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Technical Report

The Effects of Test Vehicle Mileage on Corporate Average Fuel Economy Calculations

November, 1983

NOTICE

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I. Purpose

The purpose of this analysis is to estimate the annual CAFE credit manufacturers obtain by testing vehicles at greater than 4,000 miles accumulation.

II. Background

A. A vehicle's fuel economy performance usually improves with mileage accumulation due to the gradual reduction in friction between various drivetrain parts. This improvement is most rapid during the initial "break-in" period of the vehicle (the first few thousand miles) and gradually levels off at higher mileages (twenty thousand to thirty thousand miles) before eventually declining in fuel economy at very high mileages due to losses in engine efficiency.

B. In 1975, Congress passed the Energy Policy and Conservation Act (EPCA) which mandated a 100 percent improvement in vehicle fuel economy by 1985. The baseline used for this improvement standard was the EPA fuel economy data base using the 1975 test procedures. This data base consisted of emission test vehicles that were required to be at 4,000 miles, $\pm$ 250 miles. Thus, any general increase in average CAFE test vehicle mileages over 4,000 miles will result in CAFE benefits due only to test vehicle mileage effects.

C. Data from several different types of test vehicles go into the CAFE calculation. These vehicle types along with their mileage restrictions are as follows:

1. Certification emission-data vehicles:

These are test vehicles used to demonstrate compliance with emission standards to obtain initial certification. Prior to the issuance of certification cost reduction regulations on October 13, 1981, emission-data vehicles were required to have 4,000 miles ($\pm$ 250 miles) accumulated at the time of testing. The new regulations now allow emission-data vehicles to have accumulated any mileage, as long as it is greater than a minimum mileage for vehicle stabilization, established by the manufacturer. However, if an emission-data vehicle accumulates more than 6,200 miles, the fuel economy results must be factored back to the 4,000-mile baseline.

2. Certification running change vehicles:

These are treated the same as emission-data vehicles, but are used to demonstrate compliance for design changes made after original certification. There has generally been no mileage limitations on these vehicles, except that they be stabilized. However, historically, running change test vehicles averaged 4,000 miles. Unlike emission-data vehicles, data from running change vehicles are not factored for mileage accumulation over 6,200 miles.

3. Fuel economy data vehicles:

These are vehicles used specifically for generating fuel economy data. These vehicles may, for example, have originally been emission-data vehicles, running change vehicles, or development vehicles. These too must be stabilized, but there is an upper limit of 10,000 miles accumulation. EPA allows up to 10,000 miles on FEDV's so that manufacturers can make increased use of the vehicles by repeated reconfiguration and retesting. In providing this greater test mileage flexibility, EPA did not intend nor expect that the fuel economy data would become biased so as to decrease the representativeness of label values or the stringency of the fuel economy standards.

D. To the extent that manufacturers now use test vehicles for fuel economy testing that have accumulated greater than 4,000 miles, their CAFE's will be higher than they would have been if the 4,000 miles had been adhered to since 1975. This increase is not due to design improvements that are reflected in actual in-use reductions in fuel consumption. Therefore, manufacturers may be getting false credit in their CAFE's due to a technical loophole.

E. Average FEDV mileages have increased since 1975. For all manufacturers, the average FEDV mileage was 4,900 for the 1983 model year (non-sales weighted), and peaked at 5,500 miles in the 1980 model year. Although this does not appear to be a significant increase over the 4,000-mile 1975 baseline, there was a wide variance in the test mileages for each model year (standard deviations of 950 miles to 1,600 miles). A significant amount of tests were conducted at mileages much greater than the average. Since CAFE is a sales-weighted average, the CAFE benefit from high-mileage test vehicles depends upon the sales representation of the test vehicle as well as the mileage. This report quantifies that benefit.

III. Data Analysis

A. General Methodology

The basic approach used to quantify the CAFE credit attributable only to test vehicle mileage was to adjust test results generated at over 4,250 miles to the 4,000-mile level and evaluate new CAFE's. These were then subtracted from the original CAFE's to obtain the mileage credit for each manufacturer and each CAFE class.

The equation used to factor test results to the 4,000-mile level was developed as part of a proposed fuel economy rulemaking (FR 26698, June 9, 1983), in which EPA proposed the equation to adjust test values generated from vehicles at over 6,200 miles, for labeling purposes only. This same equation was implemented in the October 13, 1981 rulemaking, applying it to emission-data vehicles at over 6,200 miles (FR 50498, October 13, 1981). The equation is as follows:

$$FE_{4,000m} = FE_T \, [0.969 + 0.842 \times 10^{-5} \, (m)]^{-1}$$

Where: $FE_{4,000m}$ = Fuel economy data adjusted to 4,000-mile test point

FE_T = Tested fuel economy value

The equation was derived by examining mileage effects on fuel economy within the fuel economy and certification data base for the 1977 through the 1981 model years. A detailed report on this derivation is attached and is titled, "The Effect of Vehicle Mileage Accumulation on Tested Fuel Economy."

For each CAFE category, individual test results that went into the original CAFE calculation were factored (adjusted to the estimated level at 4,000 miles) if the vehicle that generated the results had accumulated more than 4,250 miles. The CAFE was then recalculated with the adjusted test results using the same sales distribution as the original CAFE calculation. The fuel economy "mileage credit" is the original CAFE value minus the adjusted CAFE value, for each model year, manufacturer, and CAFE category.

Summary statistics were also derived for average test vehicle mileages in order to illustrate trends in mileage accumulation. These are illustrated in Figures 1 through 3.

B. Data Base Used

CAFE recalculations were performed for the 1979 through 1982 model years.[1] The 1981 model year was the last model year for which we had a complete CAFE data base at the time of the analysis. The 1982 model year was partially incomplete, missing final CAFE data for AMC and Chrysler. In order to reduce the complexity of the analysis, only the top ten sales manufacturers' CAFE's were examined. They account for approximately 95 percent of U. S. sales. These manufacturers are American Motors, Chrysler, Ford, General Motors, Honda, Nissan, Toyo Kogyo, Toyota, Volkswagen, and Fuji. Separate CAFE standards apply to the categories of passenger automobiles, 2-wheel-drive trucks, and 4-wheel-drive trucks. Therefore, those categories were examined for each of the ten manufacturers.

For the mileage accumulation trend analysis, data were available for the 1976 through the 1983 model years. This data base consisted of all passing valid tests used to support certification, fuel economy labeling, and CAFE's. The vehicles generating the data were emission-data vehicles, fuel economy data vehicles, and running change vehicles. This amounted to about 33,000 data points.

IV. Results

A. Mileage Accumulation Trends

Figures 1 and 2 illustrate average test vehicle mileages for the 1976 through the 1983 model years. As can be seen from the overall trend line, the average mileage of vehicles when tested has generally increased over these years. Although the average test mileage for these years was only approximately 4,500 miles (only a 500-mile increase over the 1975 baseline), nearly 20 percent of the test mileages were in the 5,000- to 10,000-mile range. The impact of these higher mileage vehicles is not necessarily indicated by their proportion in the total population. Their impact on CAFE is

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1. CAFE standards went into effect in the 1978 model year; however, EPA records for that year are not readily accessible and may not be analytically compatible with subsequent model years.

Figure 1

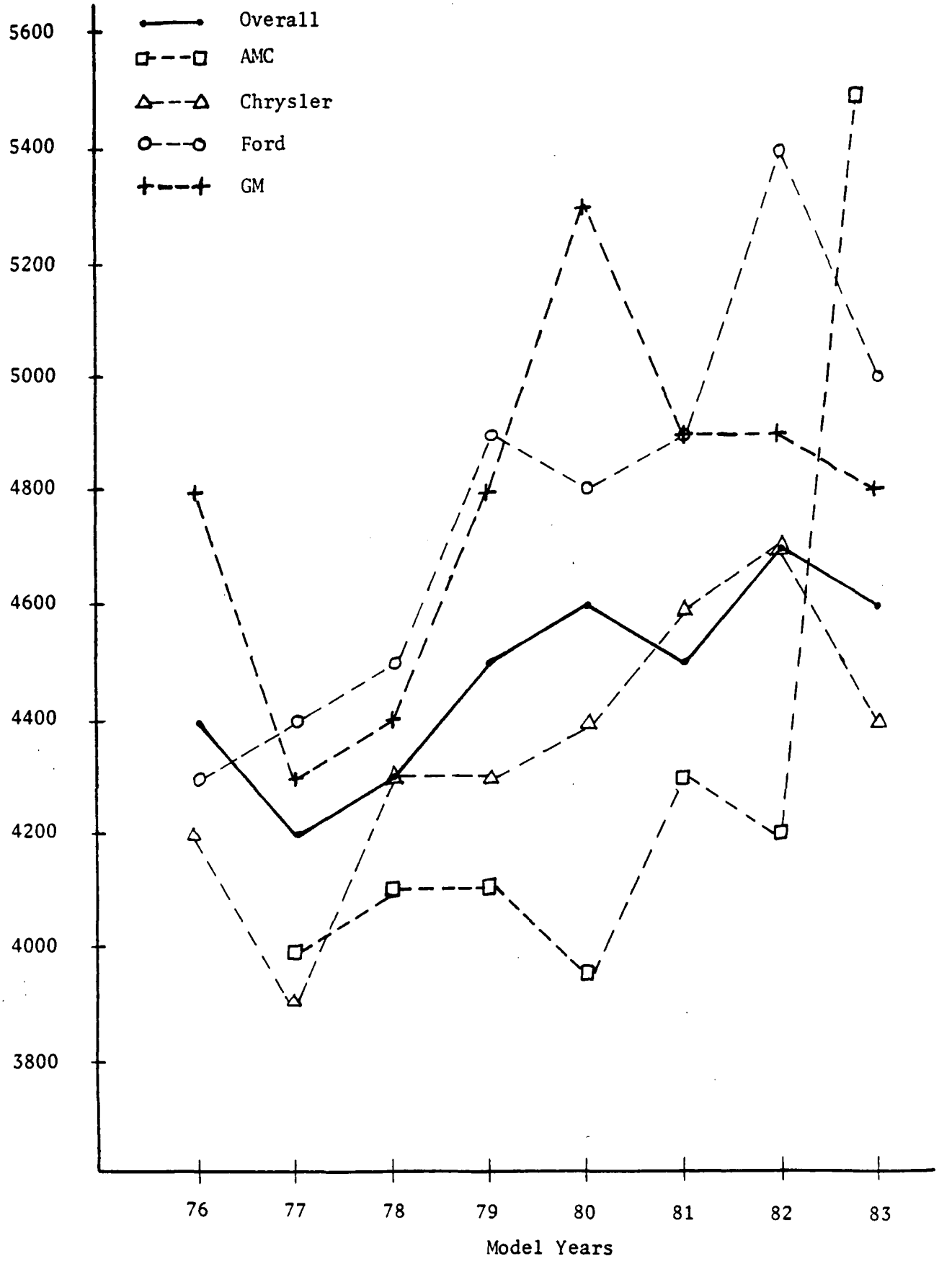
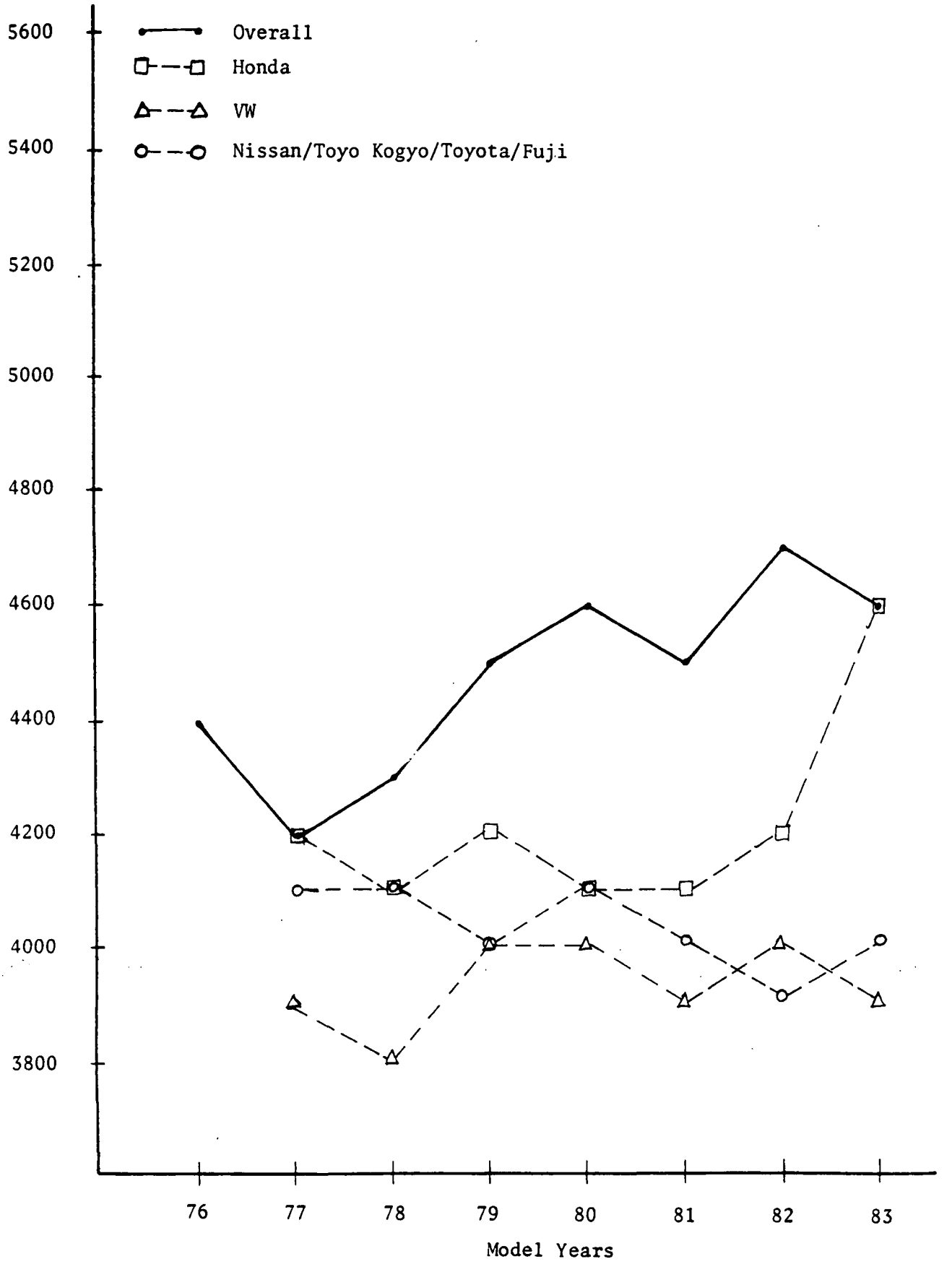

Overall
AMC
Chrysler
Ford
GM
5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
76
77
78
79
80
81
82
83
Model Years

Figure 2


5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
Overall
Honda
VW
Nissan/Toyo Kogyo/Toyota/Fuji
76
77
78
79
80
81
82
83
Model Years

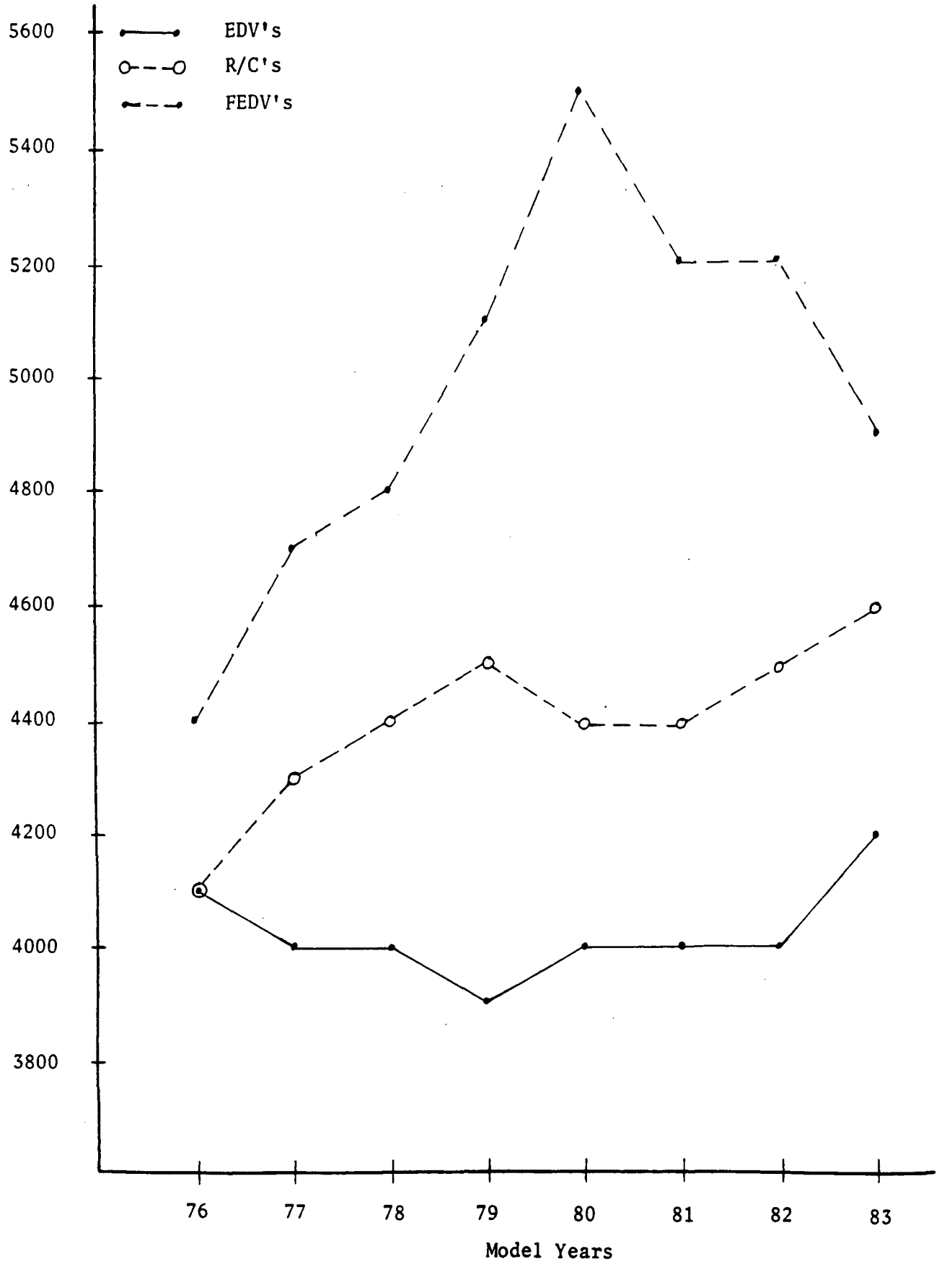
dependent on the sales fraction they represent in a manufacturer's product line. Thus, these mileage data only serve the purpose of illustrating the trends toward higher test vehicle mileages since 1975, but do not accurately reflect CAFE impacts.

On a manufacturer-specific basis, Figures 1 and 2 also illustrate individual manufacturer trends and compare general manufacturer positions. Domestic manufacturers, particularly General Motors and Ford, test their vehicles at significantly higher mileages than the foreign manufacturers. General Motors, Ford, and Chrysler also have tended to increase their average test mileages over those model years. American Motors tended to look more like the foreign manufacturers until 1982 when they exhibited a drastic increase in average test mileage. In general, with the exception of Honda, foreign manufacturers do not appear to have made an overall effort to test at higher mileages. Their averages have remained at near the 4,000-mile baseline through the years. It appears that Honda has greatly increased test mileage in 1982 and 1983.

Average test mileages of each of the previously described vehicle types are plotted by model year in Figure 3. It can be seen that on an overall average, FEDV's test mileages increased rapidly until the 1980 model year, then dropped off. It is not clear why this peak occurred, but from Figure 1 it appears to be heavily influenced by General Motors. (However, the General Motors peak is also unexplained.) Running change vehicles have exhibited a steady rise in test mileages, also exhibiting a slight peak in the 1979 model year. As expected, the EDV test mileages remained steady at around 4,000 miles, until the 1983 model year. For the 1983 model year, new rules took effect that allow manufacturers to test EDV's at any mileage. Although this was originally intended to save manufacturers money by running them at <u>less</u> than 4,000 miles, average EDV mileage data indicate an increase in mileage, presumably to obtain a fuel economy advantage. This increase in overall average EDV test mileage was nearly entirely due to the increases of American Motors, Chrysler, and Honda for 1983. (General Motors had a small increase of 200 miles over 1982.)

To summarize the test mileage trends, the overall trend from the 1975 baseline of 4,000 miles had to increase test mileage. The domestic manufacturers have tended to accumulate significantly more miles than the foreign manufacturers. Manufacturers appear to be using the new flexibility to test EDV's at higher mileages beginning in the 1983 model year, as evidenced by the increase in average EDV test mileages between the 1982 and 1983 model years.

Figure 3


EDV's
R/C's
FEDV's
5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
76
77
78
79
80
81
82
83
Model Years

B. CAFE Impacts

The results of the CAFE recalculations for the 1979 through 1982 model years are shown in Tables 1 through 3. Each table represents a CAFE category and lists the mpg offset from high test vehicle mileage for each manufacturer and model year. For the latest available complete model year (1982) the passenger automobile overall sales-weighted CAFE offset is 0.18 mpg. For two-wheel drive light-duty trucks the 1982 offset is 0.44 mpg, and for four-wheel drive light-duty trucks, the 1982 offset is 0.19 mpg.

Table 1

Passenger Automobiles

[CAFE Original - CAFE Adjusted]

Manufacturer	1979	1980	(mpg) 1981	1982
AMC	0.01	0.01	0.27	0.01
Chrysler	0.06	0.07	0.27	0.25
Ford	0.18	0.11	0.09	0.20
Fuji	0.06	0.14	0.04	0.03
GM	0.21	0.26	0.50	0.23
Honda	0.05	0.01	0.01	0.14
Nissan	0.02	0.02	0.01	0.01
Toyo Kogyo	0.00	0.00	0.01	0.02
Toyota	0.00	0.07	0.00	0.02
VW	0.07	0.02	0.01	0.01
Sales Weighted Average:	0.17	0.18	0.29	0.18

Table 1 shows the passenger automobile CAFE offsets for each manufacturer. The overall averages for the 1979 through 1982 model years appear to be fairly constant except for the 1981 model year average. Looking more closely at the sources of the 1981 increase, Table 1 shows that three manufacturers, AMC, Chrysler, and GM, accounted for virtually all of the 1981 offset. GM, in particular, had nearly double the offset of either AMC or Chrysler, and since the overall averages are sales-weighted, the high GM offset had a strong influence on the average value. However, in the 1982 model year, AMC and GM significantly reduced their offsets to values closely in line with the 1979 and 1980 model years. In

contrast, for 1982, Ford exhibited an increase in their offset after showing decreases for the 1979 through 1981 model years. Given these fluctuations in offsets over these years, there does not seem to be a clear trend of increasing or decreasing offsets for any domestic manufacturer.

As reflected in the mileage accumulation trends (Figures 1 and 2), the domestic manufacturers have consistently exhibited higher passenger automobile CAFE offsets than the foreign manufacturers. The exception to this is VW, which is actually a domestic manufacturer but shows consistently very small offsets as do the Japanese manufacturers. All of the Japanese manufacturers had negligible offsets for all model years for passenger cars, except for Honda which showed a significant increase for 1982. This increase is also reflected in Honda's mileage accumulation trend (Figure 2).

Table 2

Light-Duty Trucks, 2-Wheel Drive

[$CAFE_{Original}$ - $CAFE_{Adjusted}$]

(mpg)

Manufacturer	1979	1980	1981	1982
AMC	0.30	No Vehicles	No Vehicles	0.00
Chrysler	0.01**	0.13	0.08	0.16**
Ford	0.23**	0.34	0.34	0.30**
GM	0.19**	0.36	0.14	0.81
Nissan	0.00**	0.00	0.07	0.01
Toyo Kogyo	0.00**	0.00	0.00	0.00
Toyota	0.00**	0.00	0.01	0.01
VW	0.00**	0.00	0.00	0.00
Sales Weighted Average:	0.16**	0.29	0.19	0.44

** - Combined with 4-wheel drive trucks as a manufacturer option.

Table 3

Light-Duty Trucks, 4-Wheel Drive

[$CAFE_{Original}$ - $CAFE_{Adjusted}$]

Manufacturer	1979	1980	1981	1982
		(mpg)		
AMC	0.00	0.00	0.09	0.02
Chrysler	**	0.08	0.13	0.16**
Ford	**	0.22	0.24	0.30**
GM	**	0.34	0.34	0.18
Nissan	**	0.00	0.03	0.00
Toyota	**	0.00	0.00	0.00
Sales Weighted Average:	**	0.18	.16	0.19

** - See 2-wheel drive trucks for combined 2-wheel drive and 4-wheel drive results.

Tables 2 and 3 show the 1979 through 1982 CAFE offsets for the two light-duty truck classes. These classes are more difficult to analyze because some manufacturers in some model years elected to combine the two-wheel drive (2WD) and four-wheel drive (4WD) vehicles into one CAFE class. (These occurrences are indicated in Tables 2 and 3.)

The overall 2WD averages widely fluctuate over the 1979 through 1982 model year span. This fluctuation appears to be caused primarily by GM's offset fluctuation over that period. In particular, the overall 1982 2WD average of 0.44 mpg was due to GM's offset of 0.81 mpg which is more than twice any other manufacturer's offset. As with the passenger car class, Volkswagen and the Japanese manufacturers exhibited virtually no offset due to test vehicle mileage accumulation, whereas the domestic manufacturers were usually in the 0.15 mpg to 0.35 mpg range.

The 4WD class (Table 3) showed much the same pattern as the 2WD class concerning domestic manufacturers versus the Japanese manufacturers, although there were only two Japanese manufacturers in this class. However, AMC showed virtually no offset for its 4WD trucks. Overall, the offsets for this class tended to be lower than in the 2WD class, and GM did not exhibit the same fluctuations as they did in the 2WD class. (In fact, GM showed a significant offset drop in 1982 for this class.)

In summary, for the four model years where we have been able to recalculate CAFE's, the CAFE offsets vary greatly between manufacturers. However, domestic manufacturers tend to account for virtually all of the overall offsets. Except in a few cases, the CAFE offsets show no definite model year trends. However, our average vehicle test mileage data for the 1976 through 1983 model years indicates a general trend of increasing test vehicle mileage accumulation.