3	-0.3	-0.2	-0.2	-0.3	-0.3	-0.2	-0.3	-0.3	-0.3
46	IN SOUTH ATLANTIC REGION		-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
47	IN EAST NORTH CENTRAL REGION		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
48	IN EAST SOUTH CENTRAL REGION		-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2	-1.2
49	IN MOUNTAIN REGION		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
50	IN PACIFIC REGION		0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
51	IN WEST NORTH CENTRAL REGION		-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
52	IN WEST SOUTH CENTRAL REGION		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 18.00 AUTO CHARACTERISTICS

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	CURB WEIGHT (POUNDS):										
2	DOMESTIC SUBCOMPACT	2575.	2525.	2475.	2425.	2380.	2340.	2310.	2300.	2300.	2300.
3	FOREIGN SUBCOMPACT	2363.	2328.	2293.	2258.	2224.	2191.	2158.	2126.	2126.	2126.
4	DOMESTIC COMPACT	3370.	3100.	3050.	3000.	2900.	2800.	2750.	2700.	2700.	2700.
5	FOREIGN COMPACT	2794.	2766.	2738.	2711.	2684.	2657.	2630.	2604.	2604.	2604.
6	MID-SIZE	3670.	3550.	3450.	3400.	3250.	3100.	3050.	3000.	3000.	3000.
7	FULL SIZE	4130.	3850.	3700.	3600.	3450.	3300.	3250.	3200.	3200.	3200.
8	DOMESTIC LUXURY	4435.	4150.	4000.	3850.	3700.	3600.	3550.	3500.	3500.	3500.
9	FOREIGN LUXURY	3329.	3262.	3197.	3133.	3071.	3009.	2949.	2890.	2890.	2890.
10											
11	ENGINE DISPLACEMENT (CUBIC INCHES):										
12	DOMESTIC SUBCOMPACT	145.7	137.0	129.3	124.5	119.8	110.2	105.5	100.7	100.7	100.7
13	FOREIGN SUBCOMPACT	104.6	102.5	100.5	98.4	96.5	94.6	92.7	90.8	90.8	90.8
14	DOMESTIC COMPACT	268.4	237.0	227.5	218.4	201.8	185.3	174.2	165.3	165.3	165.3
15	FOREIGN COMPACT	116.5	114.5	112.8	111.1	109.4	107.8	106.2	104.6	104.6	104.6
16	MID-SIZE	302.4	284.3	267.2	256.5	235.0	213.3	203.7	194.0	194.0	194.0
17	FULL SIZE	322.2	299.6	284.7	269.0	251.3	232.7	224.3	218.0	218.0	218.0
18	DOMESTIC LUXURY	402.7	374.5	355.8	336.6	315.4	299.6	287.9	280.4	280.4	280.4
19	FOREIGN LUXURY	170.0	167.4	164.9	162.5	160.0	157.6	155.3	152.9	152.9	152.9
20											
21	PERCENT WITH AUTOMATIC TRANSMISSION:										
22	DOMESTIC SUBCOMPACT	64.2	62.0	60.0	58.0	56.0	54.0	52.0	50.0	50.0	50.0
23	FOREIGN SUBCOMPACT	64.2	62.0	60.0	58.0	56.0	54.0	52.0	50.0	50.0	50.0
24	DOMESTIC COMPACT	87.0	84.0	82.0	80.0	78.0	76.0	74.0	72.0	72.0	72.0
25	FOREIGN COMPACT	77.0	72.0	70.0	68.0	66.0	64.0	62.0	60.0	60.0	60.0
26	MID-SIZE	99.2	95.0	92.5	90.0	87.5	85.0	82.5	80.0	80.0	80.0
27	FULL SIZE	99.9	98.0	97.0	95.0	92.5	90.0	87.5	85.0	85.0	85.0
28	DOMESTIC LUXURY	99.1	97.0	96.0	95.0	94.0	92.0	90.0	88.0	88.0	88.0
29	FOREIGN LUXURY	89.1	87.0	84.5	82.0	79.5	77.0	74.5	72.0	72.0	72.0
30											
31	PERCENT WITH 4 CYLINDERS:										
32	DOMESTIC SUBCOMPACT	74.5	77.5	80.0	82.5	85.0	87.5	90.0	90.0	90.0	90.0
33	FOREIGN SUBCOMPACT	100.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
34	DOMESTIC COMPACT	6.6	15.0	20.0	30.0	40.0	45.0	50.0	55.0	55.0	55.0
35	FOREIGN COMPACT	100.0	95.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
36	MID-SIZE	0.0	0.0	2.5	5.0	7.5	10.0	15.0	15.0	15.0	15.0
37	FULL SIZE	0.0	0.0	2.5	5.0	7.5	10.0	12.5	15.0	15.0	15.0
38	DOMESTIC LUXURY	0.0	0.1	0.5	1.0	2.0	5.0	10.0	15.0	15.0	15.0
39	FOREIGN LUXURY	37.0	45.0	50.0	55.0	60.0	65.0	70.0	70.0	70.0	70.0
40											
41	PERCENT WITH 6 CYLINDERS:										
42	DOMESTIC SUBCOMPACT	19.9	20.0	18.0	16.0	14.0	12.0	10.0	10.0	10.0	10.0
43	FOREIGN SUBCOMPACT	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
44	DOMESTIC COMPACT	45.5	60.0	55.0	50.0	45.0	40.0	35.0	30.0	30.0	30.0
45	FOREIGN COMPACT	0.0	5.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
46	MID-SIZE	21.9	25.0	35.0	50.0	65.0	70.0	70.0	70.0	70.0	70.0
47	FULL SIZE	3.5	10.0	20.0	30.0	40.0	50.0	60.0	65.0	65.0	65.0
48	DOMESTIC LUXURY	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	35.0	35.0
49	FOREIGN LUXURY	61.6	55.0	50.0	45.0	40.0	35.0	30.0	30.0	30.0	30.0

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 19.00 GROWTH RATES, AUTO CHARACTERISTICS

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	CURB WEIGHT (POUNDS):										
2	DOMESTIC SUBCOMPACT	-3.7	-1.9	-2.0	-2.0	-1.9	-1.7	-1.3	-0.4	0.0	0.0
3	FOREIGN SUBCOMPACT	-0.6	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	0.0	0.0
4	DOMESTIC COMPACT	-3.6	-8.0	-1.6	-1.6	-3.3	-3.4	-1.8	-1.8	0.0	0.0
5	FOREIGN COMPACT	-5.7	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	0.0	0.0
6	MID-SIZE	-10.7	-3.3	-2.8	-1.4	-4.4	-4.6	-1.6	-1.6	0.0	0.0
7	FULL SIZE	-0.9	-6.8	-3.9	-2.7	-4.2	-4.3	-1.5	-1.5	0.0	0.0
8	DOMESTIC LUXURY	-1.5	-6.4	-3.6	-3.8	-3.9	-2.7	-1.4	-1.4	0.0	0.0
9	FOREIGN LUXURY	-1.2	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	0.0	0.0
10											
11	ENGINE DISPLACEMENT (CUBIC INCHES):										
12	DOMESTIC SUBCOMPACT	-8.7	-6.0	-5.6	-3.7	-3.8	-8.0	-4.3	-4.5	0.0	0.0
13	FOREIGN SUBCOMPACT	1.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	0.0	0.0
14	DOMESTIC COMPACT	3.0	-11.7	-4.0	-4.0	-7.6	-8.2	-6.0	-5.1	0.0	0.0
15	FOREIGN COMPACT	-2.6	-1.8	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	0.0	0.0
16	MID-SIZE	-6.1	-6.0	-6.0	-4.0	-8.4	-9.2	-4.5	-4.8	0.0	0.0
17	FULL SIZE	-2.0	-7.0	-5.0	-5.5	-6.6	-7.4	-3.6	-2.8	0.0	0.0
18	DOMESTIC LUXURY	1.1	-7.0	-5.0	-5.4	-6.3	-5.0	-3.9	-2.6	0.0	0.0
19	FOREIGN LUXURY	-1.9	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	0.0	0.0
20											
21	PERCENT WITH AUTOMATIC TRANSMISSION:										
22	DOMESTIC SUBCOMPACT	-1.4	-3.4	-3.2	-3.3	-3.4	-3.6	-3.7	-3.8	0.0	0.0
23	FOREIGN SUBCOMPACT	-1.4	-3.4	-3.2	-3.3	-3.4	-3.6	-3.7	-3.8	0.0	0.0
24	DOMESTIC COMPACT	-7.3	-3.4	-2.4	-2.4	-2.5	-2.6	-2.6	-2.7	0.0	0.0
25	FOREIGN COMPACT	-8.1	-6.5	-2.8	-2.9	-2.9	-3.0	-3.1	-3.2	0.0	0.0
26	MID-SIZE	-0.6	-4.2	-2.6	-2.7	-2.8	-2.9	-2.9	-3.0	0.0	0.0
27	FULL SIZE	-0.1	-1.9	-1.0	-2.1	-2.6	-2.7	-2.8	-2.9	0.0	0.0
28	DOMESTIC LUXURY	-0.2	-2.1	-1.0	-1.0	-1.1	-2.1	-2.2	-2.2	0.0	0.0
29	FOREIGN LUXURY	-0.2	-2.4	-2.9	-3.0	-3.0	-3.1	-3.2	-3.4	0.0	0.0
30											
31	PERCENT WITH 4 CYLINDERS:										
32	DOMESTIC SUBCOMPACT	6.9	4.0	3.2	3.1	3.0	2.9	2.9	-0.0	0.0	0.0
33	FOREIGN SUBCOMPACT	0.0	-5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	DOMESTIC COMPACT	5400.0	127.3	33.3	50.0	33.3	12.5	11.1	10.0	0.0	0.0
35	FOREIGN COMPACT	0.0	-5.0	-10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	MID-SIZE				100.0	50.0	33.3	50.0	0.0	0.0	0.0
37	FULL SIZE				100.0	50.0	33.3	25.0	20.0	0.0	0.0
38	DOMESTIC LUXURY			400.0	100.0	100.0	150.0	100.0	50.0	0.0	0.0
39	FOREIGN LUXURY	6.9	21.6	11.1	10.0	9.1	8.3	7.7	0.0	0.0	0.0
40											
41	PERCENT WITH 6 CYLINDERS:										
42	DOMESTIC SUBCOMPACT	-10.0	0.5	-10.0	-11.1	-12.5	-14.3	-16.7	0.0	0.0	0.0
43	FOREIGN SUBCOMPACT			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	DOMESTIC COMPACT	-16.3	31.9	-8.3	-9.1	-10.0	-11.1	-12.5	-14.3	0.0	0.0
45	FOREIGN COMPACT			200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	MID-SIZE	241.7	14.2	40.0	42.9	30.0	7.7	0.0	0.0	0.0	0.0
47	FULL SIZE	148.2	185.7	100.0	50.0	33.3	25.0	20.0	8.3	0.0	0.0
48	DOMESTIC LUXURY			100.0	50.0	33.3	25.0	20.0	16.7	0.0	0.0
49	FOREIGN LUXURY	-4.3	-10.7	-9.1	-10.0	-11.1	-12.5	-14.3	0.0	0.0	0.0

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 20.00 MISCELLANEOUS ASSUMPTIONS

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	DOMESTIC CLASS BASE PRICE/AVG (RATIO)										
2	SUBCOMPACT	0.709	0.705	0.701	0.697	0.693	0.689	0.685	0.685	0.685	0.685
3	COMPACT	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813
4	MID-SIZE	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969
5	FULL SIZE	1.004	1.006	1.008	1.010	1.012	1.014	1.016	1.016	1.016	1.016
6	LUXURY	1.641	1.644	1.647	1.650	1.653	1.656	1.659	1.659	1.659	1.659
7	DOM CLASS MAX OPT PRICE/AVG (RATIO)										
8	SUBCOMPACT	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897
9	COMPACT	0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
10	MID-SIZE	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978
11	FULL SIZE	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038
12	LUXURY	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078
13											
14	MPG (WEFA) EFFICIENCY FACTORS										
15	CITY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.00	4.00	6.00
16	DOMESTIC SUBCOMPACT	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
17	FOREIGN SUBCOMPACT	1.00	1.00	2.00	3.00	4.00	5.00	6.00	6.00	6.00	6.00
18	DOMESTIC COMPACT	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
19	FOREIGN COMPACT	1.00	1.00	2.00	3.00	4.00	5.00	6.00	6.00	6.00	6.00
20	MID-SIZE	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
21	FULL SIZE	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
22	DOMESTIC LUXURY	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
23	FOREIGN LUXURY	1.00	1.00	2.00	3.00	4.00	5.00	6.00	6.00	6.00	6.00
24	HIGHWAY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.00	4.00	6.00
25	DOMESTIC SUBCOMPACT	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
26	FOREIGN SUBCOMPACT	1.00	1.00	2.00	3.00	4.00	5.00	6.00	6.00	6.00	6.00
27	DOMESTIC COMPACT	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
28	FOREIGN COMPACT	1.00	1.00	2.00	3.00	4.00	5.00	6.00	6.00	6.00	6.00
29	MID-SIZE	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
30	FULL SIZE	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
31	DOMESTIC LUXURY	1.00	1.00	3.00	6.00	9.00	13.00	16.00	16.00	16.00	16.00
32	FOREIGN LUXURY	1.00	1.00	2.00	3.00	4.00	5.00	6.00	6.00	6.00	6.00
33											
34	MPG (EPA) EFFICIENCY FACTORS										
35	CITY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	2.00	4.00
36	DOMESTIC SUBCOMPACT	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
37	FOREIGN SUBCOMPACT	1.00	1.00	2.00	3.50	5.00	6.50	8.00	8.00	8.00	8.00
38	DOMESTIC COMPACT	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
39	FOREIGN COMPACT	1.00	1.00	2.00	3.50	5.00	6.50	8.00	8.00	8.00	8.00
40	MID-SIZE	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
41	FULL SIZE	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
42	DOMESTIC LUXURY	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
43	FOREIGN LUXURY	1.00	1.00	2.00	3.50	5.00	6.50	8.00	8.00	8.00	8.00
44	HIGHWAY EFFICIENCY FACTOR; ALL CLASSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	2.00	4.00
45	DOMESTIC SUBCOMPACT	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
46	FOREIGN SUBCOMPACT	1.00	1.00	2.00	3.50	5.00	6.50	8.00	8.00	8.00	8.00
47	DOMESTIC COMPACT	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
48	FOREIGN COMPACT	1.00	1.00	2.00	3.50	5.00	6.50	8.00	8.00	8.00	8.00
49	MID-SIZE	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
50	FULL SIZE	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
51	DOMESTIC LUXURY	1.00	1.00	3.50	7.50	12.00	17.00	21.00	21.00	21.00	21.00
52	FOREIGN LUXURY	1.00	1.00	2.00	3.50	5.00	6.50	8.00	8.00	8.00	8.00

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 21.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	AVAGE0-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	EPACDMPGC	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
3	EPACDMPGH	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
4	EPACFMPGC	1.11	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
5	EPACFMPGH	1.02	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
6	EPAFDMPGC	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
7	EPAFDMPGH	0.81	1.10	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
8	EPALDMPGC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	EPALDMPGH	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
10	EPALFMPGC	0.42	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
11	EPALFMPGH	0.05	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
12	EPAMDMPGC	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
13	EPAMDMPGH	0.73	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
14	EPASDMPGC	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
15	EPASDMPGH	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
16	EPASFMPGC	1.40	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
17	EPASFMPGH	0.40	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
18	FRMCICP	-0.93	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50
19	GASAUTOADJ	-0.350	-0.450	-0.450	-0.450	-0.450	-0.450	-0.450	-0.450	-0.450	-0.450
20	KEND*AY72/LD	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006	-0.006
21	DMVUANR	-1.135	-1.135	-1.135	-1.035	-1.035	-1.035	-1.035	-1.035	-1.035	-1.035
22	UPMVUAC+LFYEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	PC4112-1741	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8	-16.8
24	PC4121-1000	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3
25	PC4122-1001	-21.3	-21.3	-21.3	-21.3	-21.3	-21.3	-21.3	-21.3	-21.3	-21.3
26	PC4122-1783	-38.4	-38.4	-38.4	-38.4	-38.4	-38.4	-38.4	-38.4	-38.4	-38.4
27	PDCEDAVN	5.000	9.230	14.660	17.590	20.610	22.900	25.870	28.560	32.000	36.190
28	PER15+	3.9	2.9	1.9	2.4	3.4	4.6	5.5	5.5	5.3	4.9
29	PINPUTA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	PU/NCT	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.096	0.096
31	PU/NFD	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
32	PU/NLT	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102
33	PU/NMD	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
34	PU/NST	-0.110	-0.110	-0.110	-0.110	-0.110	-0.110	-0.110	-0.110	-0.110	-0.110
35	PUCEDAVN	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094	0.094
36	PURMVUUA	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12
37	PUSEDW	-63.000	-110.000	-110.000	-110.000	-110.000	-110.000	-110.000	-110.000	-110.000	-110.000
38	SAWRRDAV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	SAWRRDAVD-V	0.091	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
40	SAWRRDAVF-V	-0.060	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010
41	SCMVUA	0.300	0.300	0.300	0.400	0.400	0.400	0.400	0.400	0.400	0.400
42	SCMVUAC+LF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43	SCMVUACD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	SCMVUACF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	SCMVUACT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	SCMVUAFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	SCMVUALD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	SCMVUALF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	SCMVUALT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	SCMVUAMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	SCMVUASD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 21.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	SCMVUASF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	SCMVUAST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	SCMVUATD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	SCMVUATF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	SHRC+LFTNR	-0.001	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	SHRCD*A	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
7	SHRCDTNR	-0.0119	-0.0177	-0.0180	-0.0180	-0.0180	-0.0180	-0.0180	-0.0180	-0.0180	-0.0180
8	SHRCF*A	0.001	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	SHRFD*A	-0.084	-0.084	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100	-0.100
10	SHRFDTNR	0.0052	-0.0350	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130
11	SHRLD*A	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
12	SHRLDTNR	0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
13	SHRLF*A	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
14	SHRMD*A	0.060	0.060	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
15	SHRMDTNR	0.0057	-0.0485	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130	-0.0130
16	SHRSD*A	0.022	0.022	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
17	SHRSDTNR	-0.0067	0.0630	0.0	0.0060	0.0070	0.0080	0.0090	0.0120	0.0140	0.0160
18	SHRSF*A	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
19	SHRSFTNR	0.0160	0.0526	0.0450	0.0440	0.0430	0.0420	0.0410	0.0380	0.0360	0.0340
20	USCDMPGC	0.60	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
21	USCDMPGH	2.35	2.62	2.62	2.62	2.62	2.62	2.62	2.62	2.62	2.62
22	USCDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
23	USCDPURASE-2	0.	0.	-30.	-60.	-90.	-120.	-150.	-150.	-150.	-150.
24	USCDPUOPT-2	100.	94.	23.	17.	11.	5.	-1.	-7.	-13.	-19.
25	USCDPUTRN	-26.	-25.	-20.	-15.	-10.	-10.	-10.	-10.	-10.	-10.
26	USCFMPGC	0.60	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
27	USCFMPGH	2.63	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
28	USCFPURASE-2	-330.	-360.	-360.	-360.	-360.	-360.	-360.	-360.	-360.	-360.
29	USCFPUTRN	-21.	-10.	0.	0.	0.	0.	0.	0.	0.	0.
30	USFDMPGC	0.50	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
31	USFDMPGH	2.06	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07	2.07
32	USFDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
33	USFDPURASE-2	-5.	20.	50.	80.	110.	140.	170.	170.	170.	170.
34	USFDPUOPT-2	48.	48.	48.	48.	48.	48.	48.	48.	48.	48.
35	USFDPUTRN	9.	9.	14.	14.	14.	14.	14.	14.	14.	14.
36	USLDMPGC	0.41	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
37	USLDMPGH	1.95	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
38	USLDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
39	USLDPURASE-2	0.	30.	80.	130.	180.	230.	280.	280.	280.	280.
40	USLDPUOPT-2	47.	47.	47.	47.	47.	47.	47.	47.	47.	47.
41	USLDPUTRN	13.	13.	17.	17.	17.	17.	17.	17.	17.	17.
42	USLFMPGC	0.58	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
43	USLFMPGH	1.98	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28	2.28
44	USLFPURASE-2	189.	0.	0.	0.	0.	0.	0.	0.	0.	0.
45	USLFPUTRN	13.	20.	50.	50.	50.	50.	50.	50.	50.	50.
46	USMDMPGC	0.57	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
47	USMDMPGH	2.25	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
48	USMDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
49	USMDPURASE-2	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
50	USMDPUOPT-2	39.	39.	39.	39.	39.	39.	39.	39.	39.	39.
51	USMDPUTRN	-14.	-14.	-3.	-3.	-3.	-3.	-3.	-3.	-3.	-3.

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 21.00 CONSTANT ADJUSTMENTS

LINE	VAR LABEL ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	USSDMPGC	0.74	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
2	USSDMPGH	3.07	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
3	USSDPOPTM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	USSDPURASE-2	0.	-25.	-50.	-75.	-100.	-125.	-150.	-150.	-150.	-150.
5	USSDPUOPT-2	83.	79.	25.	-5.	-25.	-60.	-100.	-140.	-160.	-180.
6	USSDPUTRN	-12.	-7.	0.	0.	0.	0.	0.	0.	0.	0.
7	USSFMPGC	0.87	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07
8	USSFMPGH	2.67	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07	3.07
9	USSFPURASE-2	90.	200.	200.	200.	200.	200.	200.	200.	200.	200.
10	USSFPUTRN	-12.	-7.	0.	0.	0.	0.	0.	0.	0.	0.
11	USTDPOPTMFW	68.	103.	138.	173.	208.	243.	278.	313.	348.	383.
12	USTDPURASEFW	11.	11.	11.	11.	11.	11.	11.	11.	11.	11.
13	VMT/FM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	VMT/K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	VMTMVA-MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	VMTR*/K	-0.030	-0.100	0.075	0.080	0.075	0.070	0.065	0.060	0.055	0.055
17	VMTU*/K	0.090	0.050	0.100	0.150	0.080	0.075	0.070	0.065	0.060	0.055

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 22.00 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	DUMAUTOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	EFFC	0.	0.	0.	0.	0.	0.	0.	2.	4.	6.
3	EFFC*	0.	0.	0.	0.	0.	0.	0.	1.	2.	4.
4	EFFCCD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
5	EFFCCD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
6	EFFCCF	1.	1.	2.	3.	4.	5.	6.	6.	6.	6.
7	EFFCCF*	1.	1.	2.	4.	5.	7.	8.	8.	8.	8.
8	EFFCFD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
9	EFFCFD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
10	EFFCLD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
11	EFFCLD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
12	EFFCLF	1.	1.	2.	3.	4.	5.	6.	6.	6.	6.
13	EFFCLF*	1.	1.	2.	4.	5.	7.	8.	8.	8.	8.
14	EFFCMD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
15	EFFCMD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
16	EFFCSD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
17	EFFCSD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
18	EFFCSF	1.	1.	2.	3.	4.	5.	6.	6.	6.	6.
19	EFFCSF*	1.	1.	2.	4.	5.	7.	8.	8.	8.	8.
20	EFFH	0.	0.	0.	0.	0.	0.	0.	2.	4.	6.
21	EFFH*	0.	0.	0.	0.	0.	0.	0.	1.	2.	4.
22	EFFHCD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
23	EFFHCD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
24	EFFHCF	1.	1.	2.	3.	4.	5.	6.	6.	6.	6.
25	EFFHCF*	1.	1.	2.	4.	5.	7.	8.	8.	8.	8.
26	EFFHFD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
27	EFFHFD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
28	EFFHLD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
29	EFFHLD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
30	EFFHLF	1.	1.	2.	3.	4.	5.	6.	6.	6.	6.
31	EFFHLF*	1.	1.	2.	4.	5.	7.	8.	8.	8.	8.
32	EFFHMD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
33	EFFHMD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
34	EFFHSD	1.	1.	3.	6.	9.	13.	16.	16.	16.	16.
35	EFFHSD*	1.	1.	4.	8.	12.	17.	21.	21.	21.	21.
36	EFFHSF	1.	1.	2.	3.	4.	5.	6.	6.	6.	6.
37	EFFHSF*	1.	1.	2.	4.	5.	7.	8.	8.	8.	8.
38	FRMAPC	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
39	GMTWO/NER	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943
40	GPPUT/NER	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974	0.974
41	GRPUT/PTR	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994	0.994
42	NCFM3+4/FM	0.308	0.309	0.312	0.313	0.315	0.316	0.317	0.318	0.318	0.318
43	NCFM5+/FM	0.136	0.130	0.122	0.117	0.111	0.106	0.102	0.096	0.094	0.090
44	NPNET	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270	73.270
45	NPRENC/R	0.192	0.193	0.193	0.194	0.195	0.195	0.196	0.197	0.197	0.198
46	NPRFSC/R	0.062	0.061	0.060	0.059	0.059	0.058	0.057	0.057	0.056	0.055
47	NPRMTN/R	0.048	0.049	0.050	0.051	0.052	0.053	0.054	0.055	0.056	0.057
48	NPRNEW/R	0.057	0.057	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.055
49	NPRPAC/R	0.136	0.137	0.138	0.139	0.140	0.141	0.142	0.143	0.144	0.145
50	NPRSA/R	0.157	0.157	0.156	0.156	0.156	0.155	0.155	0.154	0.154	0.154

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 22.00 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	NPRWNC/R	0.077	0.077	0.077	0.076	0.076	0.076	0.076	0.075	0.075	0.075
2	NPRWSC/R	0.100	0.101	0.101	0.102	0.103	0.103	0.104	0.104	0.105	0.106
3	NPR20.29	38.23	38.89	39.54	40.13	40.55	40.81	40.91	40.78	40.39	39.76
4	OMVUACFNR	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
5	PC4113-1747	142.1	154.7	164.0	173.8	184.3	195.3	207.0	219.5	232.6	246.6
6	PSCRAPAV	81.17	85.22	89.49	93.96	98.66	103.59	108.77	114.21	119.92	125.91
7	PU/NADJCT	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163	0.163
8	PU/NADJFD	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265	0.265
9	PU/NADJLT	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229
10	PU/NADJMD	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189	0.189
11	PU/NADJST	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192	0.192
12	RWMMVI	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663	42.663
13	TXROWN	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	TXROWNCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	TXROWNFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	TXROWNLT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	TXROWNMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	TXROWNST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	TXRPUCT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	TXRPUFD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	TXRPUMD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	TXRPUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	TXPWTDAUTO	4.86	5.02	5.18	5.34	5.50	5.66	5.82	5.98	6.14	6.30
24	USCDCURB	3370.	3100.	3050.	3000.	2900.	2800.	2750.	2700.	2700.	2700.
25	USCDDISP	268.4	237.0	227.5	218.4	201.8	185.3	174.2	165.3	165.3	165.3
26	USCDFAUTO	0.870	0.840	0.820	0.800	0.780	0.760	0.740	0.720	0.720	0.720
27	USCDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	USCDF4CYL	0.066	0.150	0.200	0.300	0.400	0.450	0.500	0.550	0.550	0.550
29	USCDF6CYL	0.455	0.600	0.550	0.500	0.450	0.400	0.350	0.300	0.300	0.300
30	USCDPOPTM/T	0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955	0.955
31	USCDPUBASE-2/T	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813
32	USCFCURB	2794.	2766.	2738.	2711.	2684.	2657.	2630.	2604.	2604.	2604.
33	USCFDISP	116.5	114.5	112.8	111.1	109.4	107.8	106.2	104.6	104.6	104.6
34	USCFFAUTO	0.770	0.720	0.700	0.680	0.660	0.640	0.620	0.600	0.600	0.600
35	USCFFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	USCFF4CYL	1.000	0.950	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
37	USCFF6CYL	0.0	0.050	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
38	USFDCURB	4130.	3850.	3700.	3600.	3450.	3300.	3250.	3200.	3200.	3200.
39	USFDDISP	322.2	299.6	284.7	269.0	251.3	232.7	224.3	218.0	218.0	218.0
40	USFDFAUTO	0.999	0.980	0.970	0.950	0.925	0.900	0.875	0.850	0.850	0.850
41	USFDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	USFDF4CYL	0.0	0.0	0.025	0.050	0.075	0.100	0.125	0.150	0.150	0.150
43	USFDF6CYL	0.035	0.100	0.200	0.300	0.400	0.500	0.600	0.650	0.650	0.650
44	USFDPUPTM/T	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038
45	USFDPUBASE-2/T	1.004	1.006	1.008	1.010	1.012	1.014	1.016	1.016	1.016	1.016
46	USLDCURB	4435.	4150.	4000.	3850.	3700.	3600.	3550.	3500.	3500.	3500.
47	USLDDISP	402.7	374.5	355.8	336.6	315.4	299.6	287.9	280.4	280.4	280.4
48	USLDFAUTO	0.991	0.970	0.960	0.950	0.940	0.920	0.900	0.880	0.880	0.880
49	USLDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

THE WHARTON EFA MOTOR VEHICLE DEMAND MODEL
AUGUST CONTROL SOLUTION

TABLE 22.00 EXOGENOUS ASSUMPTIONS

LINE	ITEM	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	USLDF4CYL	0.0	0.001	0.005	0.010	0.020	0.050	0.100	0.150	0.150	0.150
2	USLDF6CYL	0.0	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.350	0.350
3	USLDPOPTM/T	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078	1.078
4	USLDPUBASE-2/T	1.641	1.644	1.647	1.650	1.653	1.656	1.659	1.659	1.659	1.659
5	USLFCURB	3329.	3262.	3197.	3133.	3071.	3009.	2949.	2890.	2890.	2890.
6	USLFDISP	170.0	167.4	164.9	162.5	160.0	157.6	155.3	152.9	152.9	152.9
7	USLFFAUTO	0.891	0.870	0.845	0.820	0.795	0.770	0.745	0.720	0.720	0.720
8	USLFFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	USLFF4CYL	0.370	0.450	0.500	0.550	0.600	0.650	0.700	0.700	0.700	0.700
10	USLFF6CYL	0.616	0.550	0.500	0.450	0.400	0.350	0.300	0.300	0.300	0.300
11	USMDCURB	3670.	3550.	3450.	3400.	3250.	3100.	3050.	3000.	3000.	3000.
12	USMDDISP	302.4	284.3	267.2	256.5	235.0	213.3	203.7	194.0	194.0	194.0
13	USMDFAUTO	0.992	0.950	0.925	0.900	0.875	0.850	0.825	0.800	0.800	0.800
14	USMDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	USMDF4CYL	0.0	0.0	0.025	0.050	0.075	0.100	0.150	0.150	0.150	0.150
16	USMDF6CYL	0.219	0.250	0.350	0.500	0.650	0.700	0.700	0.700	0.700	0.700
17	USMDPOPTM/T	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978	0.978
18	USMDPUBASE-2/T	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969	0.969
19	USSDCURB	2575.	2525.	2475.	2425.	2380.	2340.	2310.	2300.	2300.	2300.
20	USSDDISP	145.7	137.0	129.3	124.5	119.8	110.2	105.5	100.7	100.7	100.7
21	USSDFAUTO	0.642	0.620	0.600	0.580	0.560	0.540	0.520	0.500	0.500	0.500
22	USSDFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	USSDF4CYL	0.745	0.775	0.800	0.825	0.850	0.875	0.900	0.900	0.900	0.900
24	USSDF6CYL	0.199	0.200	0.180	0.160	0.140	0.120	0.100	0.100	0.100	0.100
25	USSDPOPTM/T	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897	0.897
26	USSDPUBASE-2/T	0.709	0.705	0.701	0.697	0.693	0.689	0.685	0.685	0.685	0.685
27	USSFCURB	2363.	2328.	2293.	2258.	2224.	2191.	2158.	2126.	2126.	2126.
28	USSFDISP	104.6	102.5	100.5	98.4	96.5	94.6	92.7	90.8	90.8	90.8
29	USSFFAUTO	0.642	0.620	0.600	0.580	0.560	0.540	0.520	0.500	0.500	0.500
30	USSFFOD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	USSFF4CYL	1.000	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.950
32	USSFF6CYL	0.0	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050

APPENDIX A1

PASSENGER VANS STOCK DATA

To completely separate passenger vans registered as autos from the auto data, it is necessary to estimate vans in operation. The stock of vans of each vintage surviving in a given year is a function of registrations each year and the cumulative survival probabilities associated with each vintage year.

New registrations of the four domestic and one foreign passenger vans were obtained from Wards, Automotive News, and Chilton. Registrations of the vans are shown in Table A1-1.

Initial estimates of the scrappage rates were derived from trucks in operation published in the Automotive News Almanac. These data cover all trucks, light and heavy, giving the manufacturer and age of the truck from new to fifteen years old. Five manufacturers with most of their production in light trucks (Chevrolet, Dodge, Ford, Jeep, and miscellaneous) were chosen, their stocks summed by vintage, and the July to July survival rates calculated.

Modified averages of these rates were then converted to year end survival probabilities. The fraction of light trucks scrapped during the first year of life was set at 0.2 percent. Survival rates after the fourteenth year were assumed to decline at 0.9 percent per year to the nineteenth year, 0.8 percent to the 24th year, and were held constant at 0.81 percent to the thirtieth year. After the thirtieth year, the survival probability is assumed to be zero. The survival and scrappage probabilities are shown in Table A1-2.[1/]

Aging new registrations of the five selected manufacturers by the normal scrappage rates provides expected scrappage rates over time. The normal scrappage rates are adjusted to ensure equality between expected and actual scrap-

---

[1/] The procedure and data parallel that described in Schink and Loxley, A1.4.8.

page. If actual scrappage is higher than expected on average, then the scrappage adjustment factor will be greater than one.

Defining new registrations of vans in year t as N_t and the adjustment factor as δ_t, scrappage (S_t) can be expressed as the sum of:

(1) Scrappage of vans that have survived to the end of the thirtieth year and are assumed to be automatically scrapped by the end of the year. The number of the thirty year old vans at the beginning of the year is $PSE_{30,t} * N_{t-30}$.

(2) Scrappage of vans that are registered during year t, represented by $\delta_t * q_0 * N_t$.

(3) Scrappage of vans aged one to twenty-nine years old. The number of these vans that survive at the beginning of the year is $PSE_{i-1,t} * N_{t-i-1}$ of i=1 to 29. The fraction of each age group that will be scrapped during the year is $\delta_t * q_i$; thus the expected scrappage of vans aged one to twenty-nine years is

$$\delta_t \left(\sum_{i=1}^{29} q_i * PSE_{i-1,t} * N_{t-i-1} \right)$$

Setting the expected scrappage equal to the observed scrappage:

$$S_t = PSE_{30,t} * N_{t-30}$$

$$+ \delta_t \left(q_0 * N_t + \sum_{i=1}^{29} q_i * PSE_{i-1,t} * N_{t-i-1} \right)$$

Solving for the adjustment factor, δ_t, yields:

$$\delta_t = \frac{S_t - PSE_{30,t} * N_{t-30}}{q_0 * N_t + \sum_{i=1}^{29} q_i * PSE_{i-1,t} * N_{t-i-1}}$$

The cumulative survival probabilities for each year (labeled SPLTi for i=0 to 30) and the scrappage adjustment factor (labeled SPLTADJ) are presented in Table A1-3. The adjustment factor is strongly related to light truck registrations as can be seen in Table A1-4. In years of high new registrations growth, 1955 to 1957, 1959, 1960, 1968 and 1969, SPLTADJ is greater than one. Low new registrations growth in 1958, 1974, and 1975 produces lower than normal scrappage. The stock of vans estimated by progressively cumulating each successive annual sales total using these varying survival probabilities is shown in Table A1-5.

TABLE A1-1. PASSENGER VAN NEW REGISTRATIONS

	Domestic (OMVUDVNR)	Foreign (OMVUFVNR)	Total (OMVUVNR)
1965	.0	32.689	32.689
1966	16.103	31.523	47.626
1967	15.252	30.870	46.122
1968	18.251	40.420	58.671
1969	14.867	50.361	65.671
1970	51.414	62.975	114.39
1971	60.269	61.000	121.27
1972	73.091	46.375	119.47
1973	86.833	42.409	129.24
1974	92.186	29.818	122.00
1975	102.16	21.550	123.71
1976	117.58	33.400	150.98

TABLE A1-2. NORMAL SURVIVAL AND SCRAPPAGE RATES

Years Old	P_i	q_i	PSE_i	Years Old	P_i	q_i	PSE_i
New	.9980	.0020	.9980	16	.8805	.1195	.3965
1	.9904	.0096	.9884	17	.8715	.1285	.3455
2	.9895	.0105	.9780	18	.8625	.1375	.2980
3	.9875	.0125	.9658	19	.8540	.1460	.2545
4	.9847	.0153	.9510	20	.8460	.1540	.2153
5	.9811	.0189	.9331	21	.8380	.1620	.1804
6	.9759	.0241	.9106	22	.8300	.1700	.1497
7	.9679	.0321	.8813	23	.8220	.1780	.1231
8	.9566	.0434	.8431	24	.8140	.1860	.1002
9	.9456	.0544	.7972	25	.8100	.1900	.0812
10	.9346	.0654	.7451	26	.8100	.1900	.0657
11	.9216	.0789	.6867	27	.8100	.1900	.0532
12	.9113	.0887	.6258	28	.8100	.1900	.0431
13	.9028	.0972	.5649	29	.8100	.1900	.0349
14	.8960	.1040	.5062	30	.8100	.1900	.0283
15	.8895	.1105	.4503	31+	0.0	1.0	0.0

P_i = probability that a van will survive to the end of year i given that it has survived to the end of the previous year.

q_i = probability that a van will be scrapped during year i given that it has survived until the end of the previous year.

$$q_i = 1 - P_i$$

PSE_i = cumulative survival probability, the probability that a van will survive to the end of year i.

$$PSE_i = \prod_{j=0}^{i} P_j$$

TABLE A1-3. SURVIVAL PROBABILITIES, BY VINTAGE BY YEAR

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
SPLTADJ	1.300	1.419	1.389	0.653	1.015	1.127	0.945	0.922	0.837	0.989	0.691	0.780
SPLT0	0.997	0.997	0.997	0.999	0.998	0.998	0.998	0.998	0.998	0.998	0.999	0.998
SPLT1	0.985	0.984	0.984	0.991	0.989	0.987	0.989	0.989	0.990	0.989	0.991	0.991
SPLT2	0.972	0.970	0.969	0.977	0.980	0.977	0.977	0.979	0.981	0.980	0.982	0.983
SPLT3	0.956	0.954	0.953	0.962	0.965	0.967	0.966	0.966	0.969	0.968	0.971	0.972
SPLT4	0.937	0.935	0.934	0.944	0.947	0.948	0.953	0.952	0.954	0.954	0.958	0.960
SPLT5	0.914	0.912	0.910	0.922	0.926	0.926	0.931	0.936	0.937	0.936	0.942	0.944
SPLT6	0.885	0.882	0.881	0.896	0.900	0.901	0.905	0.910	0.917	0.915	0.920	0.924
SPLT7	0.848	0.845	0.843	0.863	0.867	0.867	0.873	0.879	0.886	0.888	0.894	0.897
SPLT8	0.800	0.796	0.794	0.819	0.825	0.825	0.832	0.838	0.847	0.848	0.861	0.864
SPLT9	0.744	0.739	0.736	0.766	0.774	0.774	0.782	0.790	0.800	0.801	0.816	0.825
SPLT10	0.680	0.675	0.671	0.704	0.715	0.717	0.726	0.735	0.747	0.748	0.765	0.774
SPLT11	0.611	0.605	0.601	0.637	0.648	0.652	0.664	0.674	0.687	0.689	0.708	0.718
SPLT12	0.541	0.534	0.530	0.566	0.580	0.584	0.597	0.610	0.624	0.627	0.647	0.659
SPLT13	0.472	0.466	0.462	0.497	0.511	0.516	0.530	0.544	0.560	0.564	0.584	0.598
SPLT14	0.409	0.403	0.399	0.431	0.444	0.451	0.465	0.479	0.496	0.502	0.523	0.537
SPLT15	0.350	0.344	0.341	0.370	0.382	0.389	0.404	0.418	0.435	0.442	0.464	0.478
SPLT16	0.295	0.291	0.287	0.314	0.325	0.331	0.345	0.359	0.376	0.383	0.406	0.421
SPLT17	0.246	0.242	0.239	0.263	0.273	0.278	0.291	0.304	0.321	0.328	0.349	0.365
SPLT18	0.202	0.198	0.195	0.217	0.226	0.231	0.242	0.254	0.269	0.277	0.297	0.312
SPLT19	0.164	0.160	0.158	0.177	0.185	0.198	0.199	0.209	0.223	0.230	0.249	0.263
SPLT20	0.131	0.128	0.126	0.142	0.149	0.153	0.162	0.171	0.182	0.189	0.206	0.219
SPLT21	0.104	0.101	0.099	0.113	0.119	0.122	0.130	0.138	0.148	0.153	0.168	0.180
SPLT22	0.081	0.079	0.077	0.088	0.093	0.096	0.103	0.109	0.118	0.123	0.135	0.146
SPLT23	0.062	0.060	0.059	0.068	0.072	0.075	0.080	0.086	0.093	0.097	0.108	0.117
SPLT24	0.047	0.046	0.045	0.052	0.055	0.057	0.061	0.066	0.072	0.076	0.085	0.092
SPLT25	0.035	0.034	0.034	0.039	0.042	0.044	0.047	0.051	0.056	0.059	0.066	0.072
SPLT26	0.027	0.026	0.025	0.029	0.032	0.033	0.036	0.039	0.043	0.045	0.051	0.056
SPLT27	0.020	0.019	0.019	0.022	0.024	0.025	0.027	0.029	0.033	0.035	0.039	0.043
SPLT28	0.015	0.015	0.014	0.017	0.018	0.019	0.020	0.022	0.025	0.026	0.030	0.033
SPLT29	0.011	0.011	0.011	0.013	0.013	0.014	0.015	0.017	0.019	0.020	0.023	0.026
SPLT30	0.009	0.008	0.008	0.009	0.010	0.011	0.012	0.013	0.014	0.015	0.017	0.020

TABLE A1-3. SURVIVAL PROBABILITIES, BY VINTAGE BY YEAR (continued)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
SPLTADJ	0.936	1.129	1.015	0.828	0.436	0.879	1.039	0.681	0.503	1.071	1.229	1.071
SPLT0	0.998	0.998	0.998	0.998	0.999	0.998	0.998	0.999	0.999	0.998	0.998	0.998
SPLT1	0.989	0.987	0.988	0.990	0.994	0.991	0.988	0.991	0.994	0.987	0.984	0.987
SPLT2	0.981	0.978	0.977	0.979	0.986	0.985	0.980	0.981	0.986	0.981	0.973	0.981
SPLT3	0.972	0.968	0.965	0.967	0.974	0.975	0.972	0.972	0.975	0.970	0.965	0.970
SPLT4	0.958	0.955	0.953	0.953	0.960	0.961	0.959	0.962	0.964	0.955	0.952	0.955
SPLT5	0.943	0.938	0.937	0.938	0.945	0.944	0.942	0.947	0.953	0.939	0.932	0.939
SPLT6	0.923	0.917	0.915	0.918	0.928	0.925	0.921	0.927	0.935	0.923	0.912	0.923
SPLT7	0.896	0.889	0.887	0.890	0.905	0.902	0.894	0.901	0.912	0.898	0.888	0.898
SPLT8	0.861	0.852	0.850	0.855	0.874	0.871	0.861	0.868	0.881	0.863	0.851	0.863
SPLT9	0.820	0.808	0.805	0.812	0.835	0.832	0.821	0.829	0.844	0.822	0.806	0.822
SPLT10	0.774	0.760	0.754	0.762	0.789	0.787	0.775	0.785	0.802	0.777	0.756	0.777
SPLT11	0.718	0.706	0.699	0.705	0.736	0.734	0.723	0.734	0.754	0.725	0.702	0.725
SPLT12	0.659	0.646	0.642	0.648	0.678	0.678	0.667	0.679	0.701	0.672	0.646	0.672
SPLT13	0.599	0.586	0.582	0.591	0.620	0.620	0.610	0.623	0.646	0.611	0.586	0.611
SPLT14	0.539	0.529	0.524	0.532	0.564	0.564	0.553	0.567	0.590	0.554	0.528	0.554
SPLT15	0.481	0.472	0.469	0.476	0.506	0.509	0.499	0.512	0.535	0.499	0.476	0.499
SPLT16	0.425	0.416	0.415	0.423	0.452	0.453	0.446	0.458	0.481	0.447	0.428	0.447
SPLT17	0.370	0.363	0.362	0.371	0.399	0.401	0.393	0.407	0.429	0.399	0.384	0.399
SPLT18	0.318	0.313	0.312	0.321	0.349	0.351	0.343	0.356	0.379	0.358	0.343	0.358
SPLT19	0.269	0.265	0.266	0.275	0.301	0.304	0.298	0.309	0.330	0.321	0.308	0.321
SPLT20	0.225	0.222	0.224	0.232	0.256	0.260	0.255	0.267	0.285	0.286	0.276	0.286
SPLT21	0.186	0.184	0.186	0.194	0.216	0.220	0.216	0.227	0.245	0.253	0.245	0.253
SPLT22	0.151	0.150	0.153	0.160	0.180	0.184	0.181	0.191	0.208	0.225	0.217	0.225
SPLT23	0.121	0.121	0.123	0.130	0.147	0.152	0.150	0.159	0.174	0.199	0.193	0.199
SPLT24	0.096	0.096	0.098	0.104	0.120	0.123	0.122	0.131	0.144	0.177	0.171	0.177
SPLT25	0.076	0.076	0.077	0.083	0.096	0.100	0.099	0.107	0.118	0.156	0.152	0.156
SPLT26	0.059	0.060	0.061	0.065	0.076	0.080	0.080	0.086	0.096	0.138	0.134	0.138
SPLT27	0.046	0.047	0.048	0.051	0.060	0.063	0.064	0.070	0.078	0.120	0.118	0.120
SPLT28	0.036	0.036	0.038	0.040	0.047	0.050	0.051	0.056	0.063	0.104	0.103	0.104
SPLT29	0.028	0.028	0.029	0.032	0.037	0.039	0.040	0.044	0.050	0.090	0.090	0.090
SPLT30	0.021	0.022	0.023	0.025	0.029	0.031	0.032	0.035	0.040	0.077	0.077	0.077

TABLE A1-4. SCRAPPAGE ADJUSTMENT AND NEW REGISTRATIONS

	SPLTADJ	OLTUALDTNROK
1955	1.2999	.62727
1956	1.4186	.56140
1957	1.3887	.57718
1958	.65300	.48948
1959	1.0152	.44621
1960	1.1269	.45285
1961	.94508	.67270
1962	.92157	.78587
1963	.83728	.93415
1964	.98880	1.0504
1965	.69109	1.1942
1966	.77956	1.2349
1967	.93641	1.1948
1968	1.1293	1.4455
1969	1.0150	1.5522
1970	.82809	1.4853
1971	.43572	1.6995
1972	.87893	2.1357
1973	1.0385	2.6004
1974	.68081	2.3011
1975	.50314	2.1420

TABLE A1-5. PASSENGER VAN STOCK ESTIMATES

	KVVMID	KVV00	KVV01	KVV02	KVV03
1965	.16322E-01	.16322E-01	.0	.0	.0
1966	.56298E-01	.23776E-01	.32522E-01	.0	.0
1967	.10260	.23018E-01	.47338E-01	.32240E-01	.0
1968	.15375	.29269E-01	.45786E-01	.46845E-01	.31855E-01
1969	.21375	.32547E-01	.58253E-01	.45294E-01	.46270E-01
1970	.30105	.57100E-01	.64835E-01	.57716E-01	.44818E-01
1971	.41641	.60582E-01	.11396	.64428E-01	.57308E-01
1972	.53253	.59628E-01	.12065	.11320	.63927E-01
1973	.64862	.64487E-01	.11866	.11949	.11194
1974	.76464	.60919E-01	.12855	.11764	.11833
1975	.87870	.61794E-01	.12154	.12779	.11685
1976	.99999	.75389E-01	.12312	.12048	.12651
1977	1.1311	.78688E-01	.15023	.12202	.11912

	KVV04	KVV05	KVV06	KVV07	KVV08
1965	.0	.0	.0	.0	.0
1966	.0	.0	.0	.0	.0
1967	.0	.0	.0	.0	.0
1968	.0	.0	.0	.0	.0
1969	.31383E-01	.0	.0	.0	.0
1970	.45683E-01	.30893E-01	.0	.0	.0
1971	.44436E-01	.45205E-01	.30489E-01	.0	.0
1972	.56767E-01	.43920E-01	.44542E-01	.29900E-01	.0
1973	.63069E-01	.55829E-01	.43007E-01	.43330E-01	.28808E-01
1974	.11063	.62162E-01	.54822E-01	.41998E-01	.41967E-01
1975	.11737	.10953	.61385E-01	.53930E-01	.41080E-01
1976	.11571	.11587	.10750	.59874E-01	.52207E-01
1977	.12495	.11403	.11360	.10451	.57675E-01

	KVV09	KVV10	KVV11	KVV12
1965	.0	.0	.0	.0
1966	.0	.0	.0	.0
1967	.0	.0	.0	.0
1968	.0	.0	.0	.0
1969	.0	.0	.0	.0
1970	.0	.0	.0	.0
1971	.0	.0	.0	.0
1972	.0	.0	.0	.0
1973	.0	.0	.0	.0
1974	.27623E-01	.0	.0	.0
1975	.40772E-01	.26656E-01	.0	.0
1976	.39433E-01	.38792E-01	.25101E-01	.0
1977	.49783E-01	.37219E-01	.36168E-01	.23100E-01

KVV00 = stock by vintage of vans, new
KVV01, etc. = stock by vintage of vans, one year old
KVVMID = sum of stock by vintage of vans, midyear

APPENDIX A2

REPORT OF NEW TECHNOLOGY APPENDIX

Contract DOT-TSC-1435

The Wharton EFA, Inc. Motor Vehicle Demand Model

The work performed under this contract has not led to any new inventions. The resulting econometric model is, however, both innovative and state-of-the-art. It provides long-run policy analysis and forecasting of annual trends in the U.S. motor vehicle market, given various policy options and alternative socio-economic futures.

U.S. DEPARTMENT OF TRANSPORTATION
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
TRANSPORTATION SYSTEMS CENTER
KENDALL SQUARE, CAMBRIDGE, MA. 02142

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF TRANSPORTATION
613

U S MAIL