United States
Environmental Protection
Agency

Office of Transportation
and Air Quality

EPA420-R-05-001
July 2005

Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2005

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Robert M. Heavenrich

Advanced Technology Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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For More Information

Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2005 (EPA420-R-05-001) is available on the Office of Transportation and Air Quality's (OTAQ) Web site at:

www.epa.gov/otaq/fetrends.htm

Printed copies are available from the OTAQ library at:

U.S. Environmental Protection Agency
Office of Transportation and Air Quality Library
2000 Traverwood Drive
Ann Arbor, MI 48105
(734) 214-4311

A copy of the *Fuel Economy Guide* giving city and highway fuel economy data for individual models is available at:

www.fueleconomy.gov

or by calling the U.S. Department of Energy at (800) 423-1363.

EPA's *Green Vehicle Guide* providing information about the air pollution emissions and fuel economy performance of individual models is available on EPA's Web site at:

www.epa.gov/greenvehicles/

For information about the Department of Transportation (DOT) Corporate Average Fuel Economy (CAFE) program, including a program overview, related rulemaking activities, research, and summaries of individual manufacturer's fuel economy performance since 1978, see:

www.nhtsa.dot.gov/cars/rules/cafe/index.htm

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I. Executive Summary

Introduction

This report summarizes key fuel economy and technology usage trends related to model year 1975 through 2005 light-duty vehicles sold in the United States. Light-duty vehicles are those vehicles that EPA classifies as cars or light-duty trucks (sport utility vehicles, vans, and pickup trucks with less than 8,500 pounds gross vehicle weight ratings).

Since 1975, the fuel economy of the combined car and light truck fleet has moved through four phases:

1. a rapid increase from 1975 continuing to the mid-1980s

2. a slow increase extending into the late 1980s

3. a gradual decline until the mid-1990s

4. a period of relatively constant fuel economy since then

Model year 2005 light-duty vehicles are estimated to average 21.0 miles per gallon (mpg). The MY2005 average is the highest since 1996 and at the midpoint of the 20.6 to 21.4 mpg range that has occurred for the past dozen years, and five percent below the 1987-88 peak of 22.1 mpg.

The fuel economy values in this report are based on ‘real world’ estimates provided by the Federal government to consumers and are about 15 percent lower than the fuel economy values used by manufacturers and the Department of Transportation (DOT) for compliance with the Corporate Average Fuel Economy (CAFE) program. Since MY1990, the CAFE standards for cars has been the value set by Congress, i.e., 27.5 mpg. In 1996, DOT, as authorized by Congress, set a standard of 20.7 for light trucks and this standard remained the same until March 31, 2003, when DOT issued new light truck fuel economy standards increasing the standard from 20.7 to 21.0 mpg for MY2005, to 21.6 mpg for MY2006, and to 22.2 mpg for MY2007.

For model year 2005, light trucks are projected to account for 50 percent of all light-duty vehicles. After over two decades of steady growth, the market share for light trucks has been about half of the overall light-duty vehicle market since 2002. Most of this growth in the light truck market has been led by the increase in the popularity of sport utility vehicles (SUVs), which now account for more than one-fourth of all new light-duty vehicles.

Model year 2005 light-duty vehicles are estimated to be heavier, faster and more powerful than in 2004. This continues a twenty-plus year trend of increasing weight and power, and faster acceleration.

Importance of Fuel Economy

Fuel economy continues to be a major area of public and policy interest for several reasons, including:

1. Fuel economy is directly related to energy security because light-duty vehicles account for approximately 40 percent of all U.S. oil consumption, and much of this oil is imported.

2. Fuel economy is directly related to the cost of fueling a vehicle and is of great interest when crude oil and gasoline prices rise.

3. Fuel economy is directly related to emissions of greenhouse gases such as carbon dioxide. Light-duty vehicles contribute about 20 percent of all U.S. carbon dioxide emissions.

Characteristics of Light-Duty Vehicles for Three Model Years

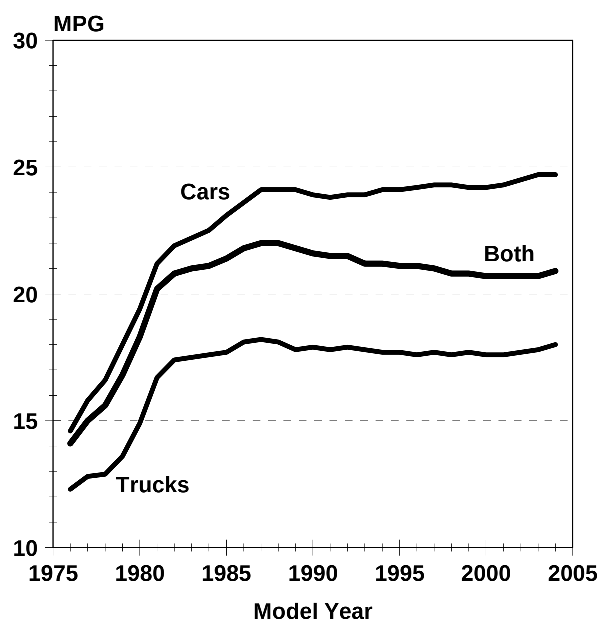
	1975	1987	2005
Adjusted Fuel Economy (mpg)	13.1	22.1	21.0
Weight (pounds)	4060	3220	4089
Horsepower	137	118	212
0-to-60 Time (seconds)	14.1	13.1	9.9
Percent Truck Sales	19%	28%	50%

Highlight #1: Fuel Economy Has Been Relatively Constant For Many Years.

> *After a decline from 22.1 mpg in 1988 to 21.0 mpg in 1994, fuel economy has been relatively constant for a decade. The average fuel economy for all model year 2005 light-duty vehicles is estimated to be 21.0 mpg, the same value as achieved in 1994 and the highest since 1996, but five percent lower than the peak value achieved in 1987-88. Average model year 2005 fuel economy is 24.7 mpg for cars and 18.2 mpg for light trucks.*

Since 1975, the fuel economy of the combined car and light truck fleet has moved through several phases: (1) a rapid increase from 1975 to the mid-1980s, (2) a slow increase extending into the late 1980s, (3) a decline from the peak in the late 1980s until the mid-1990s, and (4) since then a period of relatively constant overall fleet fuel economy. Viewing new cars and trucks separately, since 1996, the three-year moving average fuel economy for cars has ranged from 24.2 to 24.7 mpg, while that for trucks has ranged from 17.6 to 18.0 mpg, and that for all light-duty vehicles from 20.7 to 21.1 mpg.

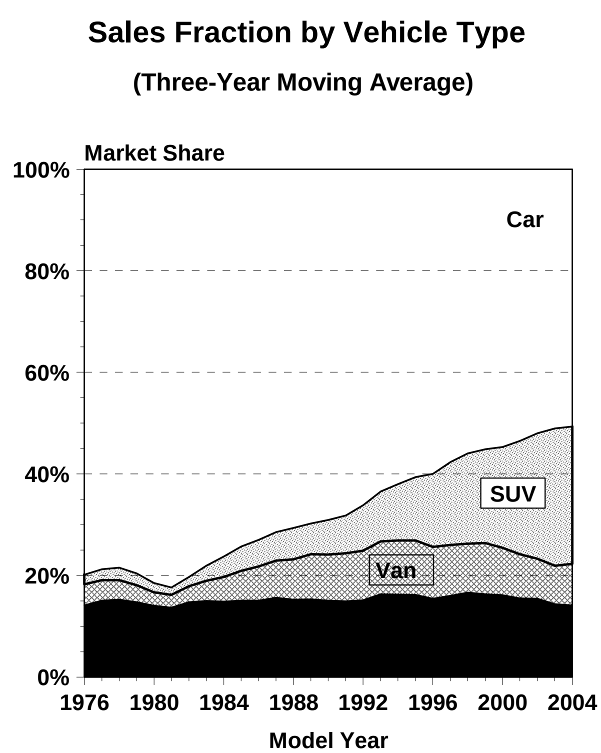
Adjusted Fuel Economy by Model Year
(Three-Year Moving Average)



Highlight #2: Trucks Represent About Half of New Vehicle Sales.

Sales of light trucks, which include sport utility vehicles (SUVs), vans, and pickup trucks, are now projected to make up about 50 percent of the U.S. light-duty vehicle market -- nearly twice their market share in 1985.

Growth in the light truck market has been led recently by the increase in the market share of SUVs. The SUV market share increased by more than a factor of ten, from less than two percent of the overall new light-duty vehicle market in 1975 to over 25 percent of the market since 2002. Over the same period, the market share for vans increased by about five percent, while that for pickups remained relatively constant. Between 1975 and 2005, market share for new passenger cars and station wagons decreased by over 30 percent. For model year 2005, cars are estimated to average 24.7 mpg, vans 20.4 mpg, SUVs 18.1 mpg, and pickups 17.1 mpg. The increased market share of light trucks, which in recent years have averaged more than six mpg less than cars, accounted for much of the decline in fuel economy of the overall new light-duty vehicle fleet from the peak that occurred in 1987-88.



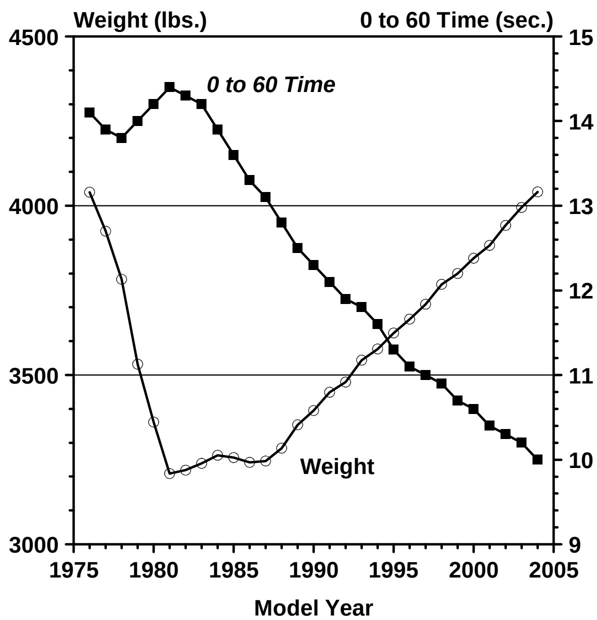
Highlight #3: As a Result of Technological Innovation, Vehicle Weight Has Increased and Performance Has Improved, While Fuel Economy Has Remained Constant.

> *Automotive manufacturers continue to apply technological innovations to the new light-duty vehicle fleet to increase light-duty vehicle weight and acceleration performance. EPA estimates that had the new 2005 light-duty vehicle fleet had the same distribution of performance and the same distribution of weight as in 1987, it could have achieved about 24 percent higher fuel economy.*

Improved engine, transmission and powertrain technologies continue to penetrate the new light-duty vehicle fleet. The trend has clearly been to apply these innovative technologies to accommodate increases in average new vehicle weight, power, and performance while maintaining a constant level of fuel economy. This is reflected by heavier average vehicle weight, rising average horsepower, and faster average 0 to 60 mile-per-hour acceleration time.

Weight and Performance

(Three Year Moving Average)



Important Notes With Respect to the Data Used in This Report

Unless otherwise indicated, the fuel economy values in this report are based on laboratory data and have been adjusted downward by about 15 percent, so that this data is equivalent to the real world estimates provided to consumers on new vehicle labels, in the EPA/DOE *Fuel Economy Guide,* and in EPA's *Green Vehicle Guide*. These adjusted fuel economy values are significantly lower than those used for compliance with CAFE standards as, in addition to the 15 percent downward adjustment for real world driving, they also exclude credits for alternative fuel capability and test procedure changes that are included in the CAFE data reported by the DOT.

The data presented in this report were tabulated on a model year basis, but several of the figures in this report use three-year moving averages which effectively smooth the trends, and these three-year moving averages are tabulated at their midpoint. For example, the midpoint for model years 2002, 2003, and 2004 is model year 2003. All average fuel economy values were calculated using harmonic, rather than arithmetic, averaging.

The source database used to generate the tables and graphs in this report for all years was frozen in November 2004. When comparing data in this report with those in previous reports in this series, please note that revisions are made in the data for some recent model years for which more complete and accurate sales and fuel economy data have become available.

Through model year 2003, the fuel economy, vehicle characteristics, and sales data used for this report were obtained from the most complete databases used for CAFE and "gas guzzler" tax on cars compliance purposes. For model year 2004, EPA used data that included confidential sales projections submitted to the Agency by the automotive manufacturers, but updated the sales data to take into account information reported in trade publications. For model year 2005, EPA has exclusively used confidential projected sales data that the auto companies are required to submit to the Agency.

Over the last five years, the final fuel economy values have varied from 0.1 mpg lower to 0.3 mpg higher compared to the original estimates based exclusively on projected sales.

II. Introduction

Light-duty automotive technology and fuel economy trends are examined herein, as in preceding reports in this series [1-31], using the latest and most complete EPA data available. When comparing data in this report with those in previous reports in this series, please note that revisions are made in the data for some model years for which more complete and accurate sales and fuel economy data have become available. Through model year 2003, the fuel economy, vehicle characteristics, and sales data used for this report were obtained from the most complete databases used for CAFE standards and "gas guzzler" compliance purposes. For all practical purposes, these databases are stable and are not expected to change in the future.

For model years 2004 and 2005, EPA has used exclusively confidential projected sales data that the auto companies are required to submit to the Agency for the Federal Government's fuel economy public information programs: the *Fuel Economy Guide* and the fuel economy labels that are placed on new vehicles. The model year 2004 data in this report EPA uses data that included confidential sales projections submitted to the agency by the automotive manufacturers, but with updated sales data to take into account information reported in trade publications. The fuel economy databases that EPA uses for this report and other purposes are based on the consumer information and regulatory databases maintained by the Agency. For a given model year, these databases change with calendar time as the initial fuel economy values and sales projections available in the Fall of the year evolve toward final and more complete fuel economy data and actual production data. This calendar time-based process can take more than one year to complete, and during this time the database is changing.

Automotive manufacturers typically submit their initial estimates of fuel economy data over a period of several months, starting a few months before the *Fuel Economy Guide* is published, and then continuing for a few months after the start of the model year as new models and vehicle configurations continue to be introduced for sale. Similarly, manufacturers typically do not start submitting their final data until several months after the end of the model year, and this process can then take several additional months to complete. Therefore, the results for the a given model year that are obtained from using the database are estimates that depend on when the analysis is done. The final fuel economy averages used in this report are often different from the initial estimates and have varied from 0.1 mpg lower to 0.3 mpg higher (i.e., about one percent) compared to the original estimates based exclusively on projected sales (see Table A-1, Appendix A). For this report, the source database was frozen in November 2004 for all model years. Appendix B lists the model year 2005 nameplates used in this report by size class.

All fuel economy averages in this report are sales-weighted harmonic averages. In prior reports in this series, up to and including the one for MY2000, the fuel economy values used in this series were just the laboratory-based city, highway, and combined mpg values — the same ones that are used as the basis for compliance with the fuel economy standards and the gas guzzler tax. Since the laboratory mpg values tend to over predict the mpg achieved in actual use, adjusted mpg values are used for the Government's fuel economy information programs: the *Fuel Economy Guide* and the *Fuel Economy Labels* that are on new vehicles and in EPA's *Green Vehicle Guide.*

* Numbers in brackets denote references listed in the references section of this report.

Starting with the report issued for MY2001, this series of reports has provided fuel economy trends in adjusted mpg values in addition to the laboratory mpg values. In this way, the fuel economy trends can be shown for both laboratory mpg and mpg values which can be considered to be an estimate of on-road mpg. In the tables, these two mpg values are called "Laboratory MPG," "Adjusted MPG," and abbreviated "ADJ" MPG and "LAB" MPG. The adjusted city mpg is obtained by multiplying the laboratory city mpg by 0.90, and the adjusted highway mpg is obtained by multiplying the laboratory highway mpg value by 0.78. Because it has been over two decades [11] since the current procedures for adjusting city and highway fuel economy were established and because both vehicle technology and vehicle driving patterns have changed over the years, EPA is currently evaluating the procedures used to determine the on-road mpg values and plans to propose appropriate changes to these procedures in about a year.

Where only one mpg value is presented in this report, it is the "adjusted composite 55/45 combined mpg", i.e.,

$$MPG_{\mathbf{55/45}} = 1 / (.55/MPG_{\mathbf{C}} + .45/MPG_{\mathbf{H}})$$

where MPG_C is 0.9 times the laboratory fuel economy on the EPA city driving cycle, and MPG_H is 0.78 times the laboratory fuel economy on the EPA highway driving cycle. If a combined "55/45" mpg value is calculated, the resulting mpg value is about 15 percent lower than the comparable value using the laboratory-based mpg values. It should be noted that an adjusted composite mpg value is *not* used in the Government's fuel economy information programs discussed above. Appendix A provides more information on averaging fuel economy data, and Appendix C provides additional data on city and highway driving.

To facilitate comparison with data in previous reports in this series, most data tables include what the $MPG_{55/45}$ value would have been had the laboratory fuel economy values not been adjusted downward, as well as the adjusted city, highway, and combined 55/45 fuel economy values. Presenting both types of mpg values facilitates the use of this report by those who study either type of fuel economy metric.

The fuel economy reported by DOT for CAFE compliance purposes is higher than the data in this report in three respects:

(1) the DOT data does not include the EPA on-road fuel economy adjustment factors for city and highway mpg,

(2) the DOT data includes credits for those manufacturers that produce dedicated and/or flexible alternate fuel vehicles, and

(3) the DOT data includes credits for test procedure adjustments.

Accordingly, the fuel economy values in this series of reports are always slightly lower than those reported by the Department of Transportation (DOT) and significantly higher than those provided in the *Fuel Economy Guide*. Table A-2, Appendix A compares CAFE data reported by The Department of Transportation (DOT) with EPA adjusted and laboratory fuel economy data.

The data presented in this report were tabulated on a model year basis, but many of the figures in this report use three-year moving averages which effectively smooth the trends, and these three-year moving averages are tabulated at their midpoint. For example, the midpoint for model years 2002, 2003, and 2004 is model year 2003 (See Table A-3, Appendix A). Use of the three-year moving averages results in an improvement in discerning real trends from what might be relatively small year-to-year variations in the data.

Other Variables

All vehicle weight data are based on inertia weight class (nominally curb weight plus 300 pounds). For vehicles with inertia weights up to and including the 3000-pound inertia weight class, these classes have 250-pound increments. For vehicles above the 3000-pound inertia weight class (i.e., vehicles 3500 pounds and above), 500-pound increments are used.

All interior volume data for cars built after model year 1977 are based on the metric used to classify cars for the DOE/EPA *Fuel Economy Guide*. The car interior volume data in this report combine that of the passenger compartment and trunk/cargo space. In the *Fuel Economy Guide*, interior volume is undefined for the two-seater class; for this series of reports, all two-seater cars have been assigned an interior volume value of 50 cubic feet.

The light truck data used in this series of reports includes only vehicles classified as light trucks with gross vehicle weight ratings (GVWR) up to 8,500 pounds. Vehicles with GVWR above 8,500 are not included in the database used for this report. Omitting these vehicles influences the overall averages for all variables studied in this report. The most recent estimates we have made for the impact of these greater than 8500-lb GVWR vehicles was made for model year 2001. In that year, there were roughly 931,000 vehicles above 8500 lb GVWR. A substantial fraction (42 percent) of the MY2001 vehicles above 8500 lb GVWR were powered by diesel engines, and three-fourths of the vehicles over 8500 lb GVWR were pickup trucks. Adding in the trucks above 8500 lb GVWR increased the truck market share for that year by three percentage points.

Based on a limited amount of actual laboratory fuel economy data, MY2001 trucks with GVWR greater than 8500 lb GVWR are estimated to have fuel economy values about 14 percent lower than the average of trucks below 8500 lb GVWR. The combined fleet of all vehicles under 8500 lb GVWR and trucks over 8500 lb GVWR is estimated to average about nine percent less in fuel economy compared to that for just the vehicles with less than 8500 lb GVWR.

In addition to fuel economy, some tables in this report contain alternate measures of vehicle fuel efficiency as used in reference 17.

"Ton-MPG" is defined as a vehicle's mpg multiplied by its inertia weight in tons. This metric provides an indication of a vehicle's ability to move weight (i.e., its own plus a nominal payload). Ton-MPG is a measure of powertrain/drive-line efficiency. Just as an increase in vehicle mpg at constant weight can be considered an improvement in a vehicle's efficiency, an increase in a vehicle's weight-carrying capacity at constant mpg can also be considered an improvement.

"Cubic-feet-MPG" for cars is defined in this report as the product of a car's mpg and its interior volume, including trunk space. This metric associates a relative measure of a vehicle's ability to transport both passengers and their cargo. An increase in vehicle volume at constant mpg could be considered an improvement just as an increase in mpg at constant volume can be.

"Cubic-feet-ton-MPG" is defined in this report as a combination of the two previous metrics, i.e., a car's mpg multiplied by its weight in tons and also by its interior volume. It ascribes vehicle utility to the ability to move both weight and volume.

This report also includes an estimate of 0-to-60 mph acceleration time, calculated from engine rated horsepower and vehicle inertia weight, from the relationship:

$$t = F\ (HP/WT)^{-f}$$

where the values used for F and f coefficients are .892 and .805 respectively for vehicles with automatic transmissions and .967 and .775 respectively for those with manual transmissions [32]. Other authors [33, 34, and 35] have evaluated the relationships between weight, horsepower, and 0-to-60 acceleration time and have calculated and published slightly different values for the F and f coefficients. Since the equation form and coefficients were developed for vehicles with conventional powertrains with gasoline-fueled engines, we have not used the equation to estimate 0-to-60 time for vehicles with hybrid powertrains or diesel engines. Published values are used for these vehicles instead.

The 0-to-60 estimate used in this report is intended to provide a quantitative time "index" of vehicle performance capability. It is the author's engineering judgment that, given the differences in test methods for measuring 0-to-60 time and given the fact that the weight is based on inertia weight, use of these other published values for the F and f coefficients would not result in statistically significantly different 0-to-60 averages or trends. The results of a similar calculation of estimated "top speed" are also included in some tables.

Grouping all vehicles into classes and then constructing time trends of parameters of interest, like mpg, can provide interesting and useful results. These results, however, are a strong function of the class definitions. Classes based on other definitions than those used in this report are possible, and results from these other classifications may also be useful.

For cars, vehicle classification as to vehicle type, size class, and manufacturer/origin generally follows fuel economy label, *Fuel Economy Guide*, and fuel economy standards protocols; exceptions are listed in Table A-4, Appendix A. In many of the passenger car tables, large sedans and wagons are aggregated as "Large," midsize sedans and wagons are aggregated as "Midsize," and "Small" includes all other cars. In some of the car tables, an alternative classification system is used, namely: Large Cars, Large Wagons, Midsize Cars, Midsize Wagons, Small Cars, and Small Wagons with the EPA Two-Seater, Mini-Compact, Subcompact, and Compact car classes combined into the "Small Car" class.

The truck classification scheme used for all model years in this report is slightly different from that used in some previous reports in this series, because pickups, vans, and sports utility vehicles (SUVs) are sometimes each subdivided as “Small,” “Midsize,” and “Large.” These truck size classifications are based primarily on published wheelbase data according to the following criteria:

	Pickup	Van	SUV
Small	Less than 105"	Less than 109"	Less than 100"
Midsize	105" to 115"	109" to 124"	100" to 110"
Large	More than 115"	More than 124"	More than 110"

This classification scheme is similar to that used in many trade and consumer publications. For those vehicle nameplates with a variety of wheelbases, the size classification was determined by considering only the smallest wheelbase produced. The classification of a vehicle for this report is based on the author’s engineering judgment and is not a replacement for definitions used in implementing automotive standards legislation.

III. **General Car and Truck Trends**

Figure 1 and Table 1 depict time trends in car, light truck, and car-plus-light truck fuel economy. Also shown on Figure 1 is the fraction of the combined fleet that are light trucks and trend lines representing three-year moving averages of the fuel economy and truck sales fraction data.

Since 1975, the fuel economy of the combined car and light truck fleet has moved through several phases:

1. a rapid increase from 1975 continuing into the mid-1980s,

2. a slow increase extending into the late 1980s,

3. a gradual decline from then until the mid 1990s, and

4. a period of relatively constant fuel economy since then.

This fourth phase is characterized by three-year moving average adjusted fuel economy levels within one percent of 20.8 mpg for nine years. This 20.8 mpg value is 1.1 mpg (5.3%) lower than the highest year's (1987) three-year moving average value and 6.8 mpg (32%) higher than the earliest three-year moving average value, that for 1976. The average fuel economy for all model year 2005 light-duty vehicles is estimated to be 21.0 mpg the same value as achieved in 1994.

The three-year moving average for car fuel economy has tended slightly upward for about a decade and is now about one mpg higher than it was in early 1990s. Similarly, the three year moving average for light-truck fuel economy is on a slight upward trend and is 0.4 mpg higher than it was in 1998. These slight upward trends for both cars and trucks have been accompanied by an increasing truck share of the market and thus has resulted in the recent flat trend in overall fleet fuel economy.

Figure 1 shows that the estimated light truck share of the market is about 50 percent and, based on the three-year moving average trend, has not leveled off. It should be noted that on March 31, 2003, NHTSA issued new light truck fuel economy (CAFE) standards setting a standard of 21.0 mpg for MY 2005, 21.6 mpg for MY 2006, and 22.2 mpg for MY 2007 and that these are the first changes in truck fuel economy standards since 1996.

Adjusted Fuel Economy and Percent Truck by Model Year (Three Year Moving Average)

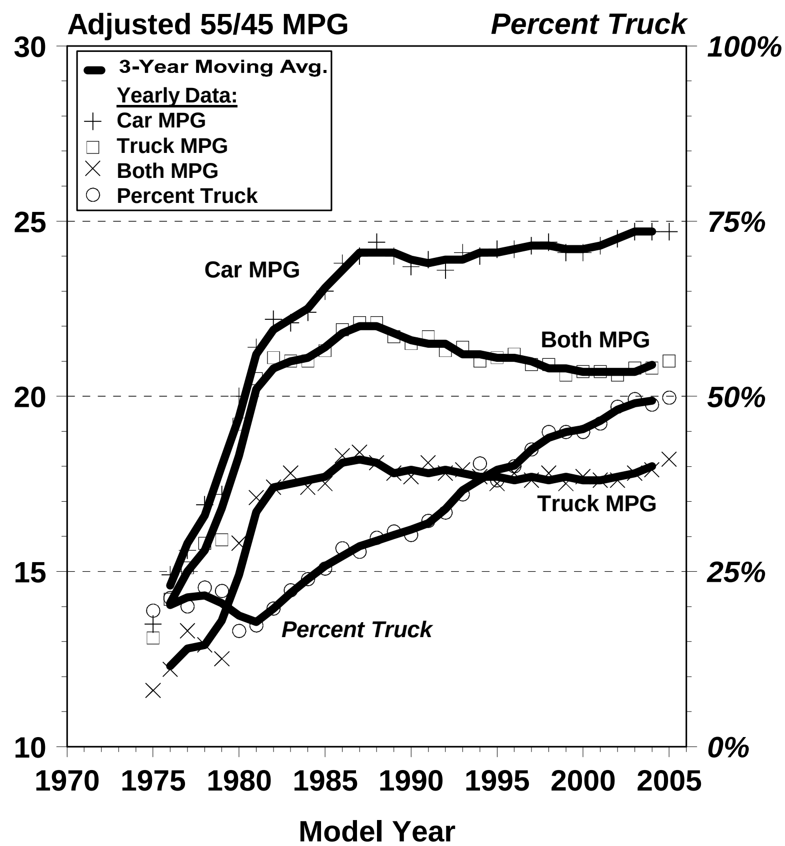


Figure 1

Table 1

Fuel Economy Characteristics of 1975 to 2005 Light-Duty Vehicles

Cars

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY ----> LAB 55/45	ADJ CITY	ADJ HWY	ADJ 55/45	TON -MPG	CU-FT -MPG	CU-FT- TON-MPG
1975	8237	.806	15.8	12.3	15.2	13.5	27.6		
1976	9722	.788	17.5	13.7	16.6	14.9	30.2		
1977	11300	.800	18.3	14.4	17.4	15.6	31.0	1780	3423
1978	11175	.773	19.9	15.5	19.1	16.9	30.6	1908	3345
1979	10794	.778	20.3	15.9	19.2	17.2	30.2	1922	3301
1980	9443	.835	23.5	18.3	22.6	20.0	31.2	2136	3273
1981	8733	.827	25.1	19.6	24.2	21.4	33.1	2338	3547
1982	7819	.803	26.0	20.1	25.5	22.2	34.2	2419	3645
1983	8002	.777	25.9	19.9	25.5	22.1	34.7	2476	3776
1984	10675	.761	26.3	20.2	26.0	22.4	35.1	2482	3776
1985	10791	.746	27.0	20.7	26.8	23.0	35.8	2553	3884
1986	11015	.717	27.9	21.3	27.7	23.8	36.4	2608	3914
1987	10731	.722	28.1	21.5	28.0	24.0	36.5	2604	3900
1988	10736	.702	28.6	21.8	28.5	24.4	37.3	2662	4007
1989	10018	.693	28.1	21.4	28.3	24.0	37.4	2630	4034
1990	8810	.698	27.8	21.1	28.1	23.7	37.8	2574	4055
1991	8524	.678	28.0	21.2	28.3	23.9	37.8	2597	4055
1992	8108	.666	27.6	20.8	28.3	23.6	38.4	2598	4169
1993	8456	.640	28.2	21.3	28.8	24.1	38.8	2655	4213
1994	8414	.596	28.1	21.1	28.8	24.0	39.1	2638	4237
1995	9396	.620	28.3	21.2	29.3	24.2	39.6	2676	4315
1996	7890	.600	28.3	21.2	29.3	24.2	39.8	2672	4345
1997	8335	.576	28.4	21.3	29.4	24.3	39.9	2674	4341
1998	7971	.551	28.5	21.3	29.6	24.4	40.5	2684	4401
1999	8379	.551	28.2	21.1	29.2	24.1	40.6	2656	4440
2000	9128	.551	28.2	21.1	29.1	24.1	40.7	2669	4468
2001	8408	.539	28.4	21.4	29.3	24.3	41.4	2700	4525
2002	8305	.515	28.6	21.6	29.3	24.5	41.8	2723	4579
2003	7952	.504	28.9	21.8	29.7	24.7	42.6	2756	4668
2004	8147	.512	28.9	21.7	29.8	24.7	43.1	2814	4814
2005	8616	.502	28.9	21.8	29.7	24.7	43.6	2822	4886

Table 1, Continued

Fuel Economy Characteristics of 1975 to 2005 Light-Duty Vehicles

Trucks

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY ----> LAB 55/45	ADJ CITY	ADJ HWY	ADJ 55/45	TON -MPG
1975	1987	.194	13.7	10.9	12.7	11.6	24.2
1976	2612	.212	14.4	11.5	13.2	12.2	26.0
1977	2823	.200	15.6	12.6	14.1	13.3	28.0
1978	3273	.227	15.2	12.4	13.7	12.9	27.5
1979	3088	.222	14.7	12.1	13.1	12.5	27.3
1980	1863	.165	18.6	14.8	17.1	15.8	30.9
1981	1821	.173	20.1	16.0	18.6	17.1	33.0
1982	1914	.197	20.5	16.3	19.0	17.4	33.7
1983	2300	.223	20.9	16.5	19.6	17.8	34.0
1984	3345	.239	20.5	16.1	19.3	17.4	33.5
1985	3669	.254	20.6	16.2	19.4	17.5	33.7
1986	4350	.283	21.4	16.9	20.2	18.3	34.4
1987	4134	.278	21.6	16.9	20.7	18.4	34.5
1988	4559	.298	21.2	16.5	20.4	18.1	34.9
1989	4435	.307	20.9	16.3	20.1	17.8	35.2
1990	3805	.302	20.7	16.1	20.2	17.7	35.6
1991	4049	.322	21.3	16.4	20.7	18.1	36.0
1992	4064	.334	20.8	16.1	20.4	17.8	36.2
1993	4754	.360	21.0	16.1	20.7	17.9	36.6
1994	5710	.404	20.8	16.0	20.3	17.7	36.7
1995	5749	.380	20.5	15.8	20.2	17.5	36.9
1996	5254	.400	20.8	16.0	20.7	17.8	37.8
1997	6124	.424	20.6	15.8	20.4	17.6	38.3
1998	6485	.449	20.9	16.0	20.8	17.8	38.3
1999	6839	.449	20.5	15.7	20.3	17.5	38.6
2000	7447	.449	20.8	16.0	20.5	17.7	38.9
2001	7202	.461	20.6	15.9	20.2	17.6	39.3
2002	7815	.485	20.6	15.8	20.3	17.6	40.0
2003	7824	.496	20.9	16.0	20.7	17.8	41.0
2004	7772	.488	20.9	16.0	20.8	17.9	41.6
2005	8534	.498	21.3	16.3	21.3	18.2	42.7

Table 1, Continued

Fuel Economy Characteristics of 1975 to 2005 Light-Duty Vehicles

Cars and Trucks

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY ----> LAB 55/45	ADJ CITY	ADJ HWY	ADJ 55/45	TON -MPG
1975	10224	1.000	15.3	12.0	14.6	13.1	26.9
1976	12334	1.000	16.7	13.2	15.7	14.2	29.3
1977	14123	1.000	17.7	14.0	16.6	15.1	30.4
1978	14448	1.000	18.6	14.7	17.5	15.8	29.9
1979	13882	1.000	18.7	14.9	17.4	15.9	29.5
1980	11306	1.000	22.5	17.6	21.5	19.2	31.2
1981	10554	1.000	24.1	18.8	23.0	20.5	33.1
1982	9732	1.000	24.7	19.2	23.9	21.1	34.1
1983	10302	1.000	24.6	19.0	23.9	21.0	34.5
1984	14020	1.000	24.6	19.1	24.0	21.0	34.7
1985	14460	1.000	25.0	19.3	24.4	21.3	35.3
1986	15365	1.000	25.7	19.9	25.1	21.9	35.8
1987	14865	1.000	25.9	20.0	25.5	22.1	35.9
1988	15295	1.000	25.9	19.9	25.5	22.1	36.6
1989	14453	1.000	25.4	19.5	25.2	21.7	36.7
1990	12615	1.000	25.2	19.3	25.1	21.5	37.1
1991	12573	1.000	25.4	19.4	25.3	21.7	37.2
1992	12172	1.000	24.9	18.9	25.0	21.3	37.6
1993	13211	1.000	25.1	19.1	25.2	21.4	38.0
1994	14125	1.000	24.6	18.7	24.7	21.0	38.1
1995	15145	1.000	24.7	18.8	25.0	21.1	38.6
1996	13144	1.000	24.8	18.7	25.1	21.2	39.0
1997	14459	1.000	24.5	18.6	24.8	20.9	39.2
1998	14457	1.000	24.5	18.5	24.9	20.9	39.5
1999	15218	1.000	24.1	18.3	24.4	20.6	39.7
2000	16574	1.000	24.3	18.4	24.5	20.7	39.9
2001	15610	1.000	24.2	18.4	24.3	20.7	40.4
2002	16120	1.000	24.1	18.3	24.1	20.6	40.9
2003	15776	1.000	24.3	18.5	24.4	20.8	41.8
2004	15920	1.000	24.4	18.5	24.6	20.8	42.4
2005	17150	1.000	24.6	18.6	24.8	21.0	43.2

Figure 2 compares laboratory 55/45 fuel economy for the combined car and truck fleet and the sales fraction for trucks. This figure shows that for the first of the four phases mentioned above, i.e., the one from 1975 through the early 1980s, truck sales fraction remained nominally at the twenty percent level, while combined car and truck fuel economy increased substantially, i.e., from about 15 to 25 mpg. During the other three phases truck sales fraction increased. Table 2 shows some of the characteristics of each year's fleet. At 4089 lb, the average weight of the model year 2005 fleet not only is nearly 900 lb heavier than it was at the minimum in 1981-82, it also is heavier than any year in the table. Since MY2004, average weight has increased by 51 lb. The model year 2005 fleet is also the most powerful and estimated to be the fastest since 1975.

Another dramatic trend over that time frame has been the substantial increase in performance of cars and light trucks as measured by their estimated 0-to-60 time. These trends are shown graphically in Figure 3 (for cars) and Figure 4 (for light trucks) which are plots of fuel economy versus performance, with model years as indicated. Both graphs show the same story: in responding to the regulatory requirements for mpg improvement, the industry increased mpg and kept performance roughly constant. After the regulatory mpg requirements stabilized, mpg improvements slowed and performance dramatically improved. This trend toward increased performance is as important as the truck market share trend in understanding trends in overall fleet mpg. Figures 5 and 6 are similar to Figures 3 and 4, but show the trends in weight and laboratory fuel economy and show that the era of weight reductions that took place for both cars and trucks between 1975 and the early 1980s has been followed by an era of weight increases.

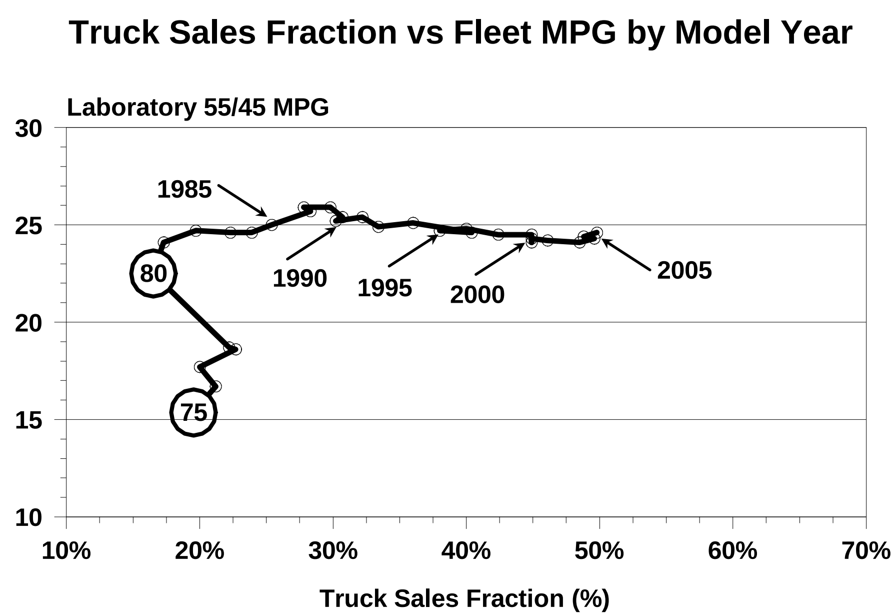


Figure 2

Car 55/45 Laboratory MPG vs 0 to 60 Time by Model Year

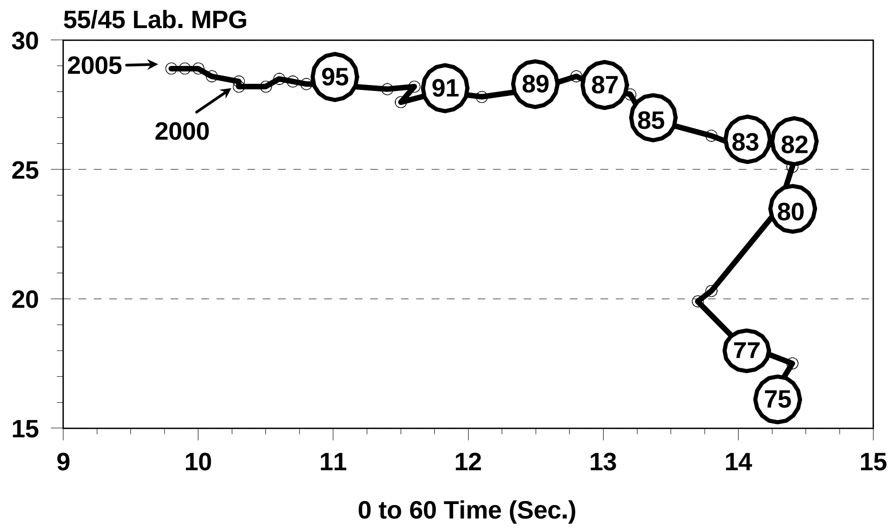


Figure 3

Truck 55/45 Laboratory MPG vs 0 to 60 Time by Model Year

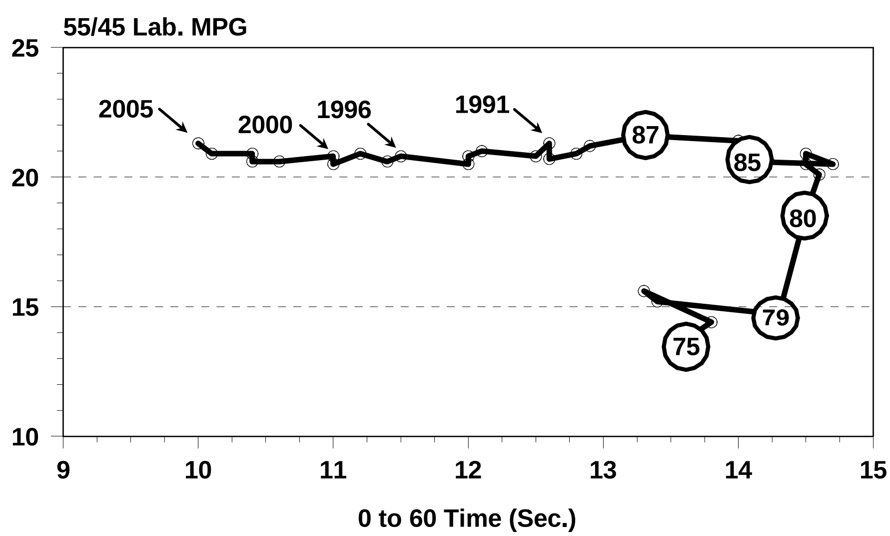


Figure 4

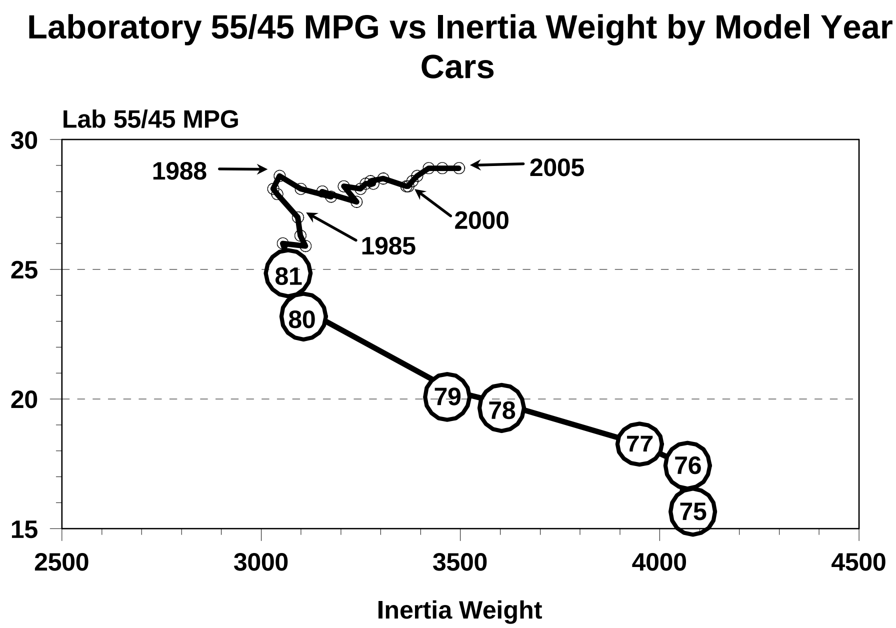


Figure 5

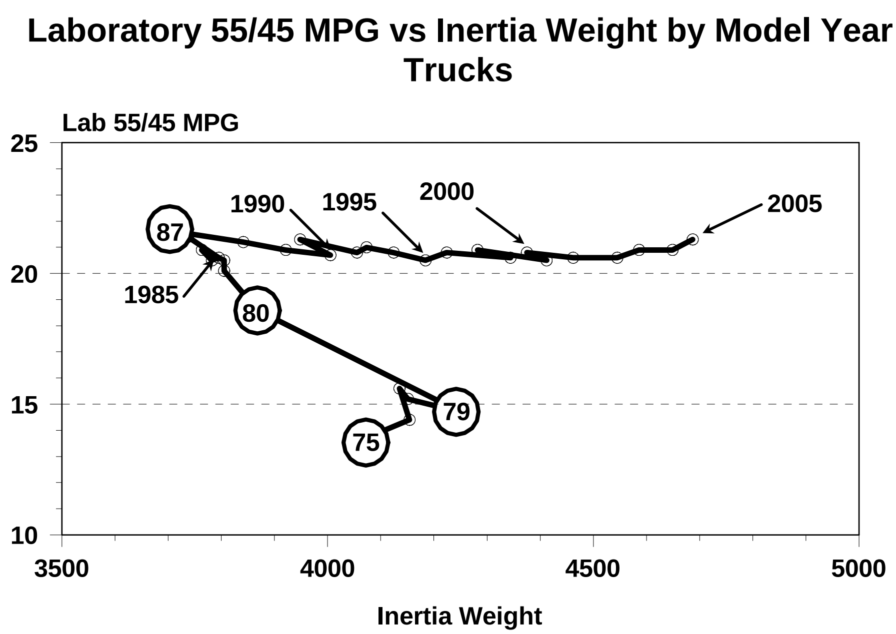


Figure 6

Table 2

Vehicle Size and Design Characteristics of 1975 to 2005

Cars

<------------ VEHICLE CHARACTERISTICS									------------>	<- PERCENT BY: ->		
										VEHICLE SIZE		
MODEL YEAR	ADJ SALES (000)	FRAC	55/45 MPG	VOL CU-FT	INERTIA WGHT LB	ENG HP	HP/ WT	0-60 TIME	TOP SPD	SMALL	MID	LARGE
1975	8237	.806	13.5		4058	136	.0331	14.2	111	55.4	23.3	21.3
1976	9722	.788	14.9		4059	134	.0324	14.4	110	55.4	25.2	19.4
1977	11300	.800	15.6	110	3944	133	.0335	14.0	111	51.9	24.5	23.5
1978	11175	.773	16.9	109	3588	124	.0342	13.7	111	44.7	34.4	21.0
1979	10794	.778	17.2	109	3485	119	.0338	13.8	110	43.7	34.2	22.1
1980	9443	.835	20.0	104	3101	100	.0322	14.3	107	54.4	34.4	11.3
1981	8733	.827	21.4	106	3076	99	.0320	14.4	106	51.5	36.4	12.2
1982	7819	.803	22.2	106	3054	99	.0320	14.4	106	56.5	31.0	12.5
1983	8002	.777	22.1	109	3112	104	.0330	14.0	108	53.1	31.8	15.1
1984	10675	.761	22.4	108	3099	106	.0339	13.8	109	57.4	29.4	13.2
1985	10791	.746	23.0	108	3093	111	.0355	13.3	111	55.7	28.9	15.4
1986	11015	.717	23.8	107	3041	111	.0360	13.2	111	59.5	27.9	12.6
1987	10731	.722	24.0	107	3031	112	.0365	13.0	112	63.5	24.3	12.2
1988	10736	.702	24.4	107	3047	116	.0375	12.8	113	64.8	22.3	12.8
1989	10018	.693	24.0	108	3099	121	.0387	12.5	115	58.3	28.2	13.5
1990	8810	.698	23.7	107	3176	129	.0401	12.1	117	58.6	28.7	12.8
1991	8524	.678	23.9	107	3154	132	.0413	11.8	118	61.5	26.2	12.3
1992	8108	.666	23.6	108	3240	141	.0428	11.5	120	56.5	27.8	15.6
1993	8456	.640	24.1	108	3207	138	.0425	11.6	120	57.2	29.5	13.3
1994	8414	.596	24.0	108	3250	143	.0432	11.4	121	58.5	26.1	15.4
1995	9396	.620	24.2	109	3263	152	.0460	10.9	125	57.3	28.6	14.0
1996	7890	.600	24.2	109	3282	154	.0464	10.8	125	54.3	32.0	13.6
1997	8335	.576	24.3	109	3274	156	.0469	10.7	126	55.1	30.6	14.3
1998	7971	.551	24.4	109	3306	159	.0475	10.6	127	49.4	39.1	11.5
1999	8379	.551	24.1	109	3365	164	.0481	10.5	128	47.7	39.7	12.6
2000	9128	.551	24.1	110	3369	168	.0492	10.3	129	47.5	34.3	18.2
2001	8408	.539	24.3	109	3380	168	.0492	10.3	129	50.9	32.3	16.8
2002	8305	.515	24.4	109	3391	173	.0504	10.1	131	48.6	36.3	15.1
2003	7952	.504	24.7	109	3421	176	.0510	10.0	132	50.8	33.4	15.9
2004	8147	.512	24.7	111	3454	181	.0519	9.9	133	44.1	39.2	16.7
2005	8616	.502	24.7	112	3497	187	.0526	9.8	134	44.1	37.7	18.3

Table 2, (Continued)

Vehicle Size and Design Characteristics of 1975 to 2005

Trucks

<-------- Vehicle Characteristics:								-------->	<- Percent By:		->
MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	WGHT LB	ENG HP	HP/ WT	0-60 TIME	TOP SPD	VEHICLE TYPE VAN	SUV	PICKUP
1975	1987	.194	11.6	4072	142	.0349	13.6	114	23.0	9.4	67.6
1976	2612	.212	12.2	4155	141	.0340	13.8	113	19.2	9.3	71.4
1977	2823	.200	13.3	4135	147	.0356	13.3	115	18.2	10.0	71.8
1978	3273	.227	12.9	4151	146	.0351	13.4	114	19.1	11.6	69.3
1979	3088	.222	12.5	4252	138	.0325	14.3	111	15.6	13.0	71.5
1980	1863	.165	15.8	3869	121	.0313	14.5	108	13.0	9.9	77.1
1981	1821	.173	17.1	3806	119	.0311	14.6	108	13.5	7.5	79.1
1982	1914	.197	17.4	3806	120	.0317	14.5	109	16.2	8.5	75.3
1983	2300	.223	17.8	3763	118	.0313	14.5	108	16.6	12.6	70.8
1984	3345	.239	17.4	3782	118	.0310	14.7	108	20.2	18.7	61.1
1985	3669	.254	17.5	3795	124	.0326	14.1	110	23.3	20.0	56.6
1986	4350	.283	18.3	3738	123	.0330	14.0	110	24.0	17.8	58.2
1987	4134	.278	18.4	3713	131	.0351	13.3	113	26.9	21.1	51.9
1988	4559	.298	18.1	3841	141	.0366	12.9	115	24.8	21.2	53.9
1989	4435	.307	17.8	3921	146	.0372	12.8	116	28.8	20.9	50.3
1990	3805	.302	17.7	4005	151	.0377	12.6	117	33.2	18.6	48.2
1991	4049	.322	18.1	3948	150	.0379	12.6	117	25.5	27.0	47.4
1992	4064	.334	17.8	4056	155	.0382	12.5	118	30.0	24.7	45.3
1993	4754	.360	17.9	4073	162	.0398	12.1	120	30.3	27.6	42.1
1994	5710	.404	17.7	4125	166	.0403	12.0	121	24.8	28.4	46.7
1995	5749	.380	17.5	4184	168	.0401	12.0	121	28.9	31.6	39.5
1996	5254	.400	17.8	4225	179	.0423	11.5	124	26.8	36.0	37.2
1997	6124	.424	17.6	4344	187	.0429	11.4	126	20.7	40.0	39.3
1998	6485	.449	17.8	4283	187	.0435	11.2	126	23.0	39.8	37.2
1999	6839	.449	17.5	4412	197	.0446	11.0	128	21.4	41.4	37.2
2000	7447	.449	17.7	4375	197	.0448	11.0	128	22.7	42.2	35.1
2001	7202	.461	17.6	4463	209	.0466	10.6	131	17.1	47.9	35.0
2002	7815	.485	17.6	4546	219	.0482	10.4	134	15.9	53.6	30.5
2003	7824	.496	17.8	4586	221	.0481	10.4	134	15.7	52.6	31.6
2004	7772	.488	17.9	4650	231	.0498	10.1	136	14.3	59.8	25.9
2005	8534	.498	18.2	4688	237	.0503	10.0	137	19.1	52.1	28.8

Table 2, (Continued)

Vehicle Size and Design Characteristics of 1975 to 2005

Cars and Trucks

MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	WGHT LB	ENG HP	HP/ WT	0-60 TIME	TOP SPD
1975	10224	1.000	13.1	4060	137	.0335	14.1	112
1976	12334	1.000	14.2	4079	135	.0328	14.3	111
1977	14123	1.000	15.1	3982	136	.0339	13.8	112
1978	14448	1.000	15.8	3715	129	.0344	13.6	112
1979	13882	1.000	15.9	3655	124	.0335	13.9	110
1980	11306	1.000	19.2	3228	104	.0320	14.3	107
1981	10554	1.000	20.5	3202	102	.0318	14.4	107
1982	9732	1.000	21.1	3202	103	.0320	14.4	107
1983	10302	1.000	21.0	3257	107	.0327	14.1	108
1984	14020	1.000	21.0	3262	109	.0332	14.0	109
1985	14460	1.000	21.3	3271	114	.0347	13.5	110
1986	15365	1.000	21.9	3238	114	.0351	13.4	111
1987	14865	1.000	22.1	3221	118	.0361	13.1	112
1988	15295	1.000	22.1	3283	123	.0372	12.8	114
1989	14453	1.000	21.7	3351	129	.0382	12.5	115
1990	12615	1.000	21.5	3426	135	.0394	12.2	117
1991	12573	1.000	21.7	3410	138	.0402	12.1	118
1992	12172	1.000	21.3	3512	145	.0413	11.8	120
1993	13211	1.000	21.4	3519	147	.0416	11.8	120
1994	14125	1.000	21.0	3603	152	.0420	11.7	121
1995	15145	1.000	21.1	3613	158	.0438	11.3	123
1996	13144	1.000	21.2	3659	164	.0447	11.1	125
1997	14459	1.000	20.9	3727	169	.0452	11.0	126
1998	14457	1.000	20.9	3744	171	.0457	10.9	126
1999	15218	1.000	20.6	3835	179	.0465	10.7	128
2000	16574	1.000	20.7	3821	181	.0472	10.6	129
2001	15610	1.000	20.7	3879	187	.0480	10.5	130
2002	16120	1.000	20.6	3951	195	.0493	10.2	132
2003	15776	1.000	20.8	3999	199	.0496	10.2	133
2004	15920	1.000	20.8	4038	206	.0509	10.0	135
2005	17150	1.000	21.0	4089	212	.0514	9.9	136

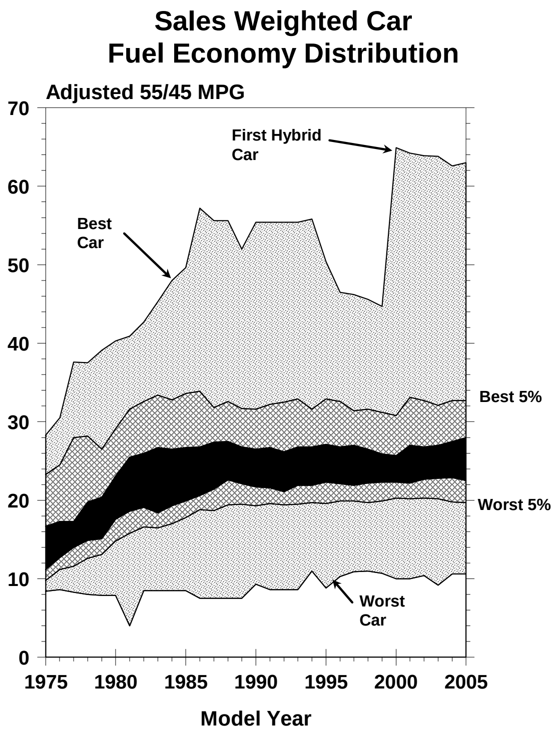


Figure 7

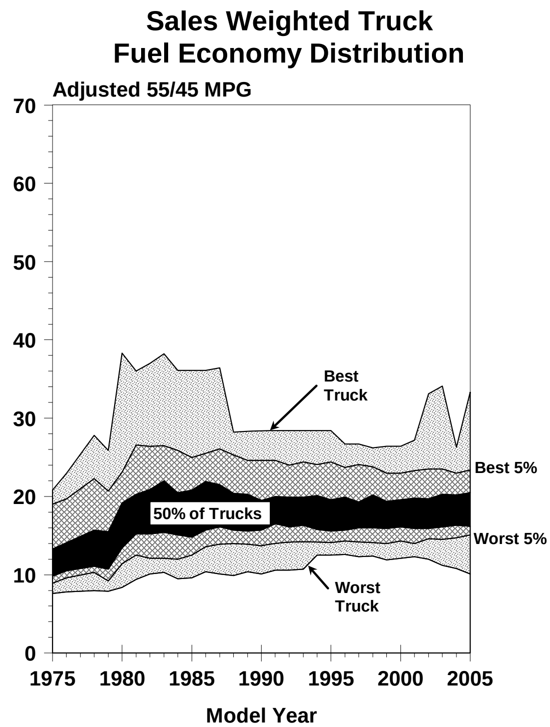


Figure 8

The distribution of fuel economy in any model year is of interest. In Figure 7, highlights of the distribution of car mpg are shown. Since 1975, the distribution has both narrowed and widened, but half of the cars have consistently been within a few mpg of each other. The fuel economy difference between the least efficient and most efficient car increased from about 20 mpg in 1975 to nearly 50 mpg in 1986, but was less than 35 mpg in 1999. With the introduction for sale of the Honda Insight gasoline-electric hybrid vehicle in model year 2000, the range became more than 50 mpg. The ratio of the highest to lowest has increased from about three to one in 1975 to about six to one today, because the fuel economy of the least fuel efficient cars has remained roughly constant in comparison to the most fuel efficient cars whose fuel economy has more than doubled.

The overall fuel economy distribution trend for trucks (see Figure 8) is similar to that for cars, but narrower with a peak in the efficiency of the most efficient truck in the early 1980s when small pickup trucks equipped with diesel engines were being sold. As a result, the fuel economy range between the most efficient and least efficient truck peaked at about 25 mpg in 1982 when nine percent of all trucks used diesel engines. The fuel economy range for trucks then narrowed, but with the introduction of the hybrid Escape SUV this year, it is back above 20 mpg. Like cars, half of the trucks built each year have always been within a few mpg of each year's average fuel economy value. Appendix D contains additional fuel economy distribution data.

IV. Technology Trends

Table 3 repeats some of the data from Tables 1 and 2 and adds powertrain information including engine displacement (CID), horsepower (HP) and specific power (HP/CID). This table also includes sales fraction data giving the percent of vehicles that: have diesel engines; are hybrids; are equipped with engines that have more than two valves per cylinder; have front- or four-wheel drive; and have manual, lockup, or continuously variable (CVT) transmissions. For MY2005: cars are predominantly powered by gasoline-fueled engines; nearly 80 percent have more than two valves per cylinder, nearly 80 percent use front wheel drive, and more than 80 percent have lockup automatic transmissions. About half of the MY2005 trucks still have two valves per cylinder; over 90 percent have lockup automatic transmissions and about half have four wheel drive. It has been two decades since diesel engines have been used in more than one percent of the fleet. Appendix E contains additional data on fuel metering and number of valves per cylinder at this level of stratification.

Table 4 compares technology usage for MY2005 by vehicle type and size. As discussed earlier, wheelbase is used in this report to distinguish whether a truck is small, mid-size, or large, and four EPA Car Classes (Two-Seater, Minicompact, Compact, and Subcompact) have been combined to form the small car class. For this table, the car classes are separated into cars and station wagons, so that the table stratifies light-duty vehicles into a total of 15 vehicle types and sizes. Note that this table does not contain any data for small vans, because none have been produced since 1996.

In some of the tables and figures in this report, only four vehicle types are used. In these cases, wagons have been merged with cars. This is because the wagon sales fraction for some instances is so small that the information is more conveniently represented by combining the two vehicle types. When they have been combined, the differences between them are not important.

Front-wheel drive (FWD) is used heavily in all of the car classes, in small wagons, large wagons and midsize vans. By comparison, none of this year's pickups will have front-wheel drive, and it is used less often in SUVs or large vans than in midsize wagons. Conversely, four-wheel drive (4WD) is used heavily in SUVs and pickups. Many of the midsize and large wagons also have 4WD, but very little use of it is made in vans and cars.

Manual transmissions are used more in small vehicles in 2005 than in the larger ones, except for midsize pickups. Similarly, usage of engines with more than two valves per cylinder is prevalent on small vehicles and also midsize cars, wagons, and SUVs.

Detailed tabulations of different technology types, including technology usage percentages for other model years, can be found in the Appendixes.

Table 3

Powertrain Characteristics of 1975 to 2005 Light-Duty Vehicles

Cars

	<--- Measured Characteristics --->						<------------------ Percent by: ------------------>							
										DRIVETRAIN		TRANSMISSION TYPE		
MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	ENGINE CID	HP	HP/ CID	Diesel	Hybrid	Multi- Valve	Front	4wd	Manual	Lock	CVT
1975	8237	.806	13.5	288	136	.515	.2			6.5	.0	19.9		
1976	9722	.788	14.9	287	134	.502	.3			5.8	.0	17.1		
1977	11300	.800	15.6	279	133	.516	.5			6.8	.0	16.8		
1978	11175	.773	16.9	251	124	.538	.9			9.6	.0	20.2	6.7	
1979	10794	.778	17.2	238	119	.545	2.1			11.9	.3	22.3	8.0	
1980	9443	.835	20.0	188	100	.583	4.4			29.7	.9	31.9	16.5	
1981	8733	.827	21.4	182	99	.594	5.9			37.0	.7	30.4	33.3	
1982	7819	.803	22.2	175	99	.609	4.7			45.6	.8	29.7	51.4	
1983	8002	.777	22.1	182	104	.615	2.1			47.3	3.1	26.5	56.7	
1984	10675	.761	22.4	179	106	.637	1.7			53.7	1.0	24.1	58.3	
1985	10791	.746	23.0	177	111	.671	.9			61.6	2.1	22.8	58.7	
1986	11015	.717	23.8	167	111	.701	.3		5.3	71.1	1.1	24.8	58.0	
1987	10731	.722	24.0	162	112	.732	.3		15.2	77.0	1.1	24.9	59.5	
1988	10736	.702	24.4	160	116	.759	.0		20.4	81.7	.8	24.3	66.1	
1989	10018	.693	24.0	163	121	.783	.0		24.9	82.5	1.0	21.0	69.3	.1
1990	8810	.698	23.7	163	129	.829	.0		33.5	84.6	1.0	19.6	72.9	.0
1991	8524	.678	23.9	163	132	.851	.1		34.9	83.2	1.4	20.5	73.5	.1
1992	8108	.666	23.6	170	141	.868	.1		34.3	80.8	1.1	17.4	76.4	.0
1993	8456	.640	24.1	166	138	.865	.0		36.0	85.1	1.2	17.8	77.0	.0
1994	8414	.596	24.0	168	143	.884	.0		41.4	84.4	.4	16.7	79.3	
1995	9396	.620	24.2	167	152	.945	.1		53.7	82.0	1.2	16.3	81.9	
1996	7890	.600	24.2	165	154	.958	.1		57.6	86.5	1.5	14.9	83.6	.1
1997	8335	.576	24.3	164	156	.974	.1		58.9	86.5	1.7	13.5	85.8	1.0
1998	7971	.551	24.4	164	159	.993	.2		63.4	87.0	2.3	12.3	87.4	.1
1999	8379	.551	24.1	166	164	1.008	.2		63.7	87.2	2.2	10.9	88.4	.0
2000	9128	.551	24.1	165	168	1.032	.2	.1	66.4	84.9	2.1	11.2	87.7	.0
2001	8408	.539	24.3	165	168	1.042	.3	.1	67.4	84.1	3.2	11.4	87.5	.2
2002	8305	.515	24.5	166	173	1.066	.4	.3	70.4	84.9	3.8	11.2	88.1	.4
2003	7952	.504	24.7	166	176	1.086	.4	.6	73.0	81.7	3.8	11.1	87.9	.9
2004	8147	.512	24.7	168	181	1.097	.3	.9	77.5	81.3	5.4	13.8	84.3	1.2
2005	8616	.502	24.7	171	187	1.114	.4	1.4	79.1	78.0	6.2	13.0	83.3	2.0

Table 3, Continued

Powertrain Characteristics of 1975 to 2005 Light-Duty Vehicles

Trucks

<--- Measured Characteristics ---> <------------------ Percent by: ------------------>

MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	ENGINE CID	HP	HP/ CID	Diesel	Hybrid	Multi-Valve	DRIVETRAIN Front	4wd	TRANSMISSION TYPE Manual	Lock	CVT
1975	1987	.194	11.6	311	142	.476	.0				17.1	37.0		
1976	2612	.212	12.2	319	141	.458	.0				22.9	34.8		
1977	2823	.200	13.3	318	147	.482	.0				23.6	32.0		
1978	3273	.227	12.9	314	146	.481	.8				29.0	32.4		
1979	3088	.222	12.5	298	138	.486	1.8				18.0	35.2	2.1	
1980	1863	.165	15.8	248	121	.528	3.5			1.4	25.0	53.0	24.6	
1981	1821	.173	17.1	247	119	.508	5.6			1.9	20.1	51.6	31.1	
1982	1914	.197	17.4	243	120	.524	9.3			1.7	20.0	45.7	33.2	
1983	2300	.223	17.8	231	118	.543	4.7			1.4	25.8	45.9	36.1	
1984	3345	.239	17.4	224	118	.557	2.3			4.9	31.0	42.1	35.1	
1985	3669	.254	17.5	224	124	.586	1.1			7.1	30.6	37.1	42.2	
1986	4350	.283	18.3	211	123	.621	.7			5.9	30.3	42.7	42.0	
1987	4134	.278	18.4	210	131	.654	.3			7.4	31.5	39.9	44.8	
1988	4559	.298	18.1	227	141	.650	.2			9.0	33.3	35.5	53.1	
1989	4435	.307	17.8	234	146	.653	.2			9.9	32.0	32.7	56.8	
1990	3805	.302	17.7	237	151	.668	.2			15.5	31.3	28.1	67.4	
1991	4049	.322	18.1	228	150	.681	.1			9.7	35.3	31.0	67.4	
1992	4064	.334	17.8	234	155	.685	.1			13.6	31.4	27.3	71.5	
1993	4754	.360	17.9	235	162	.710	.0			15.1	29.4	23.3	75.7	
1994	5710	.404	17.7	239	166	.717	.0		6.1	13.1	36.9	23.5	75.1	
1995	5749	.380	17.5	244	168	.715	.0		8.9	17.7	40.7	20.5	78.6	
1996	5254	.400	17.8	243	179	.757	.1		12.9	20.1	37.1	15.6	83.5	
1997	6124	.424	17.6	248	187	.775	.0		14.2	13.9	43.2	14.6	85.0	
1998	6485	.449	17.8	242	187	.795	.0		16.3	18.7	42.0	13.4	86.0	
1999	6839	.449	17.5	249	197	.814	.0		17.4	17.4	44.6	9.1	90.5	
2000	7447	.449	17.7	242	197	.832	.0		20.9	19.4	42.4	8.0	91.7	
2001	7202	.461	17.6	243	209	.882	.0		28.1	18.5	43.8	6.3	93.4	
2002	7815	.485	17.6	244	219	.918	.0		36.1	18.5	47.6	5.0	94.7	.0
2003	7824	.496	17.8	243	221	.927	.0		37.7	19.2	46.5	4.8	93.7	1.2
2004	7772	.488	17.9	248	231	.949	.0	.0	43.8	17.8	52.7	4.2	94.3	1.0
2005	8534	.498	18.2	247	237	.973	.0	.2	49.5	24.2	46.8	4.1	93.6	2.2

Table 3, Continued

Powertrain Characteristics of 1975 to 2005 Light-Duty Vehicles

Cars and Trucks

<--- Measured Characteristics ---> <------------------ Percent by: ------------------>

MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	ENGINE CID	HP	HP/ CID	Diesel	Hybrid	Multi-Valve	DRIVETRAIN Front	4wd	TRANSMISSION Manual	Lock	TYPE CVT
1975	10224	1.000	13.1	293	137	.507	.2			5.3	3.3	23.2		
1976	12334	1.000	14.2	294	135	.493	.2			4.6	4.8	20.9		
1977	14123	1.000	15.1	287	136	.510	.4			5.5	4.7	19.8		
1978	14448	1.000	15.8	266	129	.525	.9			7.4	6.6	23.0	5.2	
1979	13882	1.000	15.9	252	124	.532	2.0			9.2	4.3	25.1	6.7	
1980	11306	1.000	19.2	198	104	.574	4.3			25.0	4.9	35.4	17.8	
1981	10554	1.000	20.5	193	102	.580	5.9			31.0	4.0	34.1	33.0	
1982	9732	1.000	21.1	188	103	.593	5.6			37.0	4.6	32.8	47.8	
1983	10302	1.000	21.0	193	107	.599	2.7			37.0	8.1	30.8	52.1	
1984	14020	1.000	21.0	190	109	.618	1.8			42.1	8.2	28.4	52.8	
1985	14460	1.000	21.3	189	114	.650	.9			47.8	9.3	26.5	54.5	
1986	15365	1.000	21.9	180	114	.678	.4			52.6	9.3	29.8	53.5	
1987	14865	1.000	22.1	175	118	.710	.3			57.7	9.6	29.1	55.4	
1988	15295	1.000	22.1	180	123	.726	.1			60.0	10.5	27.6	62.2	
1989	14453	1.000	21.7	185	129	.743	.1			60.2	10.5	24.6	65.5	
1990	12615	1.000	21.5	185	135	.781	.1			63.8	10.1	22.2	71.2	
1991	12573	1.000	21.7	184	138	.796	.1			59.6	12.3	23.9	71.6	
1992	12172	1.000	21.3	191	145	.807	.1			58.4	11.2	20.7	74.8	
1993	13211	1.000	21.4	191	147	.809	.0			59.9	11.3	19.8	76.5	
1994	14125	1.000	21.0	197	152	.816	.0		27.1	55.6	15.2	19.5	77.6	
1995	15145	1.000	21.1	196	158	.857	.0		36.7	57.6	16.2	17.9	80.7	
1996	13144	1.000	21.2	197	164	.878	.1		39.7	60.0	15.7	15.2	83.5	
1997	14459	1.000	20.9	199	169	.890	.1		39.9	55.8	19.3	14.0	85.5	
1998	14457	1.000	20.9	199	171	.904	.1		42.3	56.4	20.1	12.8	86.8	
1999	15218	1.000	20.6	203	179	.921	.1		42.9	55.8	21.3	10.1	89.4	
2000	16574	1.000	20.7	200	181	.942	.1	.0	46.0	55.5	20.2	9.7	89.5	
2001	15610	1.000	20.7	201	187	.968	.1	.0	49.3	53.8	21.9	9.0	90.2	
2002	16120	1.000	20.6	203	195	.994	.2	.2	53.8	52.7	25.0	8.2	91.3	
2003	15776	1.000	20.8	204	199	1.007	.2	.3	55.5	50.7	25.0	8.0	90.8	1.1
2004	15920	1.000	20.8	207	206	1.025	.2	.5	61.0	50.3	28.5	9.1	89.2	1.1
2005	17150	1.000	21.0	209	212	1.044	.2	.8	64.4	51.2	26.4	8.6	88.4	2.0

Table 4

MY2005 Technology Usage by Vehicle Type and Size
(Percent of Vehicle Type/Size Strata)

Vehicle Type	Size	Front Wheel Drive	Four Wheel Drive	Manual Trans.	Multi-Valve
Car	Small	77.	6.	25.	88
	Midsize	92.	2.	6.	84
	Large	62.	4.	0.	40
	All	80.	4.	13.	77
Wagon	Small	81.	18.	24.	97
	Midsize	34.	36.	7.	90
	Large	59.	41.	0.	81
	All	58.	29.	14.	92
Van	Small	---	---	--	--
	Midsize	93.	5.	0.	40
	Large	0.	15.	0.	0
	All	87.	6.	0.	37
SUV	Small	19.	78.	18.	74
	Midsize	23.	62.	3.	66
	Large	6.	65.	0.	51
	All	15.	64.	2.	58
Pickup	Small	0.	63.	37.	100
	Midsize	0.	29.	32.	51
	Large	0.	45.	6.	37
	All	0.	43.	10.	39

Figures 9 through 13 show trends in drive use for the five vehicle classes. Cars used to be nearly all rear-wheel drive, but since 1988 they have been over 80 percent front-wheel drive with a small four-wheel (4WD) drive fraction. In recent years, the there has been a slight increase in the use of front wheel drive in cars with use of this technology increasing from about one percent in the late 1990s to four percent this year. Only a small percentage of wagons still have rear-wheel drive, but in recent years they have made substantial use of 4WD.

Drive usage for vans is similar to that for cars, although the trend since the introduction of front-wheel drive vans is sharper than it was for cars and appears to be continuing. Five out of six vans currently use front wheel drive, compared to essentially none before 1984. SUVs are mostly 4WD; with the beginning of a trend toward front-wheel drive just showing up since MY2000. Pickups remain the bastion of rear-wheel drive with the increasing amount of 4WD the only other drive option. Except for a brief period in the early 1980s, front-wheel drive has not been used in pickups

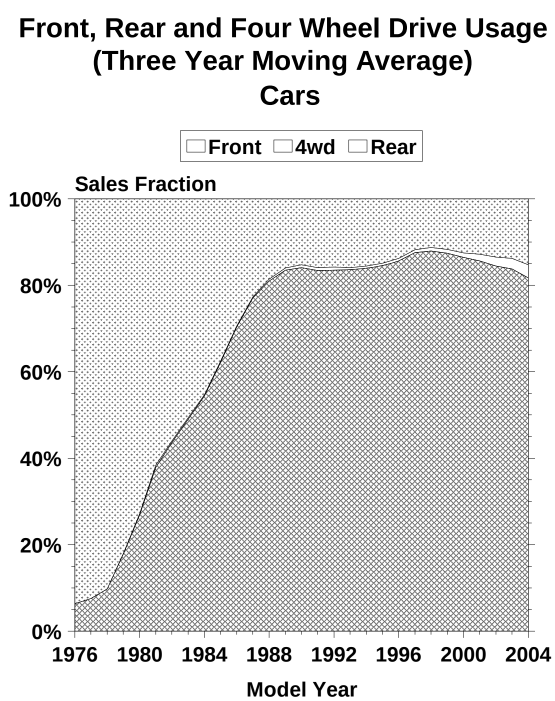


Figure 9

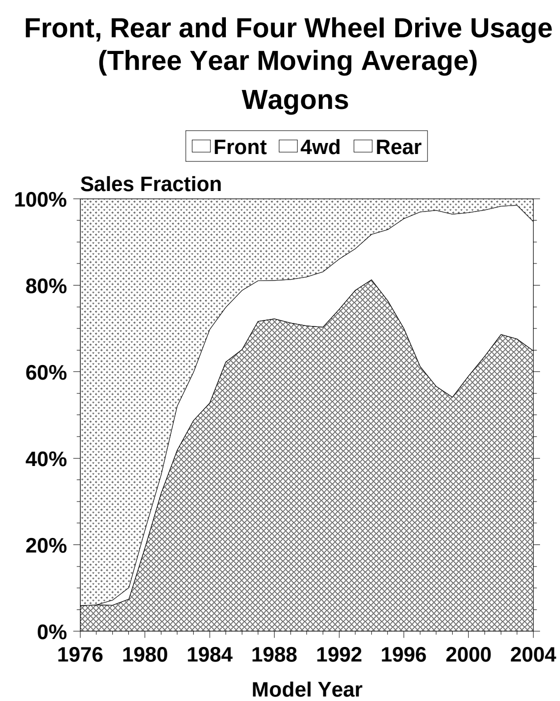


Figure 10

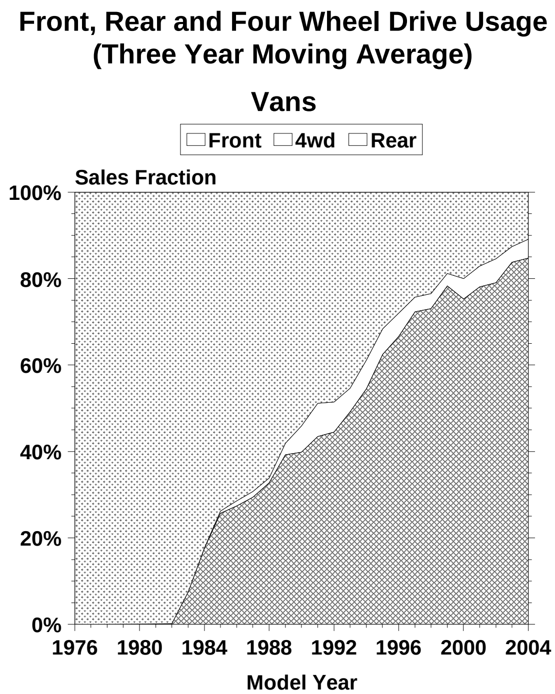


Figure 11

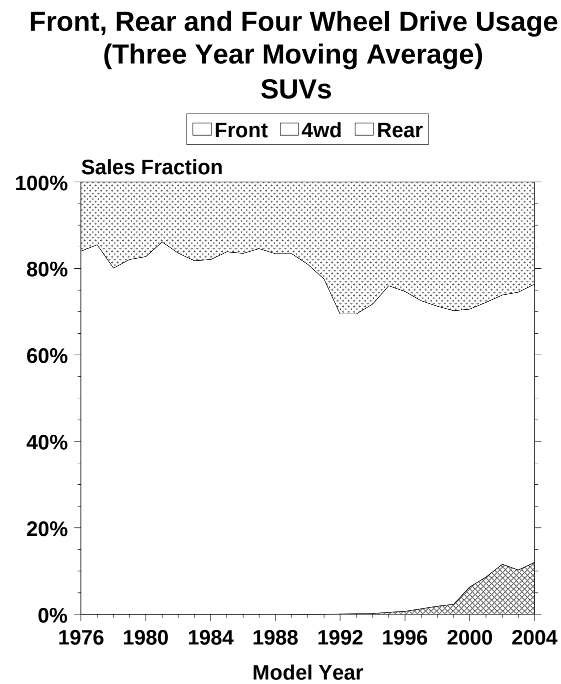


Figure 12

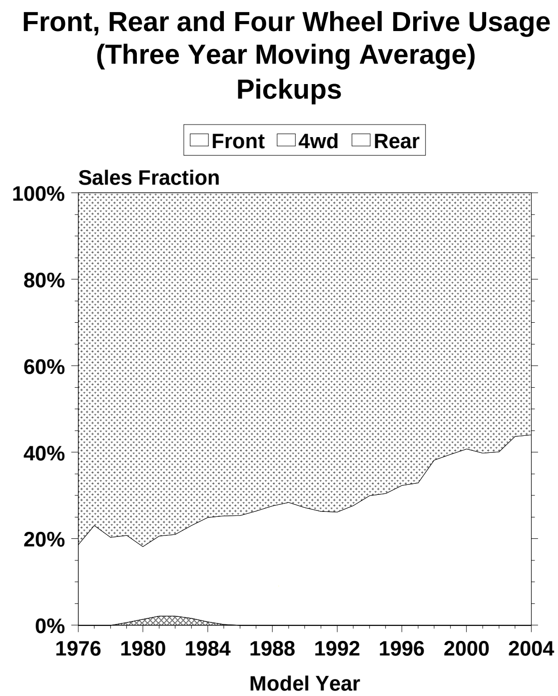


Figure 13

Three important changes in transmission design have occurred in recent years:

1) the use of additional gears for both automatic and manual transmissions,

2) for the automatics, conversion to lockup (L3, L4, L5, L6 and now L7) torque converter transmissions, and

3) the use of continuously variable transmissions (CVTs).

Figures 14 to 17 indicate that the L4 transmission remains the predominant transmission type for all vehicle classes. For purposes of this analysis, cars and wagons have been combined as "cars," because the trends for wagons are not significantly different from that for cars. Where manual transmissions are used, the 5-speed (M5) transmission now predominates.

Because only a small fraction of vehicles are equipped with M6, L6, L7 and CVT transmissions in MY2005, these transmission types are combined as 'Other' on Figure 14. Their combined sales fraction is too small to show on Figures 15 to 17. More data stratified by transmission type can be found in Appendix J.

The increasing trend in Ton-MPG shown in Table 1 can be attributed to better vehicle design, including more efficient engines, better transmission design, and better matching of the engine and transmission. Powertrains are matched to the load better when the engine operates closer to its best efficiency point more of the time. For many conventional engines, this point is approximately 2000 RPM and 2/3 of the maximum torque at that speed. One way to make the engine operate more closely to its best efficiency point is to increase the number of gears in the transmission and, for automatic transmissions, employing a lockup torque converter.

Table 5 compares Ton-MPG by transmission and vehicle type between 1987, the peak year for passenger car fuel economy, and this year. In 1987 every transmission type shown in the table achieved less than 40 Ton-MPG. This year, every transmission type achieves at least 40 Ton-MPG with one exception: M6 equipped cars and SUVs which respectively achieve averages of 29 and 35 Ton-MPG.

A recent powertrain trend has been the development and introduction of CVTs in some vehicle models. These transmissions differ from conventional automatic transmissions and manual transmissions in that CVTs do not have a fixed number of gears. Transmissions alter the ratio of engine speed to drive wheel speed. In conventional transmissions, this speed ratio is limited to a fixed number of discrete values. For a CVT, the ratio is continuous.

In addition to novelty, the advantage of a CVT is that the engine speed/drive wheel speed ratio can be altered to enhance vehicle performance or fuel economy in ways not available with conventional transmissions. While this vehicle technology has great potential, a decade and a half after being introduced for use in an MY1987 Subaru Justy, CVTs are currently used in just two percent of the light-duty vehicle fleet, compared to about one percent last year.

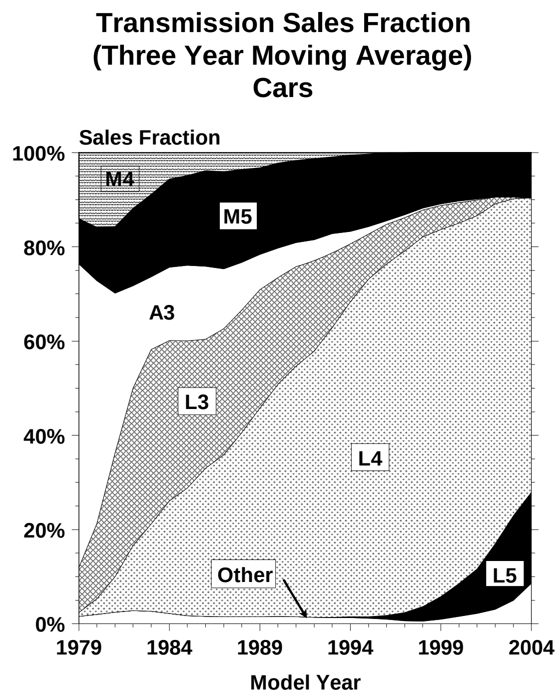


Figure 14

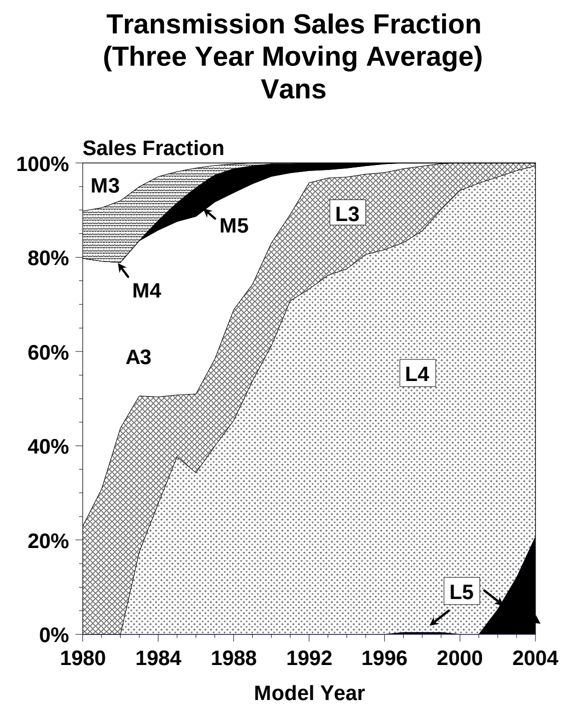


Figure 15

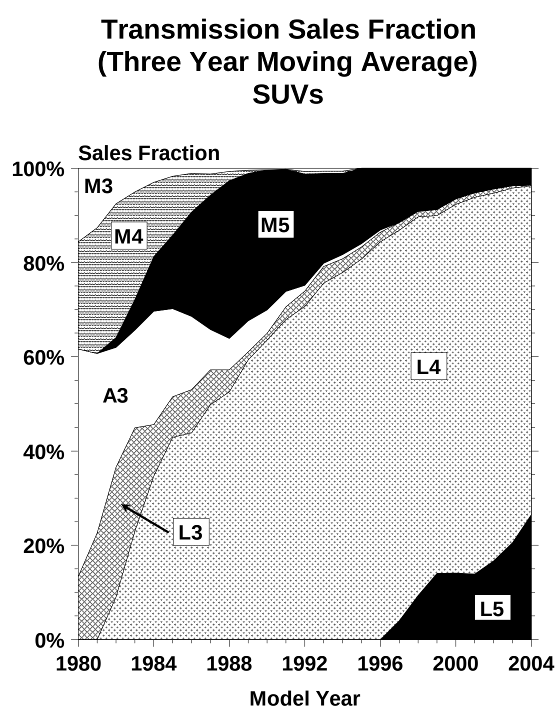


Figure 16

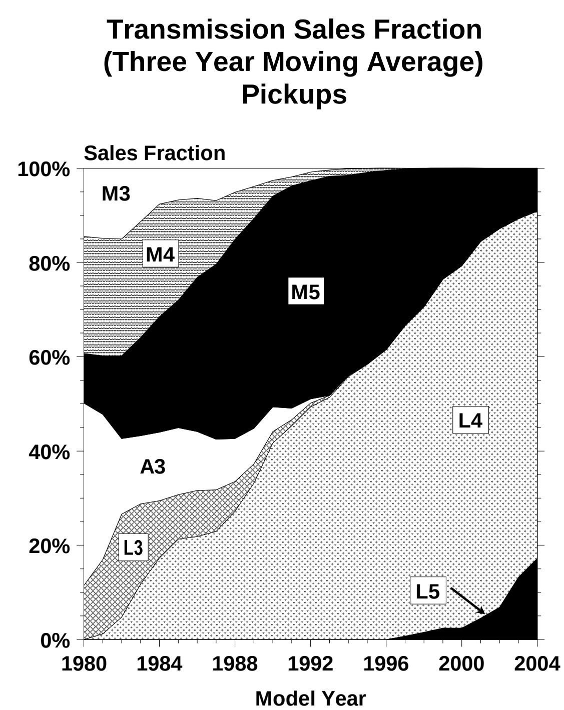


Figure 17

Table 5

Ton-MPG by Transmission and Vehicle Type

(Conventionally Powered Vehicles)

	Car		**Van**		**SUV**		**Pickup**	
Trans	**2005**	**1987**	**2005**	**1987**	**2005**	**1987**	**2005**	**1987**
M4	--	38	--	33	--	35	--	36
M5	43	37	--	37	42	34	41	35
M6	39	--	--	--	35	--	40	--
CVT	45	--	46	--	43	--	--	--
L3	--	36	--	36	--	31	--	32
L4	44	37	45	36	43	35	44	34
L5	44	--	48	--	41	--	39	--
L6	44	--	--	--	46	--	--	--

Figures 18 through 21 compare the trends since 1975 for horsepower (HP), displacement (CID), and specific power or horsepower per cubic inch (HP/CID) for cars, vans, SUVs, and pickups. For all four vehicle types, significant CID reductions occurred in the late 1970s and early 1980s. Engine displacement has been flat for cars and vans since the mid-1980s and has been flat for SUVs since the mid-1990s, but is still increasing for pickups. Average horsepower has increased substantially for all of these vehicle types since 1981 with the highest increase occurring for pickups whose HP is now more than double what it was then (i.e., 255 vs 115 HP). Light-duty vehicle engines, thus, have also improved in specific power with engines used in passenger cars improving at a faster rate than truck engines. In fact, for the past several years, car engines have averaged at least 1.0 HP/CID. As shown in Table 6, SUVs now average 1.0 HP/CID, but vans and pickups have yet to reach the 1.0 HP/CID level.

Table 6

MY2005 Engine Characteristics by Vehicle Type

Vehicle Type	**HP**	**CID**	**HP/ CID**	**Multi-Valve**
Car	185	172	1.10	77%
Wagon	197	161	1.24	92%
Van	210	219	.97	37%
SUV	236	239	1.01	59%
Pickup	255	279	.92	39%
All	212	209	1.04	64%

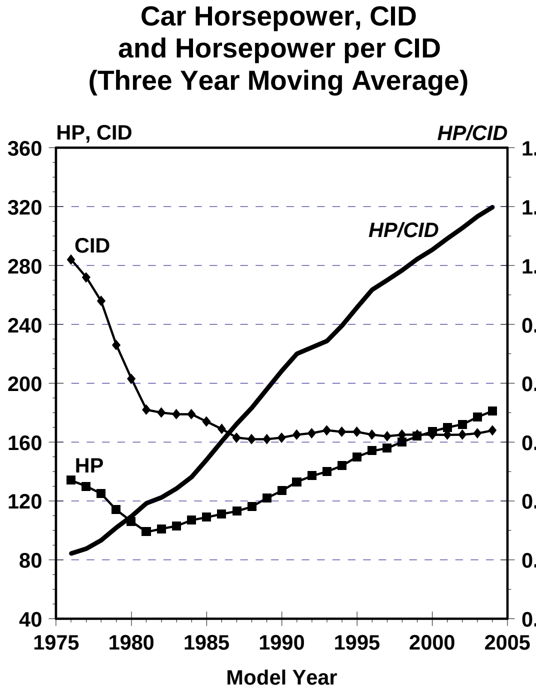


Figure 18

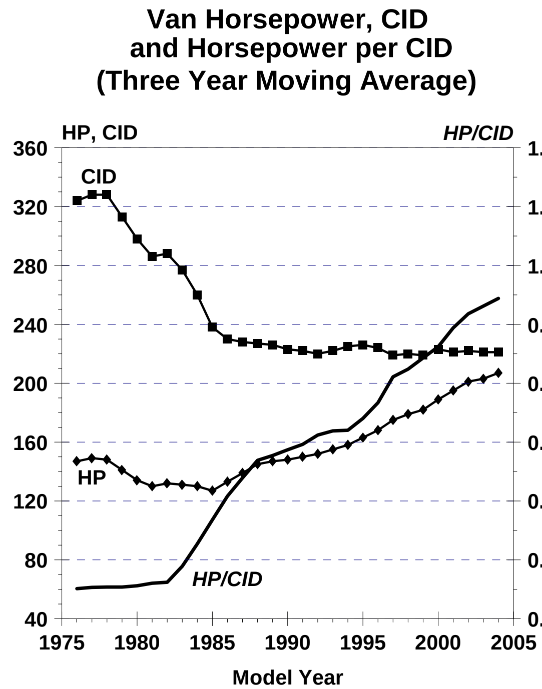


Figure 19

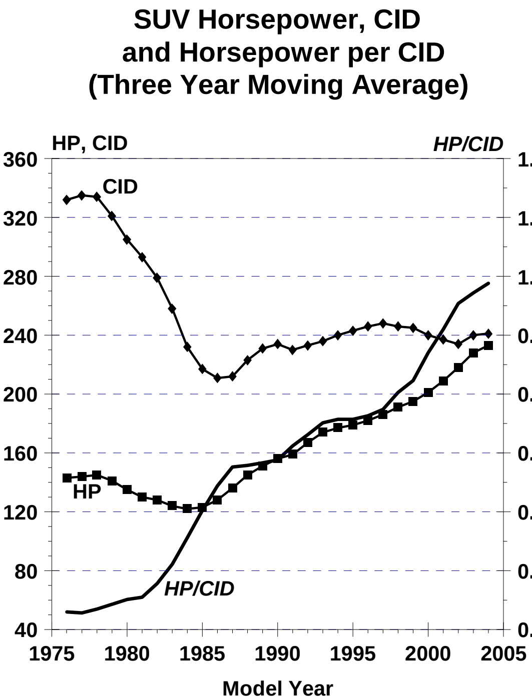


Figure 20

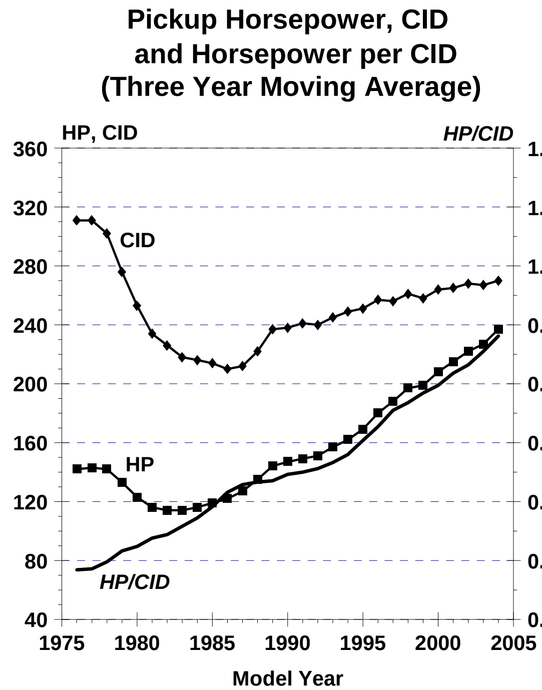


Figure 21

Table 7 compares CID, HP, and HP/CID by vehicle type and number of cylinders for model years 1987 and 2005. Table 7 shows that the increase in horsepower shown for the fleet in Table 1 extends to all vehicle type and cylinder member strata. All strata show improvements, ranging from about 40 to over 85 percent in horsepower. Because of the less than equal changes in displacement (-6% to 15%), it can be seen that the primary reason for the horsepower increase is increased specific power — up between 37 and 93 percent from 1987 to 2005. At the number-of-cylinders level of stratification, model year 2005 cars achieve higher specific power than SUVs, vans, and pickup trucks. Table 8 shows similar data to that in Table 7, but the stratification is based on inertia weight. This table clearly shows that, for every case for which a comparison can be made, there were substantial increases in HP and with just two exceptions (2250 lb cars and 4000 lb SUVs), substantial decreases in CID occurred between 1987 and 2005 with increases in specific power ranging from 44 to 166 percent.

A reason for the lower specific power of some truck engines is that these vehicles may be used to carry heavy loads or pull trailers and thus need more "torque rise," (i.e., an increase in torque as engine speed falls from the peak power point) to achieve acceptable driveability. Engines equipped with four valves per cylinder typically have inherently lower torque rise than two valve engines with lower specific power.

Table 7

Improvement in Horsepower and Specific Power by Vehicle Type and Number of Cylinders

Vehicle Type	Cyl.	HP 1987	HP 2005	Percent Change	CID 1987	CID 2005	Percent Change	HP/CID 1987	HP/CID 2005	Percent Change
Cars	4	92	147	60%	121	127	5%	.772	1.163	51%
	6	143	212	48%	198	200	1%	.733	1.067	45%
	8	155	290	87%	299	289	-3%	.520	1.005	93%
Vans	4	100	150	50%	143	148	3%	.702	1.014	44%
	6	149	207	39%	219	214	-2%	.703	.974	39%
	8	167	274	64%	319	315	-1%	.521	.869	67%
SUVs	4	95	155	63%	127	141	11%	.755	1.099	46%
	6	138	225	63%	198	221	12%	.709	1.025	44%
	8	181	293	62%	336	316	-6%	.537	.927	73%
Pickups	4	96	162	69%	140	161	15%	.686	1.010	47%
	6	136	204	50%	222	233	5%	.638	.874	37%
	8	169	291	72%	320	318	-1%	.527	.911	73%

Table 8

Improvement in Horsepower and Specific Power by Inertia Weight

Inertia Weight	HP 1987	HP 2005	Percent Change	CID 1987	CID 2005	Percent Change	HP/CID 1987	HP/CID 2005	Percent Change
Cars									
2000	55	73	33%	70	61	-13%	.799	1.197	50%
2250	69	160	132%	90	99	10%	.766	1.563	104%
2500	78	112	44%	104	93	-11%	.749	1.195	60%
2750	96	117	22%	124	103	-17%	.790	1.140	44%
3000	111	138	24%	147	124	-16%	.767	1.117	46%
3500	147	187	27%	217	171	-21%	.703	1.115	59%
4000	157	238	52%	294	214	-27%	.551	1.135	106%
4500	140	268	91%	306	284	-7%	.458	.950	107%
5000	191	260	36%	410	221	-46%	.466	1.170	151%
5500	187	434	132%	412	326	-21%	.454	1.325	192%
6000	173	351	103%	412	337	-18%	.420	1.032	146%
Vans									
4000	148	183	24%	222	197	-11%	.689	.936	36%
4500	163	218	34%	313	219	-30%	.521	1.003	93%
5000	167	201	20%	322	232	-28%	.516	.872	69%
5500	195	264	35%	346	304	-12%	.564	.862	53%
6000	130	279	115%	379	322	-15%	.343	.864	152%
SUVs									
3000	117	161	38%	150	144	-4%	.780	1.118	43%
3500	134	162	21%	191	149	-22%	.710	1.095	54%
4000	127	197	55%	172	197	15%	.737	1.008	37%
4500	144	231	60%	325	231	-29%	.450	1.006	123%
5000	175	263	50%	326	263	-19%	.535	1.019	91%
5500	209	294	41%	350	299	-15%	.596	.995	67%
6000	137	304	122%	376	329	-13%	.366	.922	152%
Pickups									
3500	121	155	28%	178	166	-7%	.696	.937	35%
4000	141	196	39%	273	205	-25%	.530	.959	81%
4500	168	219	30%	316	247	-22%	.531	.892	68%
5000	183	279	52%	332	305	-8%	.550	.910	66%
5500	130	295	127%	379	324	-15%	.343	.911	166%

Figures 22 and 23 show how the car and truck fleet have evolved from one that consisted almost entirely of carbureted engines to one which is now almost entirely port fuel injected. In 1975, about 95 percent of all cars had carburetors as did almost all of the trucks. For MY2005, about 80 percent of cars have multi-valve, port fuel injected engines, as do more than 40 percent of the trucks.

Figures 24 through 27 show that engines with more valves per cylinder deliver higher values of HP per CID. Improvements in HP per CID apply to all of the engines, regardless of the number of valves they have. Engines with *only* two valves per cylinder deliver substantially more horsepower per CID then they used to, typically about a 50 percent increase for the time period shown. The difference in HP and HP-per-CID is because the different vehicle types use different technologies. Figures 28 through 31 show that usage of two-valve engines is decreasing for all vehicle types and is now a nominal 20 percent for cars, compared to 40 percent for SUVs and 60 percent for vans and pickups.

Car Sales Fraction by Engine Type (Three Year Moving Average)

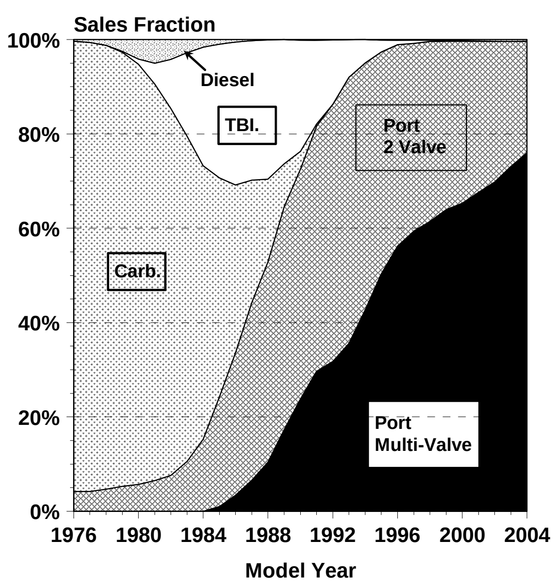


Figure 22

Truck Sales Fraction by Engine Type (Three Year Moving Average)

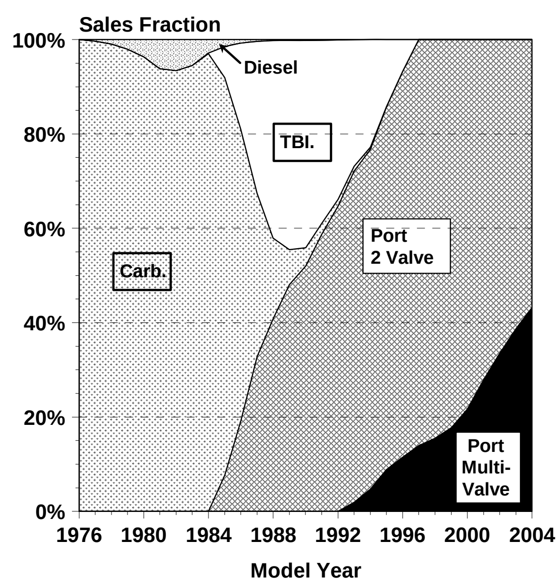


Figure 23

HP/CID by Number of Valves Per Cylinder
(Three Year Moving Average)
Cars

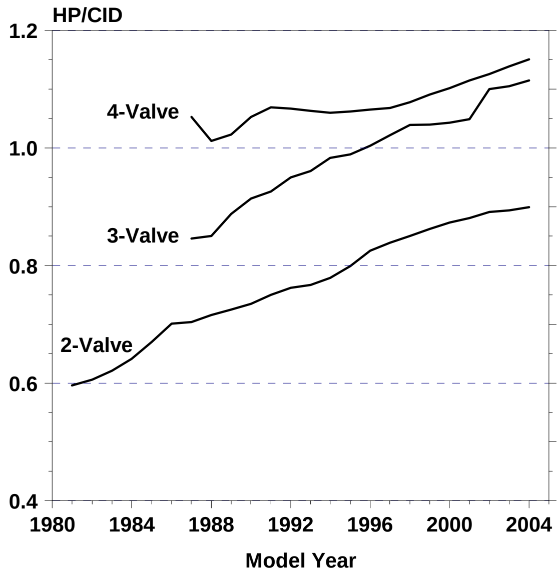


Figure 24

HP/CID by Number of Valves Per Cylinder
(Three Year Moving Average)
Vans

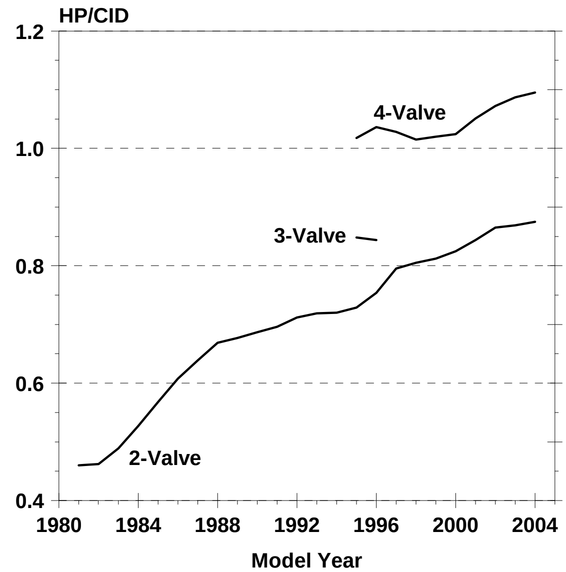


Figure 25

HP/CID by Number of Valves Per Cylinder
(Three Year Moving Average)
SUVs

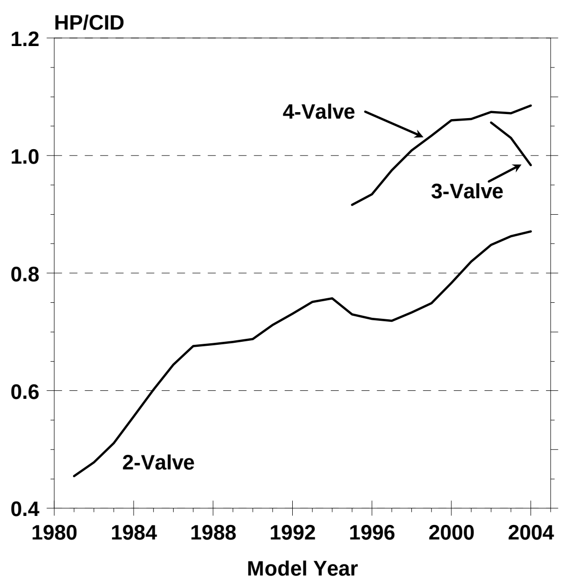


Figure 26

HP/CID by Number of Valves Per Cylinder
(Three Year Moving Average)
Pickups

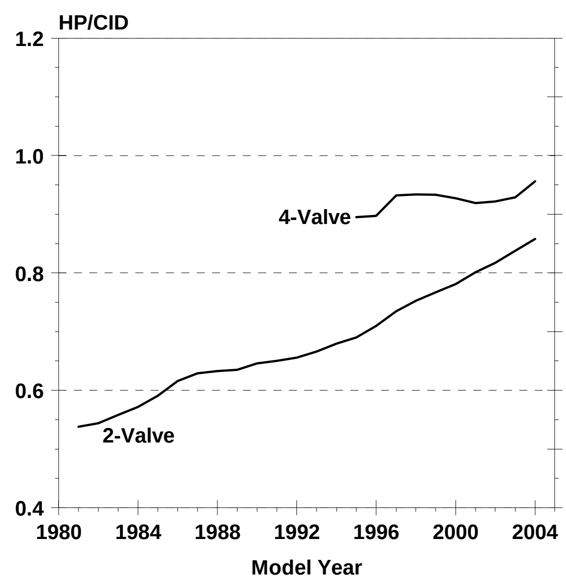


Figure 27

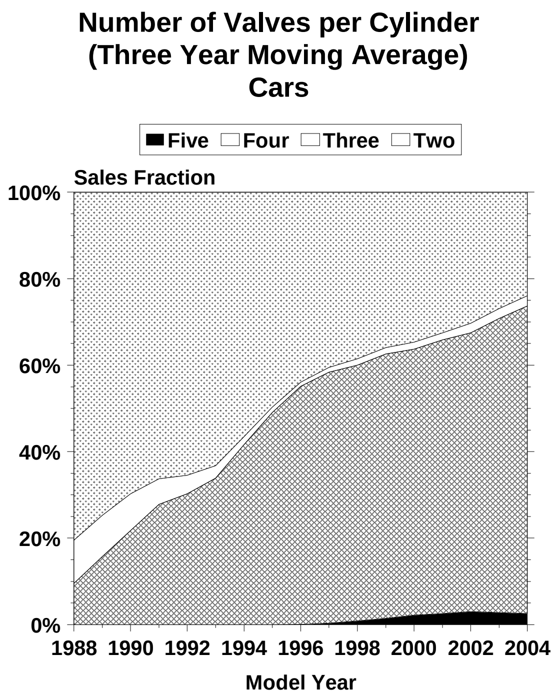


Figure 28

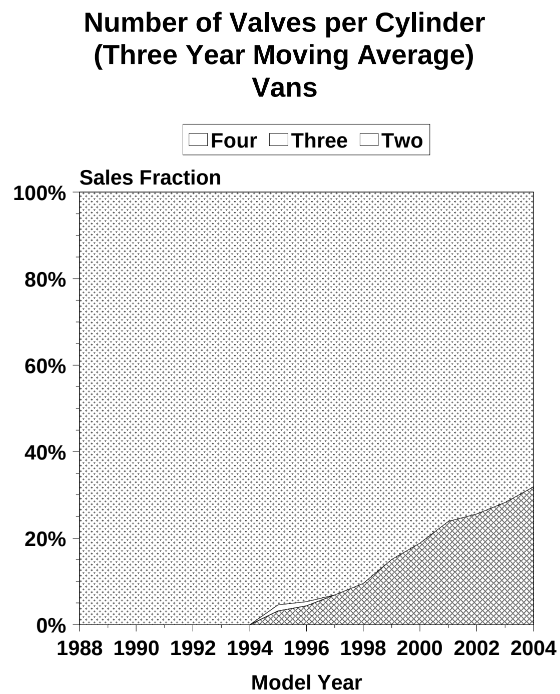


Figure 29

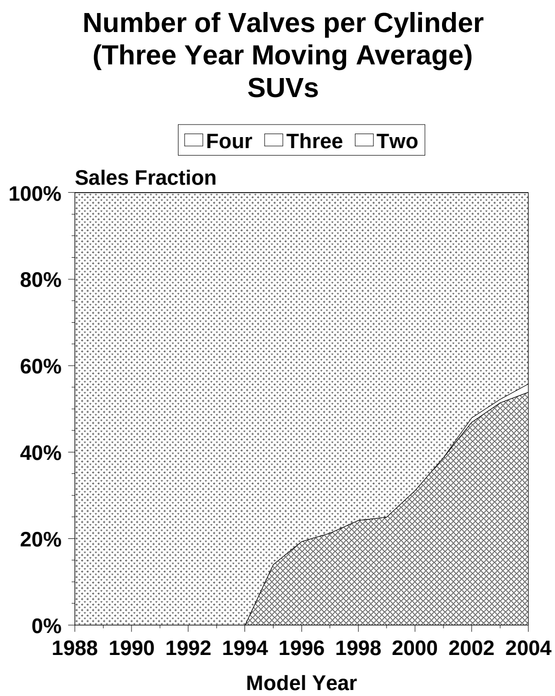


Figure 30

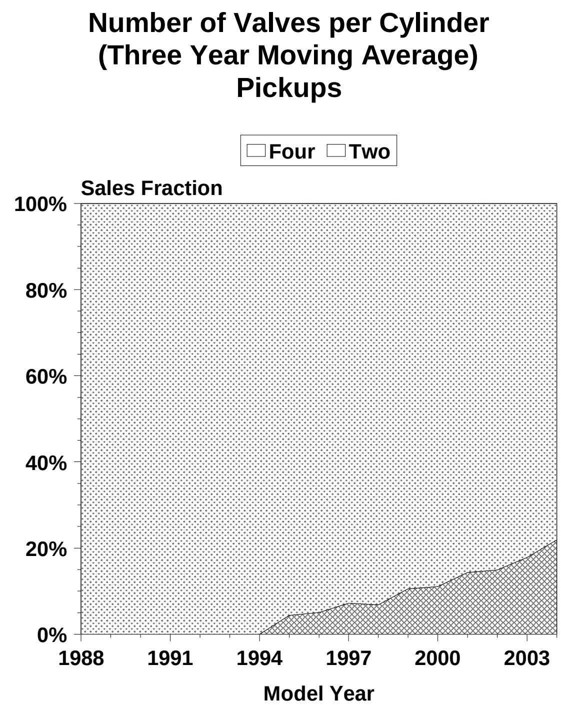


Figure 31

As mentioned earlier, in this report vehicle performance of hybrid and diesel vehicles is based on published 0 to 60 mph acceleration time values, while the performance of conventionally powered vehicles is determined by an estimate of 0 to 60 acceleration time calculated from the ratio of vehicle power to weight. Obtaining increased power to weight in a time when weight is trending upwards implies that horsepower is increasing. Increased horsepower can be obtained by increasing the engine's displacement, the engine's specific power (HP/CID), or both. Increasing specific power has been the primary driver for increases in performance for the past two decades.

For the current model year fleet, specific power has been studied, and both car and truck engines been classified according to characteristics that exist in the database used for this report: (1) by the number of valves per cylinder, (2) by the manufacturer's fuel recommendation, and (3) by the presence or absence of an intake boost device such as a turbocharger or supercharger. While studying the presence or absence of means for varying the engine's valve timing is also of interest, the database currently does not include that information. Figures 32 and 33 and Table 9 show the results for the MY2005 car fleet. Higher HP/CID is associated with: (a) more valves per cylinder, (b) higher octane fuel, and (c) intake boost. The technical approaches result in specific power ranges for cars and trucks from about .9 to about 1.8 and about .9 to 1.4 respectively. The relative sales fraction for each technical option is shown in Table 9. The data used for this table excludes hybrid vehicles and for Figures 32 and 33 exclude both diesels and hybrids.

Table 9 shows the incremental effect, on a sales weighted basis, of adding each technical option, but not all of the technical options are sales significant. The effect of the use of higher octane fuel cannot be discounted, because roughly 18 percent of the current car fleet is comprised of vehicles which use engines for which high octane fuel is recommended. By comparison, about six percent of this year's light trucks require premium fuel.

Engine technology which delivers improved specific power can be used in many ways ranging from reduced displacement and improved fuel economy at constant (or worse) performance, to increased performance and the same fuel economy at constant displacement. Figures 34 and 35 give, as an indication of how the different technologies are used, plots of fuel economy and performance. The trend lines in these two figures reflect the fuel economy/ performance tradeoff, on the average. By drawing a vertical line at the average performance, and a horizontal line at the average mpg, the space in each figure is divided into four areas of better/worse performance crossed with better/worse fuel economy compared to the averages. As both figures show, the technologies that result in improved specific power tend to be in the Quadrant III of the graph where the performance is better than the average and the fuel economy is worse than the average, suggesting that the technologies are being implemented in the direction of better vehicle performance, not better vehicle fuel economy. In terms of sales, roughly 40 percent of the car data is in the Quadrant II (the Slower/Higher one), 40 percent is in Quadrant III (the Faster/Lower one), and 10 percent is in each of the other two quadrants. Truck sales, however, are roughly split 30 percent in each of Quadrants II and III, and 10 percent each in Quadrants I and IV.

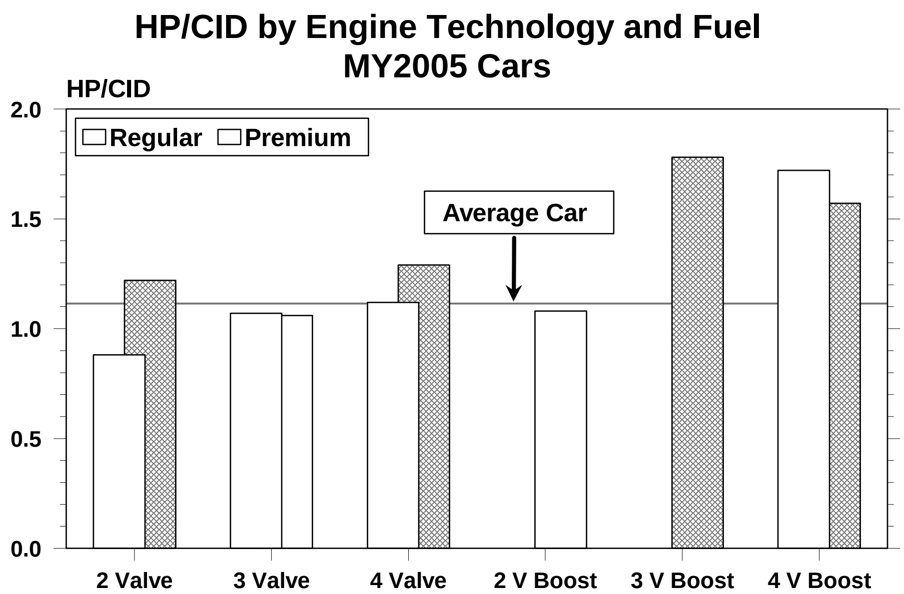


Figure 32

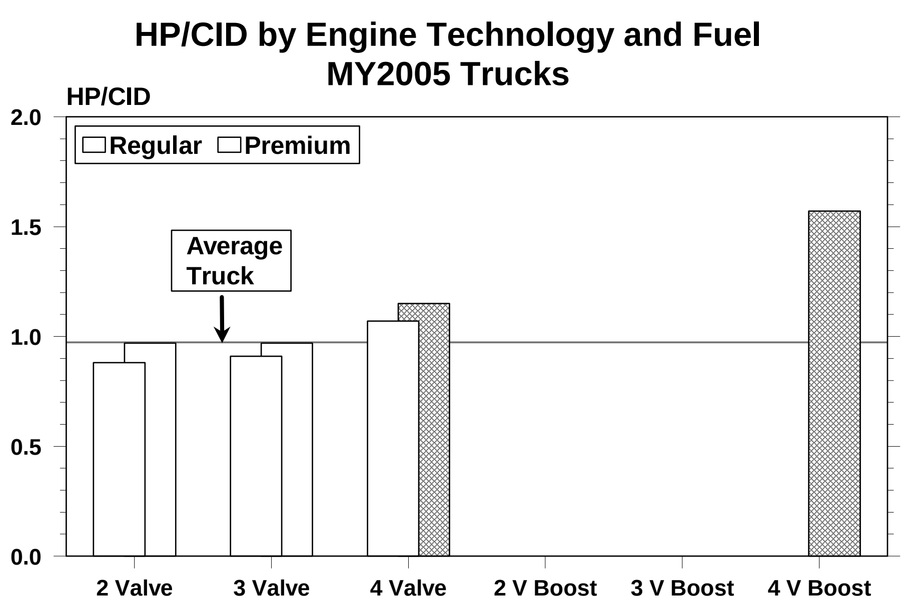


Figure 33

Table 9

HP/CID and Sales Fraction by Fuel and Engine Technology

Model Year 2005 Cars

Fuel/Boost	**Number of Valves per Cylinder**								
	Two		**Three**		**Four**		**Five**		**Total**
	HP/CID	**Sales Fract.**	**HP/CID**	**Sales Fract.**	**HP/CID**	**Sales Fract.**	**HP/CID**	**Sales Fract.**	**Sales Fract.**
Regular/No Boost	.88	.197	1.07	.006	1.12	.612	----	-----	.814
Premium/No Boost	1.22	.008	1.06	.018	1.29	.091	1.26	.007	.124
Regular/Boost	----	----	----	-----	1.72	.001	----	-----	.001
Premium/Boost	1.08	.007	1.78	.001	1.57	.034	1.57	.016	.057
Diesel/No Boost	----	-----	----	-----	1.02	.001	----	-----	.001
Diesel/Boost	.94	.003	----	-----	----	-----	----	-----	.003
Total		.213		.024		.738		.021	1.000

Model Year 2005 Trucks

Fuel/Boost	**Number of Valves per Cylinder**								
	Two		**Three**		**Four**		**Five**		**Total**
	HP/CID	**Sales Fract.**	**HP/CID**	**Sales Fract.**	**HP/CID**	**Sales Fract.**	**HP/CID**	**Sales Fract.**	**Sales Fract.**
Regular/No Boost	.88	.494	.91	.055	1.07	.388	----	.001	.937
Premium/No Boost	.97	.016	.97	.004	1.15	.036	1.22	.002	.057
Regular/Boost	---	----	---	----	----	-----	----	----	.000
Premium/Boost	---	----	---	----	1.43	.005	----	----	.005
Diesel/No Boost	---	----	---	----	----	-----	----	----	.000
Diesel/Boost	---	----	---	----	----	-----	----	----	.000
Total		.509		.058		.428		.001	1.000

55/45 Laboratory MPG vs 0 to 60 : MY2005 Cars

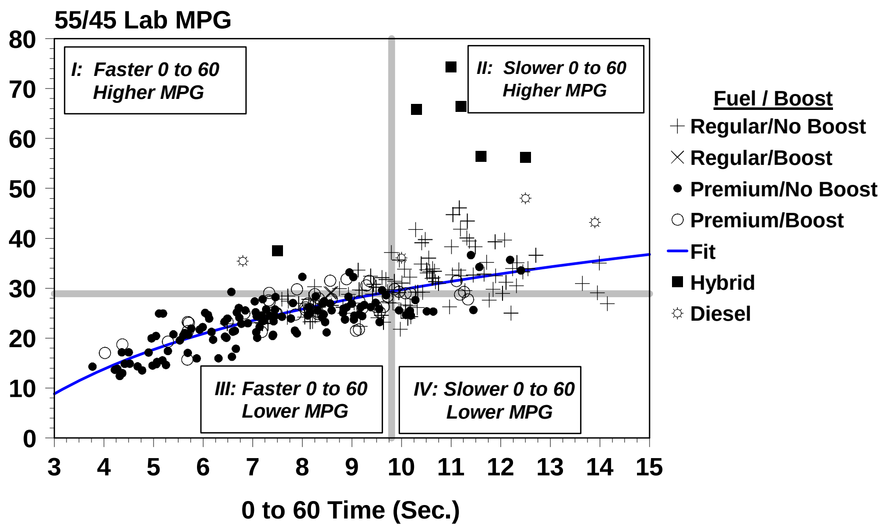


Figure 34

55/45 Laboratory MPG vs 0 to 60 : MY2005 Trucks

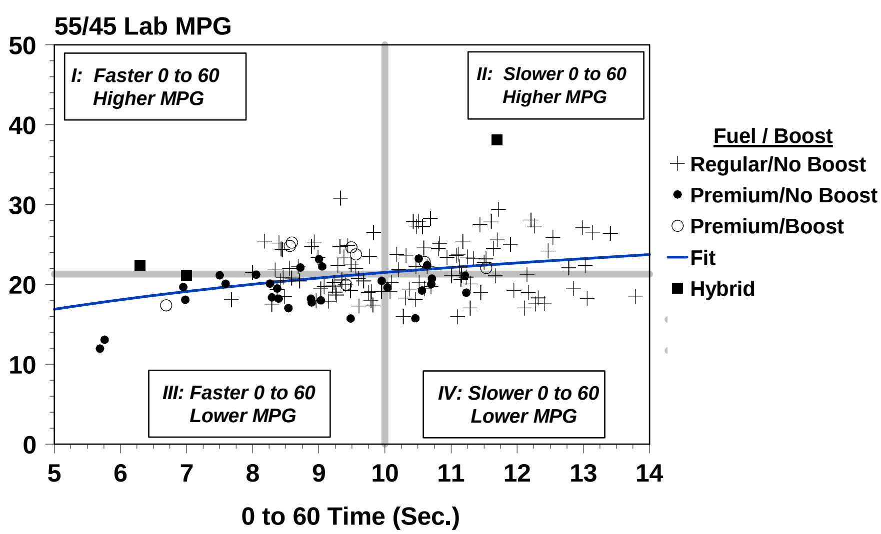


Figure 35

Figures 34 and 35 indicate that hybrid and diesel vehicles are technologies with significant potential for improving fuel economy. As previously shown in Table 3, the popularity of hybrid cars has increased an order of magnitude since the introduction for sale in the U.S. market of the MY2000 Honda Insight. Table 10 compares the fuel economy ratings, the ratio of highway to city fuel economy, and ton-mpg of the MY2005 hybrid and diesel vehicles in the database used for this report with those for the average conventionally powered MY2005 car and truck. All of the hybrid and some of the diesel vehicles in the table have a lower highway/city ratio than the average conventional ones. In addition, there are several cases in the table (e.g., the Ford Escape Hybrid) for which the highway to city fuel economy ratio is less than 1.0, and these represent cases where a vehicle achieves higher fuel economy in city than in highway driving. This year's diesel cars achieve ton-mpg values that are roughly the same as some of the hybrid cars, but hybrid cars typically have lower 0 to 60 acceleration time than cars with diesel engines. For MY2005, the Toyota Prius achieves 83 ton-mpg, almost twice that of the average car.

Table 10

Characteristics of MY2005 Hybrid and Diesel Vehicles

Model Name	Inertia Weight	CID	Trans	Lab 55/45 MPG	<-- Adjusted City MPG	HWY MPG	-> 55/45 MPG	Hwy/ City Ratio	Ton-MPG
Diesel Cars									
Mercedes E320	4000	197	L5	35.5	26.6	36.7	30.3	1.38	60.7
Golf	3000	116	M5	48.2	37.6	46.3	41.1	1.23	61.6
Golf/Jetta	3500	116	L5	42.4	32.1	43.1	36.2	1.34	63.4
Jetta Wagon	3500	116	M5	47.5	36.5	47.0	40.5	1.29	70.9
New Beetle	3500	116	L6	45.0	35.9	41.6	38.3	1.16	67.0
Passat Wagon	4000	121	L5	36.1	26.9	37.8	30.9	1.40	61.8
Hybrid Cars									
Accord	3500	183	L5	37.5	29.0	36.6	32.0	1.26	55.9
Civic	3000	82	CVT	56.2	47.8	47.2	47.5	.99	71.3
Civic	3000	82	M5	56.4	45.9	50.6	47.9	1.10	71.8
Insight	2000	61	M5	74.3	60.9	65.8	63.0	1.08	63.0
Insight	2250	61	CVT	66.4	56.5	55.7	56.1	.99	63.2
Prius	3000	91	CVT	65.8	59.9	50.5	55.3	.84	83.0
Hybrid Trucks									
Escape 2wd	4000	140	CVT	39.5	35.6	30.8	33.3	.86	66.5
Escape 4wd	4000	140	CVT	36.7	32.9	28.8	30.9	.87	61.9
GM C15 Pickup 2wd	5000	325	L4	22.4	17.8	20.8	19.0	1.16	47.6
GM K15 Pickup 4wd	5500	325	L4	21.0	17.0	19.0	17.9	1.12	49.1
Average Car	3497	171	--	28.8	21.6	29.6	24.3	1.37	42.5
Average Truck	4689	247	--	21.3	16.2	21.3	18.2	1.31	42.7

All but two of the vehicles in Table 10 (the Honda Insight and the Toyota Prius) have conventionally powered counterparts. Tables 11 and 12 compare the adjusted 55/45 fuel economy and an estimate of annual fuel usage (assuming 15,000 miles per year) for these vehicles with their conventionally powered (baseline) counterparts. The comparisons in both tables are limited to a basis of: model name, drive, inertia weight, transmission, and engine size (CID) and in most cases more than one comparison is made. Differences in the performance attributes of these vehicles complicate making the forward analysis of the fuel economy improvement potential due to hybridization and dieselization. In particular, hybrid vehicles are often reported to have faster 0 to 60 acceleration times than their conventional counterparts, while vehicles equipped with diesel engines have higher low-end torque, but slower 0 to 60 times. In addition, some hybrid vehicles use

Table 11

Comparison of Hybrid Cars and Trucks With Their Conventional Counterparts

	<---- Hybrid Version ----->					<---- Baseline Version ---->					<Improvement>	
Model Name	**Inertia Weight**	**CID**	**Trans**	**ADJ 55/45 MPG**	**Gal Per Year***	**Inertia Weight**	**CID**	**Trans**	**ADJ 55/45 MPG**	**Gal Per Year***	**ADJ 55/45 MPG**	**Gal Per Year***
Accord	3500	183	L5	32.0	469	3500	183	L5	24.4	616	31%	147
						3500	144	L5	27.4	547	17%	78
Civic	3000	82	CVT	47.5	316	2750	102	CVT	37.0	406	29%	90
Civic	3000	82	M5	47.9	313	3000	122	M5	27.7	542	73%	229
						2750	102	M5	34.0	441	41%	127
Escape 2wd	4000	140	CVT	33.3	451	3500	182	L4	21.6	695	54%	244
						3500	140	L4	23.1	651	44%	200
						3500	140	M5	26.4	568	26%	118
Escape 4WD	4000	140	CVT	30.9	485	4000	182	L4	19.3	777	60%	292
						3500	140	L4	19.9	755	56%	270
						3500	140	M5	23.7	634	31%	149
GM C15 Pickup 2wd	5000	325	L4	19.0	788	5000	364	L4	16.8	894	13%	106
						5500	293	L4	17.3	868	10%	80
						5000	325	L4	17.5	857	9%	69
						5000	262	L4	17.8	843	7%	55
						5000	293	L4	18.2	825	5%	36
GM K15 Pickup 4wd	5500	325	L4	17.9	840	5500	364	L4	14.7	1020	21%	181
						5000	262	L4	15.0	1001	19%	161
						5500	325	L4	16.2	928	10%	88
						5000	325	L4	16.5	910	8%	70
						5500	293	L4	17.3	868	3%	28

*Note:

Gallons per year calculation is based on all vehicles being driven 15,000 miles per year.

technologies such as cylinder deactivation and CVT transmissions that are not offered in their counterparts. Given the difficulty in choosing the "right" baseline vehicle, Table 11 thus typically includes multiple baseline cases and comparisons. In addition, because the Escape Hybrid is equipped with a CVT and the conventionally powered Escapes are not, Table 11 includes baseline data for both manual and automatic transmission versions of this vehicle.

Fuel economy improvements and fuel savings per year for the hybrid vehicles in Table 11 depend considerably on selection of the baseline vehicle. For example, the fuel economy improvements for the four wheel drive GM K15 Pickup vary from 3 to 21 percent, while the manual transmission equipped Civic hybrid provides a fuel economy improvement of about 40 to 70 percent. Even though the GM hybrid pickup trucks offer relatively low fuel economy improvements, for a vehicle driven 15,000 miles per year, their fuel saving potential is relatively significant. Similarly, fuel economy improvements for diesels range from about 25 to nearly 55 percent and these vehicles also offer relatively high savings in fuel usage. It should be noted that this analysis does not include several highly publicized vehicles that are likely to be offered for sale in the US market in calendar year 2005 including, for example, the diesel equipped MY2005 Jeep Liberty SUV and the MY2006 Lexis RX400 hybrid SUV because data for these vehicles had not been provided to EPA by the manufacturers when the database used for this report was prepared.

Table 12

Comparison of Diesel Cars With Their Conventional Counterparts

	<—--- Diesel Version ----->					<---- Baseline Version ---->					<Improvement>	
Model Name	**Inertia Weight**	**CID**	**Trans**	**ADJ 55/45 MPG**	**Gal Per Year***	**Inertia Weight**	**CID**	**Trans**	**ADJ 55/45 MPG**	**Gal Per Year***	**ADJ 55/45 MPG**	**Gal Per Year***
Mercedes E320	4000	197	L5	30.3	494	4000	195	L5	22.7	660	33%	165
Jetta	3500	116	L5	36.2	414	3500	109	L5	24.6	610	47%	196
Jetta Wagon	3500	116	M5	40.5	370	3500	121	M5	26.4	568	54%	198
						3500	109	M5	26.7	562	52%	192
New Beetle	3500	116	L6	38.3	392	3500	109	L6	25.0	600	53%	207
New Beetle	3000	116	M5	41.1	365	3000	121	M5	26.6	564	54%	199
						3000	109	M5	26.8	559	53%	194
Passat	3500	121	L5	30.9	485	3500	109	L5	24.7	608	25%	122

*Note:

Gallons per year calculation is based on all vehicles being driven 15,000 miles per year.

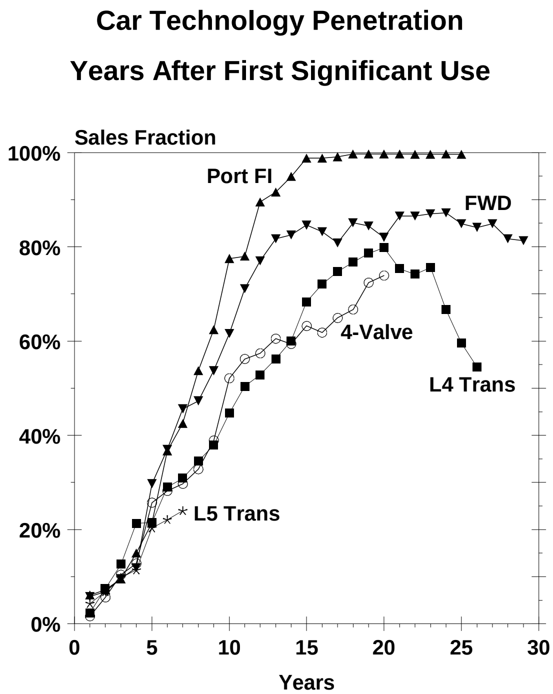


Figure 36

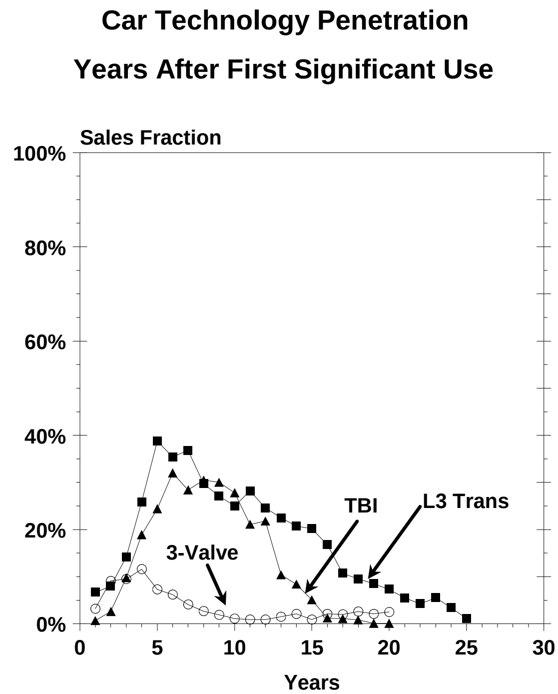


Figure 37

Figure 36 compares penetration rates for five passenger car technologies, namely port fuel injection (Port FI), front-wheel drive (FWD), four valves per cylinder (4-Valve), and four- and five-speed lockup transmissions (L4 and L5). This figure indicates that it may take a decade for a technology to prove itself and attain a sales fraction of 40 to 50 percent and as long as another five or ten years to reach maximum market penetration. It thus takes some time after the introduction of a new technology for it to fully penetrate the market. The L4 case represents a technology that took 20 years to reach a peak (of about 80 percent), and one that is now rapidly declining.

A similar comparison of three technologies whose sales fraction peaked out at about 40 percent or less is shown in Figure 37. This figure shows that it often may take a number of years for technologies such as 3-valve-per-cylinder engines (3-valve), throttle body fuel injection (TBI), and lockup 3-speed (L3) transmissions to reach their maximum sales fraction, and, even then, use of these technologies may continue for a decade or longer. For the limited number of cases studied, the time a given technology needs to attain and then pass a market share of about 40 to 50 percent appears to be an indicator of whether it will ever attain a stabilized high level of market penetration.

Laboratory 55/45 Fuel Consumption vs Inertia Weight MY1975 and MY2005 Cars

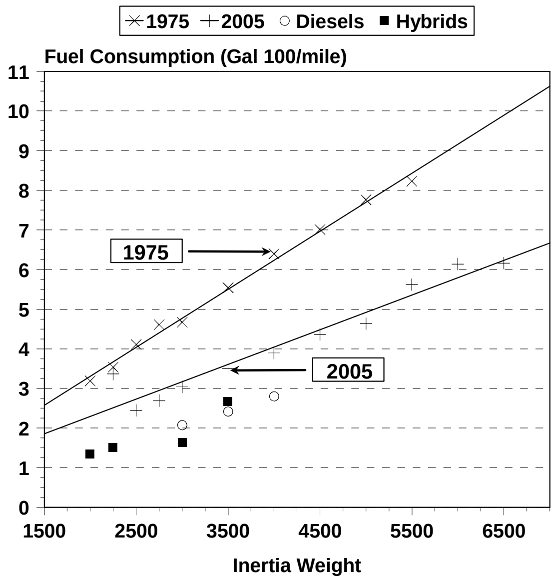


Figure 38

Laboratory 55/45 Fuel Consumption vs Inertia Weight MY1975 and MY2005 Trucks

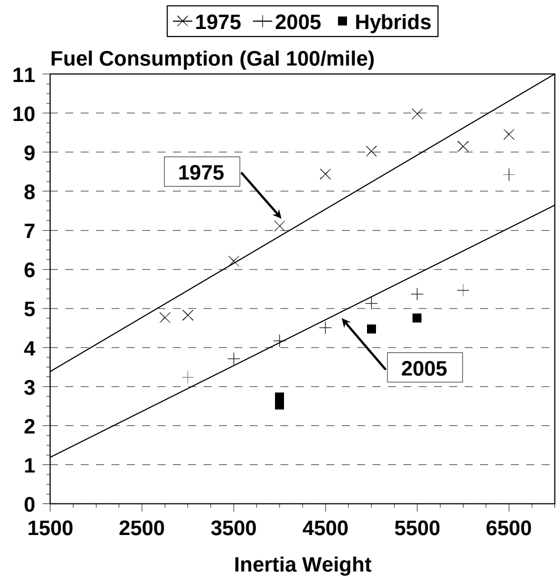


Figure 39

Cars and light trucks with conventional drivetrains have a fuel consumption and weight relationship which is well known and is shown on Figures 38 and 39. Fuel consumption goes up with weight. Because vehicles with different propulsion systems, i.e., diesels and hybrids, occupy a different place on such a fuel consumption and weight plot, the lines in these figures were prepared without using the diesel or the hybrid data. At constant weight, MY2005 cars typically consume about 30 to 40 percent less fuel per mile than their MY1975 counterparts. On this same constant weight basis, this year's cars with diesel engines nominally consume about 30 percent less fuel than the conventionally powered ones while this year's hybrid cars are about 25 to 50 percent better. Similarly, at constant weight this year's conventionally powered trucks achieve about 40 percent better fuel consumption than MY1975 vehicles did. On a constant weight basis, the Ford Escape Hybrids achieve about 40 percent better fuel consumption than their MY2005 counterparts, but the GM C15 and K15 pickups are only about 10 percent better.

Figures 40 and 41 show the improvement that occurred between 1975 and 2005 for fuel consumption as a function of 0-to-60 time for cars and trucks. Figures 42 and 43 compare Ton-MPG data vs 0-to-60 time and show that at constant vehicle performance, there has been substantial improvement in Ton-mpg, particularly for hybrid and diesel vehicles. While hybrid powertrains offer significant potential for fuel economy and vehicle performance improvement, their market share is not yet significant because some five years after the introduction for sale of the first hybrid car (the MY2000 Insight), they account for two percent of all MY2005 cars and an even smaller percentage of MY2005 trucks.

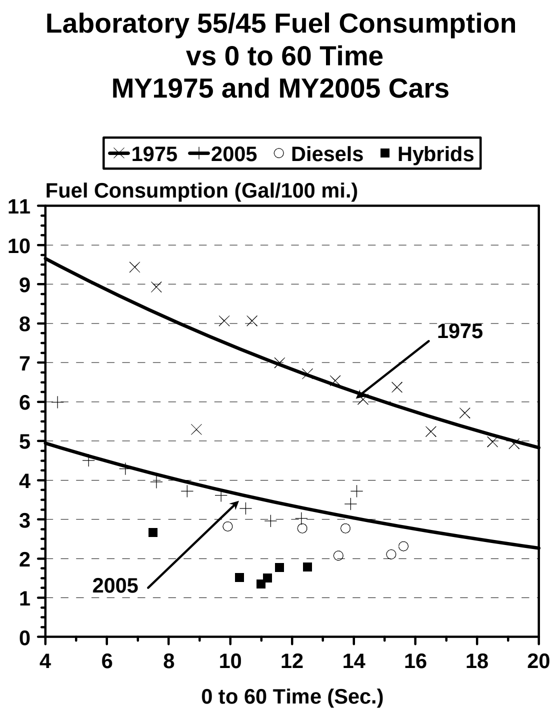


Figure 40

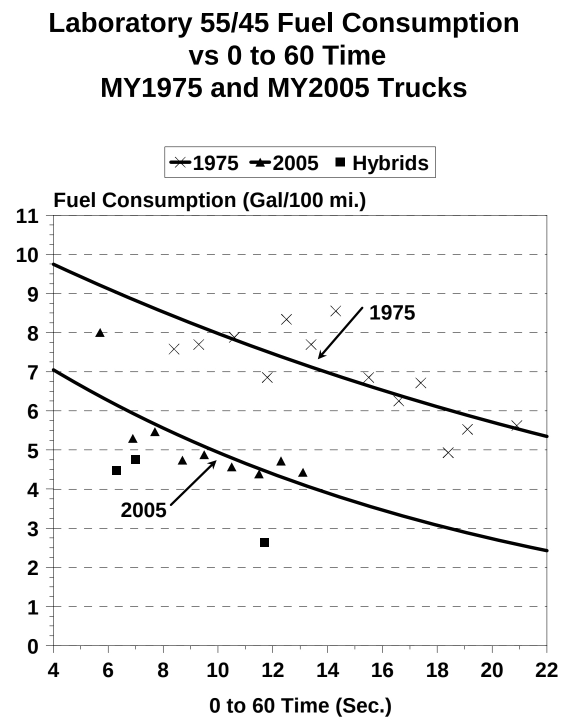


Figure 41

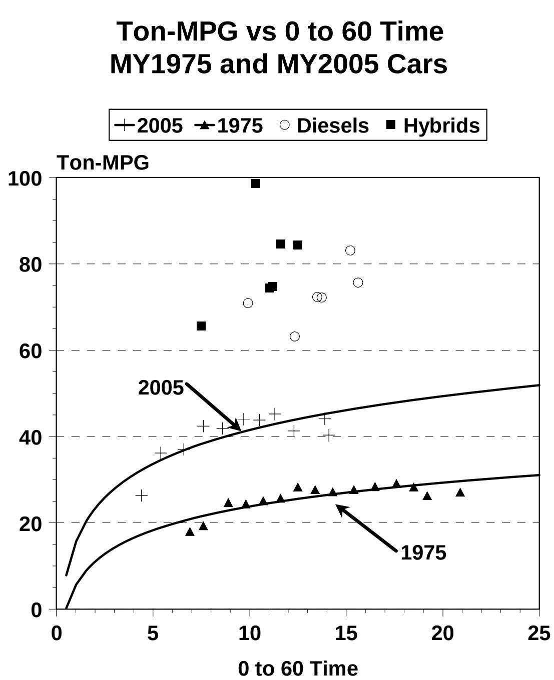


Figure 42

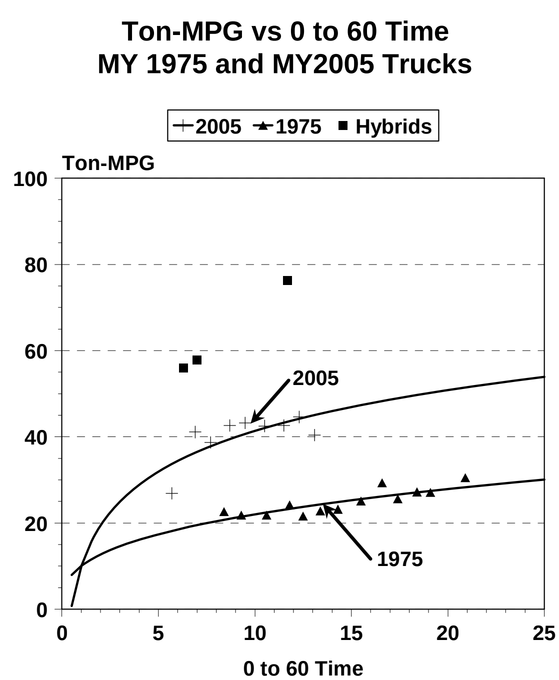


Figure 43

V. **Trends by Vehicle Type and Size**

Table 1 showed that trucks are expected to account for about 50 percent of light-duty vehicles produced during model year 2005. As shown in Figure 44 and Table 13, the sales fraction for SUVs has increased; the sales fractions for cars and wagons has declined; that for pickups and vans has remained nearly constant. Considering the five classes: cars, wagons, SUVs, vans, and pickups, since 1975 the biggest increase in market share has been for SUVs, up from less than two percent to 26 percent this year, and the biggest decrease has been for cars, down from over 70 percent to about 45 percent. In addition, the combination of wagons and vans has also been roughly a constant for the past two decades because while wagons have dropped from a sales fraction of nine percent in 1975 to about four percent this year, vans have increased from a sales fraction of about four percent in 1975 to about 10 percent this year. The market dynamic, therefore, has been and is between cars and SUVs with the former dropping in sales fraction and the latter increasing. If the SUV is the new "family" car, then a case could be made that the market shares for pickups, people movers (vans and wagons) and "family" cars have not changed much over time.

Figures 45 to 49 compare sales fractions by vehicle type and size with the fleet stratified into five vehicle types: cars (i.e., coupes, sedans, and hatchbacks), station wagons, vans, sports utility vehicles (SUVs), and pickup trucks; and three vehicle sizes: small, midsize, and large. As shown in Figure 45, large cars accounted for about 20 percent of all car sales in the late 1970s, but their share of the car market dropped slightly in the early 1980s and has not changed significantly since then. Within the car segment of the market, the market share for small cars peaked in the late 1980s at about 65 percent and is now lower than at anytime since 1975.

Sales Fraction by Vehicle Type
(Three Year Moving Average)

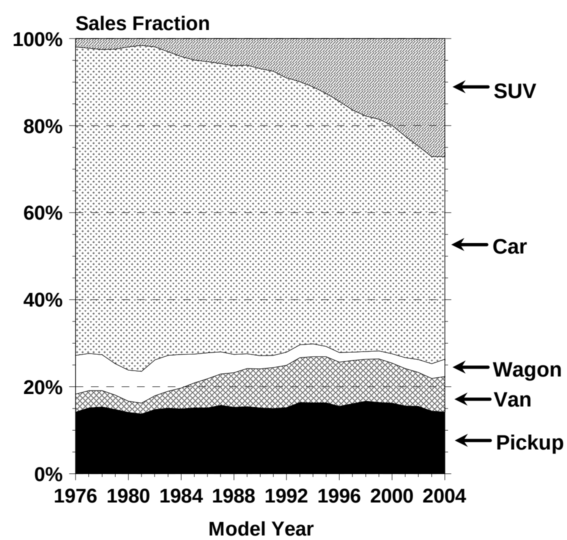


Figure 44

Large wagons accounted for more than 20 percent of the wagon segment of the market in the late 1970s but then lost market share relatively consistently and were not produced at all between 1996 and 2004. They reemerged in 2004 year but do not yet have a meaningful three year moving average for their market share and account for less than one percent of all MY2005 vehicles. Similarly (see Figure 47), large vehicles accounted for nearly 40 percent of all vans through the early 1980s compared to less than 10 percent now. Small vans have never had a significant market share, and none have been produced in recent years. Figures 48 and 49 show that there have been significant trends towards increased market share for both large SUVs and pickups.

Table 13 compares the sales fractions by vehicle type and size on a different basis, that for the total market. Since 1975, the largest increases in sales fractions have been for midsize and large SUVs. These two classes are expected to account for about 25 percent of all light vehicles built this year, compared to a combined total of about 1.3 and 4.2 percent in 1975 and 1987, respectively. Conversely, the largest sales fraction decrease has occurred for small cars which accounted for 40 percent of all light-duty vehicles produced in 1975 and over 43 percent in 1987. While the small car class has consistently remained the largest of the 15 vehicle sizes and types, its market share of the total market has since decreased to about 20 percent. An overall decrease has occurred for large cars which accounted for about 15 percent of total light-duty sales in 1975 when they ranked third. Between then and 1987, their sales fraction dropped by over 40 percent.

Car Sales Fraction by Vehicle Size (Three Year Moving Average)

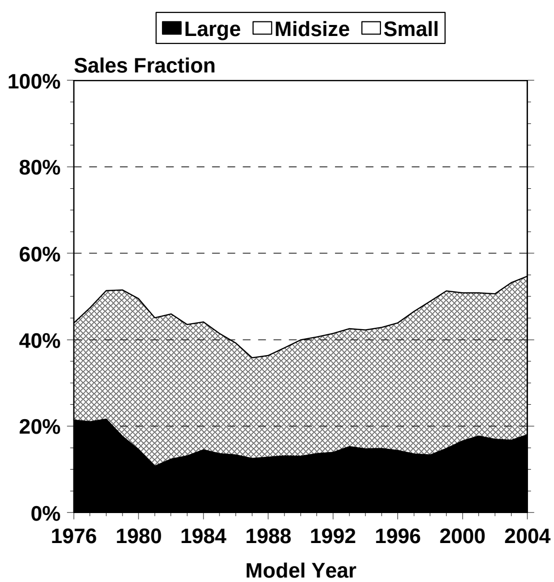


Figure 45

Wagon Sales Fraction by Vehicle Size (Three Year Moving Average)

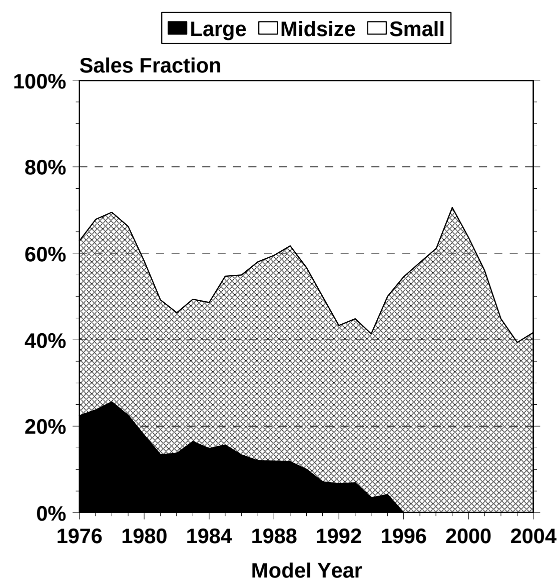


Figure 46

Van Sales Fraction by Vehicle Size (Three Year Moving Average)

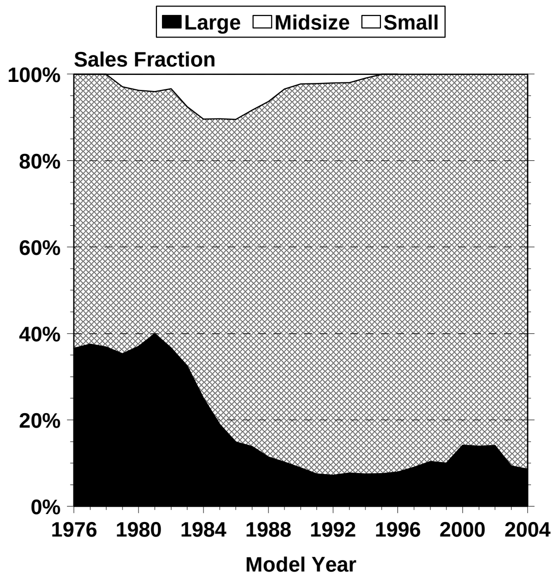


Figure 47

SUV Sales Fraction by Vehicle Size (Three Year Moving Average)

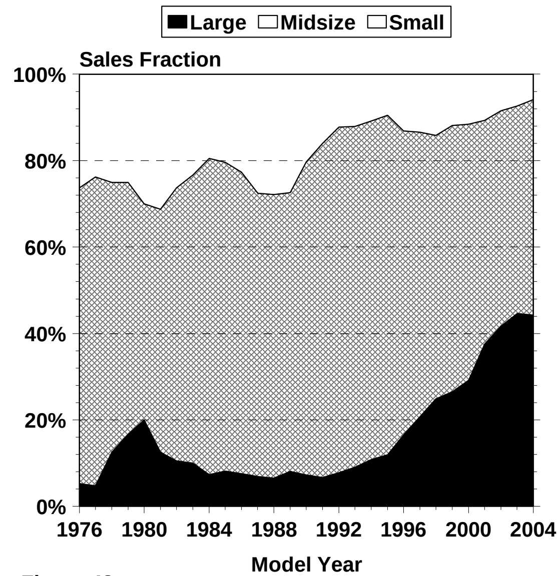


Figure 48

Pickup Sales Fraction by Vehicle Size (Three Year Moving Average)

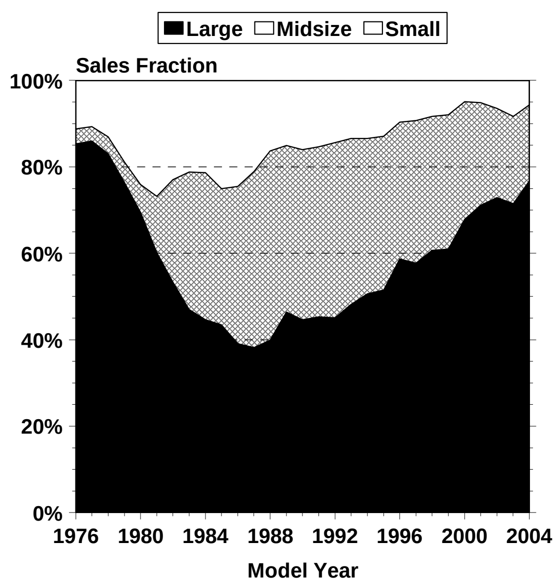


Figure 49

Table 13

Sales Fractions of MY1975, MY1987 and MY2005
Light-Duty Vehicles by Vehicle Size and Type

Vehicle Type	Size	Sales Fraction 1975	1987	2005	Differences in Sales Fraction: From 1975 To 2005	From 1975 To 1987	From 1987 To 2005
Car	Small	40.0%	43.4%	20.2%	-19.8%	3.4%	-23.2%
	Midsize	16.0%	15.2%	17.0%	1.1%	-0.8%	1.9%
	Large	15.2%	8.2%	8.7%	-6.5%	-7.0%	0.5%
	All	71.1%	66.8%	45.9%	-25.3%	-4.4%	-20.9%
Wagon	Small	4.7%	2.4%	2.0%	-2.7%	-2.2%	-0.5%
	Midsize	2.8%	2.4%	1.9%	-0.9%	-0.4%	-0.5%
	Large	1.9%	0.6%	0.5%	-1.5%	-1.3%	-0.1%
	All	9.4%	5.4%	4.3%	-5.1%	-4.0%	-1.1%
Van	Small	0.0%	0.8%	0.0%	0.0%	0.8%	-0.8%
	Midsize	3.0%	5.7%	8.9%	6.0%	2.8%	3.2%
	Large	1.5%	0.9%	0.6%	-0.9%	-0.6%	-0.4%
	All	4.5%	7.5%	9.5%	5.0%	3.0%	2.0%
SUV	Small	0.5%	1.7%	1.0%	0.5%	1.2%	-0.7%
	Midsize	1.2%	3.8%	12.6%	11.4%	2.6%	8.8%
	Large	0.1%	0.4%	12.3%	12.2%	0.3%	11.9%
	All	1.8%	5.9%	25.9%	24.1%	4.0%	20.0%
Pickup	Small	1.6%	3.0%	0.1%	-1.5%	1.4%	-2.9%
	Midsize	0.5%	7.1%	1.9%	1.4%	6.5%	-5.2%
	Large	11.0%	4.4%	12.4%	1.4%	-6.6%	8.0%
	All	13.1%	14.4%	14.4%	1.2%	1.3%	-0.1%
All	Trucks	19.4%	27.8%	49.8%	30.3%	8.4%	22.0%

Figures 50 through 54 show trends in performance, weight, and adjusted fuel economy for cars, wagons, vans, SUVs, and pickups. For all five vehicle types, there has been for the past decade an a half a clear trend towards increased weight with average weight for all three types of trucks higher now, than in 1975. You have to go back to 1978 to find a heavier car or wagon fleet. On the average 2005 cars, wagons, vans, SUVs, and pickups are as powerful and fast as they have ever been. Their respective Ton-mpg values are also the highest ever. Figure 55 shows the five classes compared on a Ton-mpg basis. In this measure of efficiency, vans lead, cars and wagons are about the same and better than SUVs which are like pickups.

Table 14 shows the lowest, average, and highest adjusted mpg performance in the five classes for the three selected years. Improvements in nearly every class are seen from 1975 to 1987. For 2005, the mpg performance is such that the large vehicles in some categories have better fuel economy than the corresponding entry for small vehicles in 1975. In Table 15, the percentage changes obtainable from the entries in Table 14 are presented. Average mpg for midsize cars and midsize wagons have improved over 90 percent since 1975. Overall, the across-the-board improvements in mpg seen in Table 14 are reproduced here.

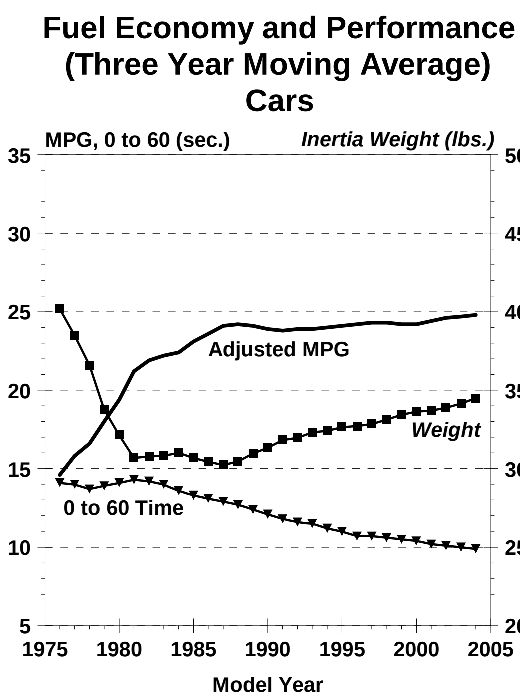


Figure 50

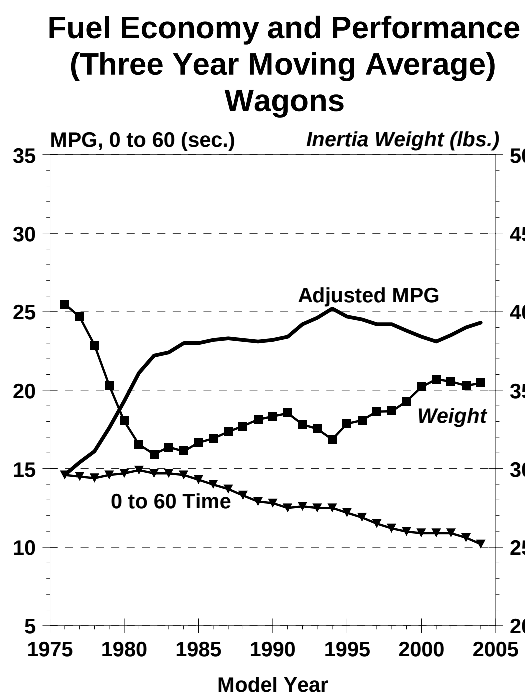


Figure 51

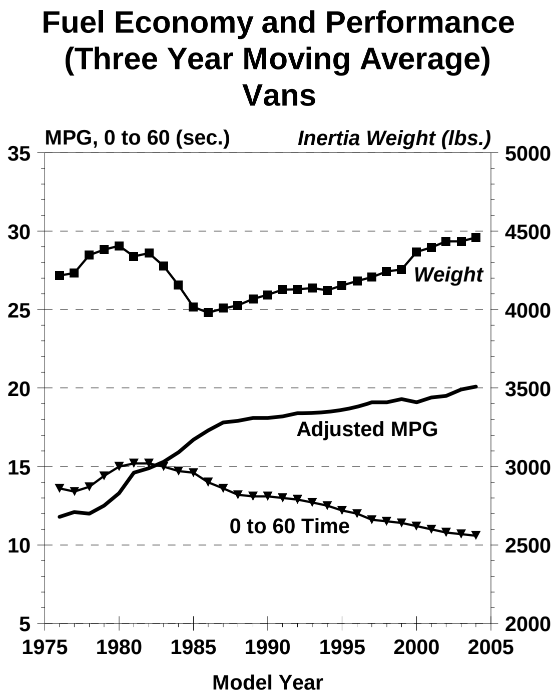


Figure 52

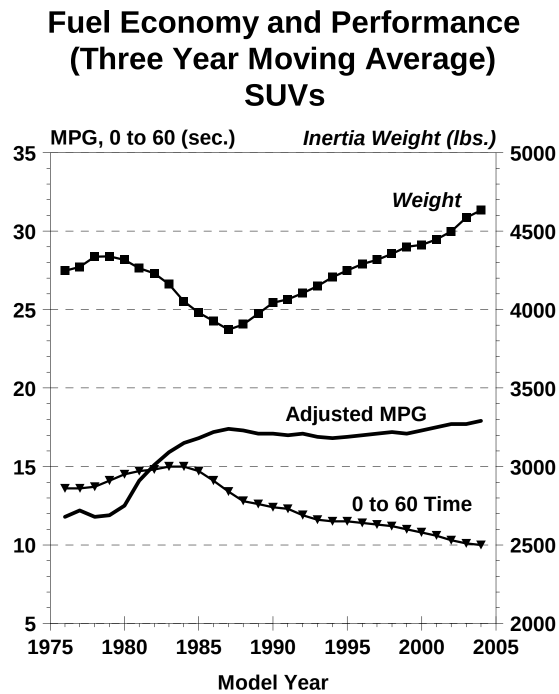


Figure 53

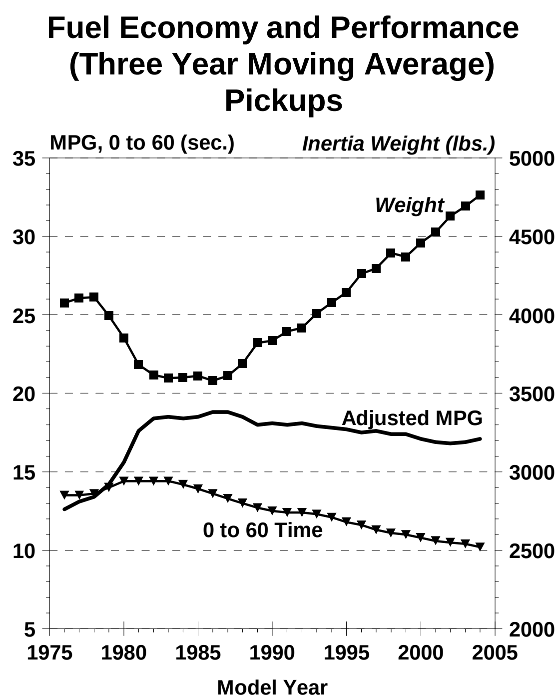


Figure 54

Table 14

Lowest, Average and Highest Adjusted Fuel Economy by Vehicle Type and Size

Vehicle Type	Size	1975 Low.	1975 Avg.	1975 High.	1987 Low.	1987 Avg.	1987 High.	2005 Low.	2005 Avg.	2005 High.
Car	Small	8.6	15.6	28.3	7.5	25.6	55.6	10.6	26.4	63.0
	Midsize	8.6	11.6	18.4	9.1	22.2	27.3	11.8	24.8	55.3
	Large	8.4	11.2	14.6	8.8	20.4	23.6	11.8	22.0	26.0
	All	8.4	13.4	28.3	7.5	24.0	55.6	10.6	24.8	63.0
Wagon	Small	11.8	19.1	24.1	16.7	26.2	33.0	17.2	26.3	40.5
	Midsize	8.4	11.3	25.0	19.1	21.9	27.3	16.7	22.7	30.9
	Large	8.4	10.2	12.8	18.7	19.0	19.1	18.6	19.1	20.2
	All	8.4	13.8	25.0	16.7	23.2	33.0	16.7	23.7	40.5
Van	Small	16.2	17.5	18.5	14.9	20.7	26.1	****	****	****
	Midsize	8.2	11.3	18.4	11.0	18.1	26.2	15.0	20.7	22.7
	Large	8.9	10.7	14.5	10.2	14.5	17.6	14.4	16.3	17.8
	All	8.2	11.1	18.5	10.2	17.8	26.2	14.4	20.4	22.7
SUV	Small	10.2	13.7	16.3	16.7	20.6	28.1	15.6	21.3	26.3
	Midsize	8.2	10.2	18.4	10.1	16.9	28.7	13.5	19.4	33.3
	Large	7.9	10.3	13.7	12.4	14.5	19.5	12.8	16.8	21.4
	All	7.9	11.0	18.4	10.1	17.6	28.7	12.8	18.1	33.3
Pickup	Small	13.0	19.2	20.8	12.8	22.1	27.9	17.7	21.2	23.8
	Midsize	17.8	17.9	18.0	14.4	21.6	36.4	16.9	20.0	25.7
	Large	7.6	11.1	18.5	11.0	15.1	20.5	10.1	16.7	23.3
	All	7.6	11.9	20.8	11.0	19.2	36.4	10.1	17.1	25.7
All	Cars	8.4	13.5	28.3	7.5	24.0	55.6	10.6	24.7	63.0
All	Trucks	7.6	11.6	20.8	10.1	18.4	36.4	10.1	18.2	33.3
All	Vehicles	7.6	13.1	28.3	7.5	22.1	55.6	10.1	21.0	63.0

Table 15

Percent Change in Lowest, Average and Highest Adjusted Fuel Economy by Vehicle Type and Size

Vehicle Type	Size	From 1975 to 2005 Low.	Avg.	High.	From 1975 to 1987 Low.	Avg.	High.	From 1987 to 2005 Low.	Avg.	High.
Car	Small	23%	69%	123%	-12%	64%	96%	41%	3%	13%
	Midsize	37%	114%	201%	6%	91%	48%	30%	12%	103%
	Large	40%	96%	78%	5%	82%	62%	34%	8%	10%
	All	26%	85%	123%	-10%	79%	96%	41%	3%	13%
Wagon	Small	46%	38%	68%	42%	37%	37%	3%	0%	23%
	Midsize	99%	101%	24%	127%	94%	9%	-12%	4%	13%
	Large	121%	87%	58%	123%	86%	49%	0%	1%	6%
	All	99%	72%	62%	99%	68%	32%	0%	2%	23%
Van	Small	***	***	***	-7%	18%	41%	***	***	****
	Midsize	83%	83%	23%	34%	60%	42%	36%	14%	-12%
	Large	62%	52%	23%	15%	36%	21%	41%	12%	1%
	All	76%	84%	23%	24%	60%	42%	41%	15%	-12%
SUV	Small	53%	55%	61%	64%	50%	72%	-6%	3%	-5%
	Midsize	65%	90%	81%	23%	66%	56%	34%	15%	16%
	Large	62%	63%	56%	57%	41%	42%	3%	16%	10%
	All	62%	65%	81%	28%	60%	56%	27%	3%	16%
Pickup	Small	36%	10%	14%	-1%	15%	34%	38%	-3%	-14%
	Midsize	-4%	12%	43%	-18%	21%	102%	17%	-6%	-28%
	Large	33%	50%	26%	45%	36%	11%	-7%	11%	14%
	All	33%	44%	24%	45%	61%	75%	-7%	-10%	-28%
All	Cars	26%	83%	123%	-10%	78%	96%	41%	3%	13%
All	Trucks	33%	57%	60%	33%	59%	75%	0%	0%	-8%
All	Vehicles	33%	60%	123%	0%	69%	96%	35%	-4%	13%

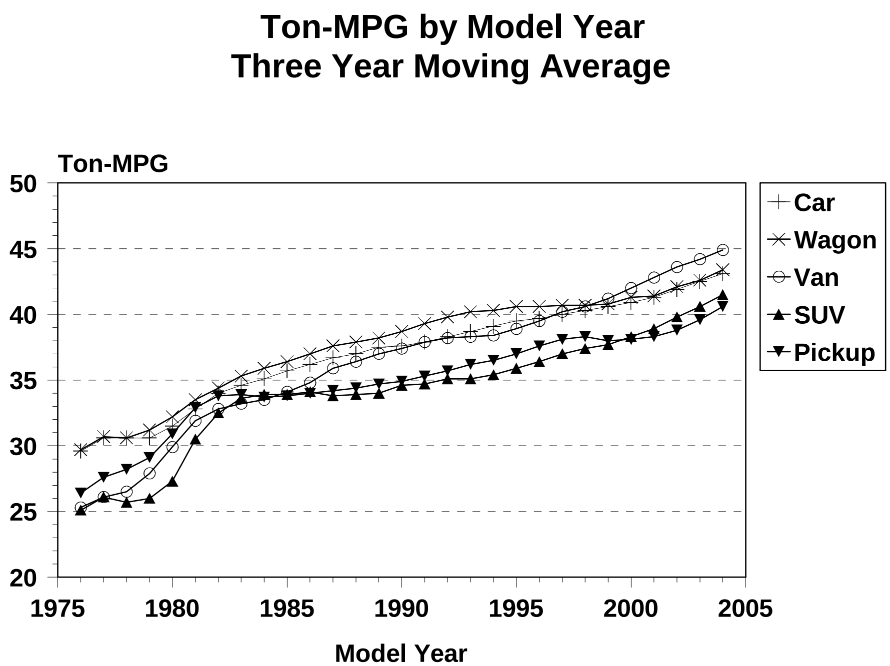


Figure 55

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Figures 56 through 60 provide an indication of the market share of different weight vehicles within the different classes. Trends within classes are shown which underlie the increasing weight shown by the classes as a whole. In 1975 over half of the combined car and truck fleet consisted of cars with an inertia weight of 4,000 lb or more compared to about 10 percent this year. Conversely, the market share of trucks in the inertia weight classes of 4,000 lb or more have increased substantially and these vehicles to about 45 percent compared to about 15 percent in 1975. Figures 58, 59, and 60 provide additional details of the truck data presented in Figure 57 for vans, SUVs and pickups respectively. Appendixes E, F and G contain a series of tables describing light-duty vehicles at the vehicle size/type level of stratification in more detail and Appendix H provides similar data by vehicle type and inertia weight class.

Car Market Share by Inertia Weight Class
(Three Year Moving Average)

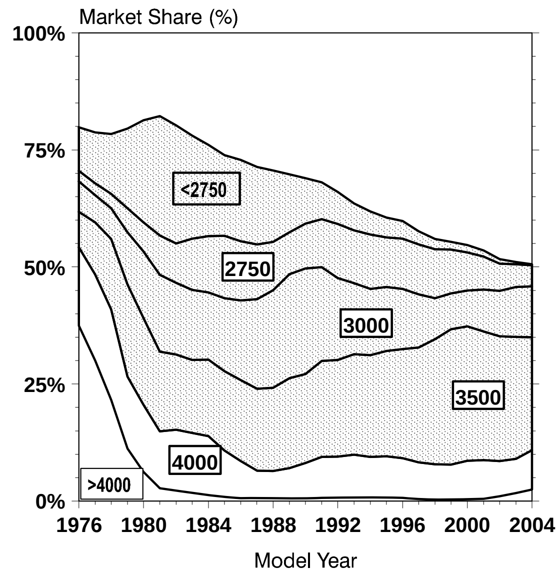


Figure 56

Truck Market Share by Inertia Weight Class
(Three Year Moving Average)

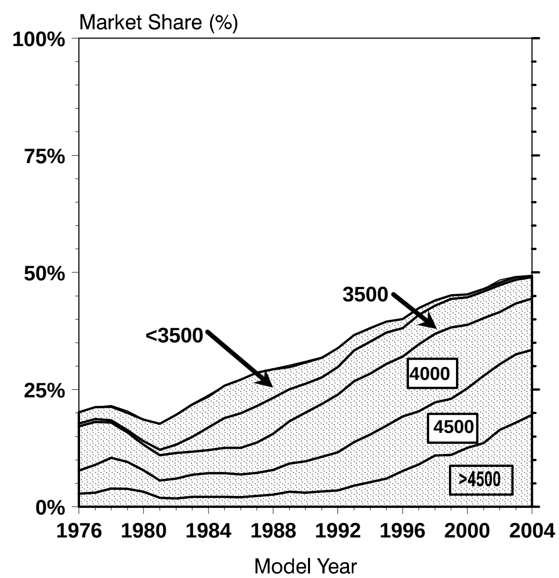


Figure 57

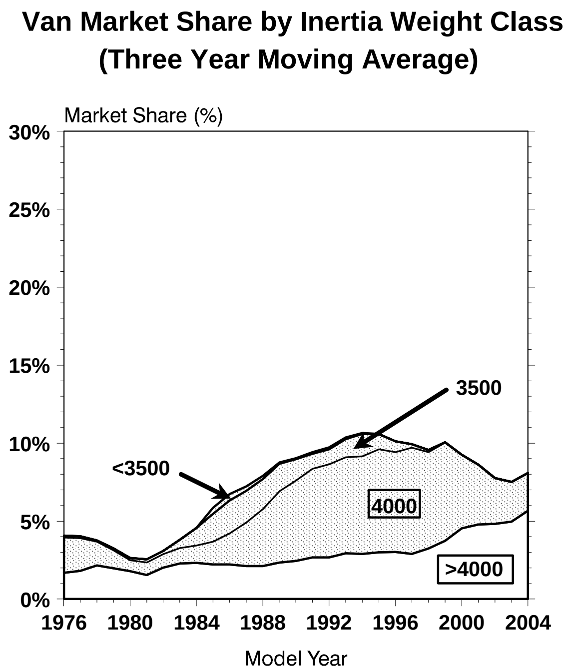


Figure 58

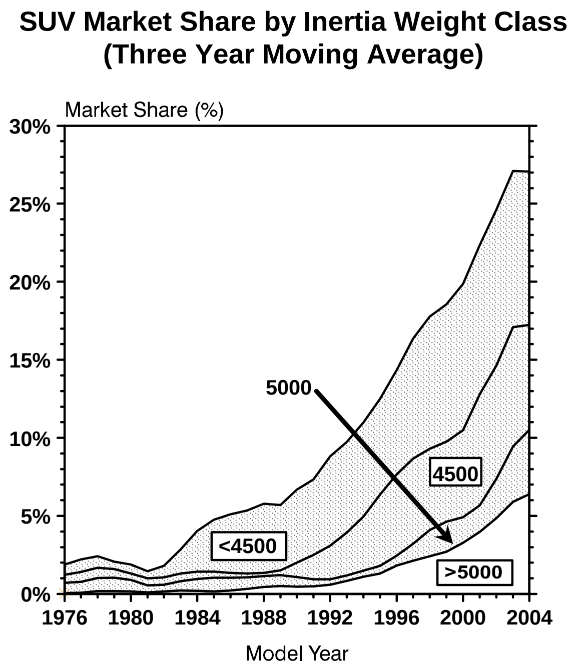


Figure 59

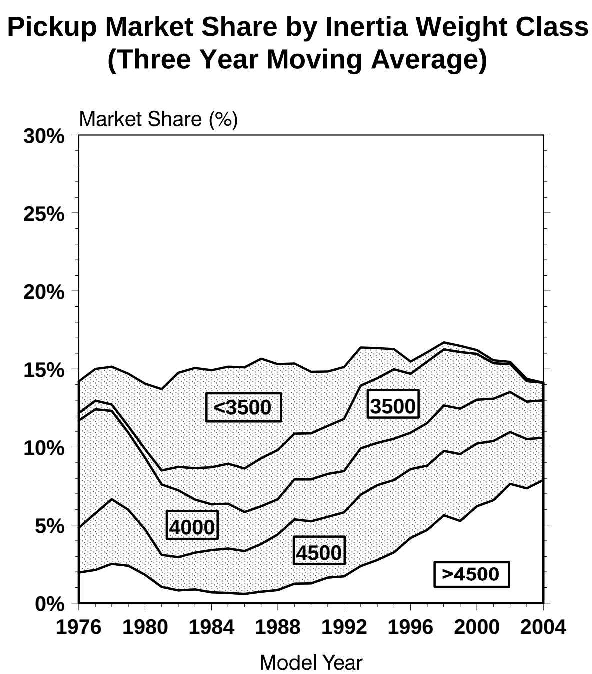


Figure 60

VI. **Marketing Groups**

In its century of evolution, the automotive industry existed first as small, individual companies that relatively quickly went out of business or grew into larger corporations. In that context, the historic term ‘manufacturer’ usually meant a corporation that was associated with a single country that manufactured vehicles for sale in just that country and perhaps exported vehicles to a few other countries, too. Over the years, the nature of the automotive industry has changed substantially, and it has evolved into one in which global consolidations and alliances among heretofore independent manufacturers have become the norm, rather than the exception.

The reports in this series include analyses of fuel economy trends in terms of the whole fleet of cars and light trucks and in various subcategories of interest, e.g., by weight class, by size class, etc. In addition, there has been a treatment of trends by groups of manufacturers. Initially, these groups were derived from the “Domestic” and “Import” categories which are part of the automobile fuel economy standards categories. This classification approach evolved into a market segment approach in which cars were apportioned to a “Domestic,” “European,” and “Asian” category, with trucks classified as “Domestic” or “Imported.” As the automotive industry has became more transnational in nature, this type of vehicle classification became less useful. In this report, trends by groups of manufacturers are now used to reflect the transnational and transregional nature of the automobile industry. To reflect the transition to an industry in which there are only a small number of independent companies, the fleet has been divided into eight major marketing group segments, and an ninth catch-all group (“Others”) that contains independent manufacturers not assigned to one of the eight major marketing groups.

These eight major marketing groups are:

1) The General Motors Group includes: GM, Opel, Saab, Isuzu, Fiat, Subaru, Suzuki and Daewoo;

2) The Ford Motor Group includes: Ford, Jaguar, Volvo, Land Rover, Aston Martin, and Mazda;

3) The DaimlerChrysler Group includes Chrysler, Mercedes Benz and Mitsubishi;

4) The Toyota Group includes Toyota, Scion and Lexus;

5) The Honda Group includes Honda and Acura;

6) The Nissan Group includes Nissan and Infiniti;

7) The Hyundai-Kia (HK) Group includes Hyundai and Kia; and

8) The VW Group includes Volkswagen, Audi, SEAT, Skoda and Bentley.

Taken together, the eight major marketing groups comprise 98 percent of the MY2005 new vehicle market in the U.S. It is expected that these marketing groups will continue and perhaps expand as further consolidations in the automotive industry occur.

Table 16 compares laboratory fuel economy values for the marketing groups described above for model year 2005 with the overall fleet average. For each marketing group, the table also shows the effect of adding each of the manufacturers in that group. For example, if just GM cars were considered, the GM group would have an average laboratory car fuel economy of 28.8 mpg, adding cars manufactured by Subaru lowers this value by a tenth of an mpg, adding Suzuki and Saab doesn't change GM's average fuel economy for cars, but including Daewoo increases it to 28.9 mpg.

The GM, Ford, and DC Groups are all at or above the fleet average in percent truck and below the overall fleet average in combined car and truck fuel economy, but the remaining groups are all below the fleet average in percent truck and are above the overall fleet average in mpg.   Table 17 presents similar data to that in Table 16, except this table uses adjusted fuel economy values.

A more detailed comparison of model year 2005 laboratory fuel economy, by vehicle type and size, is presented in Table 18.   Stratifying by just marketing group and vehicle type for MY2005, the Honda Marketing Group achieves the highest fuel economy for cars, vans and SUVs and the Toyota Marketing Group for wagons and pickups.   Table 19 is a companion table to Table 18, but like Table 17 uses adjusted mpg data. When vehicle size is also taken into consideration, the GM group achieves the highest fuel economy in five of the 13 vehicle types and size classes for which they manufacturer vehicles and ties Ford in Midsize Wagons; Toyota leads in four classes, Honda in two, and Nissan and Daimler Chrysler lead one class each.

Figures 61 through 68 compare model year 1975 to 2005 percent truck, laboratory 55/45 fuel economy for cars, trucks, and both cars and trucks for the GM, Ford, DaimlerChrysler, Toyota, Honda, Hyundai-Kia, Nissan, and VW marketing groups, respectively. For all eight of these marketing groups, combined car and truck fuel economy is lower now than it was in 1987 Because the absolute values of fuel economy differ somewhat across the marketing groups, a separate presentation of the fuel economy trends was prepared by normalizing the fuel economy for each Group by the fuel economy in 1987, the year in which fuel economy for the fleet as a whole was the highest. In this way, a relative measure of how each group, compared to its own value in 1987, can be seen. The results are shown in Figures 69 through 76.

All the marketing groups have lower absolute fuel economy now than they did in 1987. The declines are very similar, except for the VW Group which has not declined as much, due at least in part to the fact their truck share shown on Figure 68 has remained very low.   More information stratified by marketing group can be found in the Appendixes M through Q.

Table 16

Model Year 2005 Laboratory 55/45 Fuel Economy by Marketing Group

Group	Group Member Added	<-- FUEL ECONOMY --> Cars	Trucks	Both	Percent Truck
GM	GM	28.8	20.8	23.6	58%
	Above plus Subaru	28.7	20.9	23.7	56%
	Above plus Isuzu	28.7	20.9	23.7	57%
	Above plus Suzuki	28.7	21.0	23.7	57%
	Above plus Saab	28.7	21.0	23.8	56%
	Above plus Daewoo	28.9	21.0	24.0	54%
	Entire GM Group	28.9	21.0	24.0	54%
Ford	Ford	26.8	20.2	22.4	60%
	Above plus Mazda	27.1	20.3	22.8	57%
	Above plus Volvo	27.1	20.4	22.9	56%
	Above plus Jaguar	26.9	20.4	22.9	54%
	Above plus Land Rover	26.9	20.3	22.8	55%
	Above plus Ast. Mart.	26.9	20.3	22.8	55%
	Entire Ford Group	26.9	20.3	22.8	55%
DC	Chrysler	26.5	21.1	22.8	64%
	Above plus Mitsubishi	26.9	21.3	23.1	61%
	Above plus Mercedes	26.6	21.2	23.2	58%
	Entire DC Group	26.6	21.2	23.2	58%
Toyota	Toyota	33.1	22.9	27.5	45%
Honda	Honda	33.1	24.8	29.3	38%
Nissan	Nissan	29.2	21.0	25.4	39%
HK	Hyundai	29.7	24.8	27.5	40%
	Above plus Kia	29.8	22.9	26.1	46%
VW	VW	28.6	19.5	27.5	9%
	Above plus Bentley	28.4	19.5	27.3	9%
Others		26.1	20.9	24.3	30%
All	Fleet Average	28.9	21.3	24.6	50%

Table 17

Model Year 2005 Adjusted 55/45 Fuel Economy by Marketing Group

Group	Group Member Added	<-- FUEL ECONOMY --> Cars	Trucks	Both	Percent Truck
GM	GM	24.7	17.8	20.2	58%
	Above plus Subaru	24.6	17.9	20.3	56%
	Above plus Isuzu	24.6	17.9	20.3	57%
	Above plus Suzuki	24.6	17.9	20.3	57%
	Above plus Saab	24.6	17.9	20.3	56%
	Above plus Daewoo	24.8	17.9	20.5	54%
	Entire GM Group	24.8	17.9	20.5	54%
Ford	Ford	22.9	17.2	19.1	60%
	Above plus Mazda	23.1	17.4	19.5	57%
	Above plus Volvo	23.1	17.4	19.5	56%
	Above plus Jaguar	23.0	17.4	19.6	54%
	Above plus Land Rover	23.0	17.3	19.5	55%
	Above plus Ast. Mart.	23.0	17.3	19.5	55%
	Entire Ford Group	23.0	17.3	19.5	55%
DC	Chrysler	22.6	18.1	19.5	64%
	Above plus Mitsubishi	23.0	18.2	19.8	61%
	Above plus Mercedes	22.7	18.1	19.8	58%
	Entire DC Group	22.7	18.1	19.8	58%
Toyota	Toyota	28.3	19.5	23.5	45%
Honda	Honda	28.3	21.1	25.1	38%
Nissan	Nissan	24.9	18.0	21.7	39%
HK	Hyundai	25.4	21.2	23.5	40%
	Above plus Kia	25.4	19.5	22.3	46%
VW	VW	24.5	16.7	23.5	9%
	Above plus Bentley	24.5	16.7	23.5	9%
Others		22.3	17.8	20.8	30%
All	Fleet Average	24.7	18.2	21.0	50%

Table 18

Model Year 2005 Laboratory 55/45 Fuel Economy by Marketing Group

VEHICLE TYPE/SIZE	GM	Ford	DC	Toyota	Honda	Nissan	HK	VW	Others	All
Cars										
Small	31.3	28.8	28.2	34.7	38.3	29.2	31.4	29.0	26.6	30.9
Midsize	27.8	26.4	27.9	31.8	30.1	29.1	29.6	27.4	25.4	29.0
Large	27.0	25.1	24.5	23.8	----	----	23.1	21.6	23.4	25.7
All	28.9	26.9	27.1	32.9	33.1	29.2	29.8	28.4	26.1	29.1
Wagons										
Small	32.1	28.2	27.6	36.3	----	----	----	31.2	25.8	30.9
Midsize	27.4	27.4	25.2	----	----	----	----	27.1	----	26.6
Large	----	----	22.3	----	----	----	----	----	----	22.3
All	29.7	27.5	25.3	36.3	----	----	----	28.5	25.8	27.8
Cars and Wagons										
Small	31.4	28.8	28.1	34.9	38.3	29.2	31.4	29.1	26.6	30.9
Midsize	27.8	26.8	27.1	31.8	30.1	29.1	29.6	27.3	25.4	28.7
Large	27.0	25.1	23.9	23.8	----	----	23.1	21.6	23.4	25.5
All	28.9	26.9	26.6	33.1	33.1	29.2	29.8	28.4	26.1	28.9
Vans										
Small	----	----	----	----	----	----	----	----	----	0.0
Midsize	22.9	24.1	24.7	25.0	25.7	24.8	21.3	----	----	24.2
Large	19.3	18.7	----	----	----	----	----	----	----	19.1
All	21.9	23.5	24.7	25.0	25.7	24.8	21.3	----	----	23.8
SUVs										
Small	27.6	----	18.7	29.5	----	----	----	----	----	25.0
Midsize	24.8	20.9	21.8	23.3	24.4	25.7	23.4	----	22.0	22.7
Large	20.2	18.6	18.2	18.7	----	20.1	----	19.5	20.0	19.7
All	21.0	20.0	20.5	23.0	24.4	21.2	23.4	19.5	20.9	21.2
Pickups										
Small	26.6	----	----	22.4	----	----	----	----	----	24.9
Midsize	24.5	22.7	----	----	----	----	----	----	----	23.4
Large	20.1	18.8	18.7	21.6	----	18.7	----	----	----	19.6
All	20.7	19.7	18.7	21.6	----	18.7	----	----	----	20.0
Fleet										
All	24.0	22.8	23.2	27.5	29.3	25.4	26.1	27.3	24.3	24.6

Table 19

Model Year 2005 Adjusted 55/45 Fuel Economy by Marketing Group

VEHICLE TYPE/SIZE	GM	Ford	DC	Toyota	Honda	Nissan	HK	VW	Others	All
Cars										
Small	26.8	24.6	24.1	29.6	32.6	24.9	26.8	24.8	22.8	26.4
Midsize	23.8	22.6	23.9	27.2	25.8	24.9	25.3	23.5	21.8	24.8
Large	23.2	21.5	21.0	20.4	----	----	19.8	18.5	20.1	22.0
All	24.7	23.0	23.2	28.1	28.3	24.9	25.4	24.3	22.3	24.8
Wagons										
Small	27.4	24.1	23.5	30.9	----	----	----	26.6	22.1	26.3
Midsize	23.4	23.4	21.6	----	----	----	----	23.2	----	22.7
Large	----	----	19.1	----	----	----	----	----	----	19.1
All	25.4	23.5	21.6	30.9	----	----	----	24.4	22.1	23.7
Cars and Wagons										
Small	26.8	24.6	24.0	29.8	32.6	24.9	26.8	24.9	22.8	26.4
Midsize	23.8	22.9	23.1	27.2	25.8	24.9	25.3	23.4	21.8	24.6
Large	23.2	21.5	20.5	20.4	----	----	19.8	18.5	20.1	21.8
All	24.8	23.0	22.7	28.3	28.3	24.9	25.4	24.3	22.3	24.7
Vans										
Small	----	----	----	----	----	----	----	----	----	----
Midsize	19.6	20.6	21.1	21.4	22.0	21.2	18.2	----	----	20.7
Large	16.5	16.0	----	----	----	----	----	----	----	16.3
All	18.7	20.0	21.1	21.4	22.0	21.2	18.2	----	----	20.4
SUVs										
Small	23.5	----	15.9	25.1	----	----	----	----	----	21.3
Midsize	21.1	17.9	18.6	19.8	20.8	21.9	20.0	----	18.8	19.4
Large	17.3	15.9	15.5	16.0	----	17.2	----	16.7	17.1	16.8
All	17.9	17.0	17.5	19.6	20.8	18.1	20.0	16.7	17.8	18.1
Pickups										
Small	22.7	----	----	19.1	----	----	----	----	----	21.2
Midsize	20.9	19.4	----	----	----	----	----	----	----	20.0
Large	17.1	16.1	16.0	18.4	----	16.0	----	----	----	16.7
All	17.6	16.8	16.0	18.4	----	16.0	----	----	----	17.1
Fleet										
All	20.5	19.5	19.8	23.5	25.1	21.7	22.3	23.4	20.8	21.0

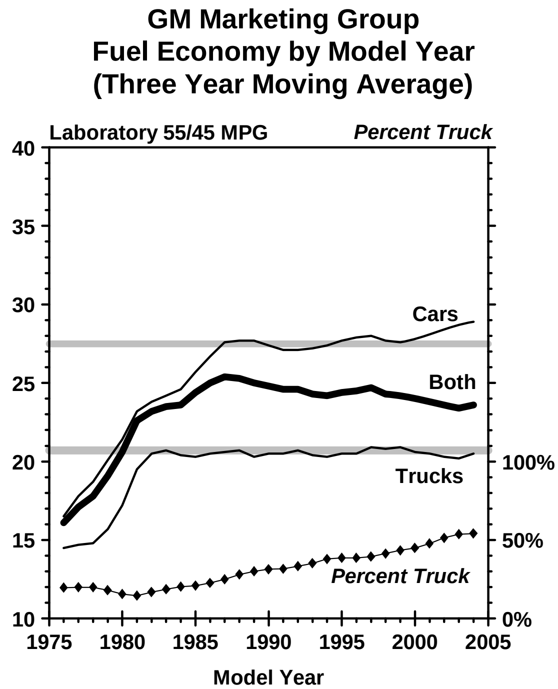
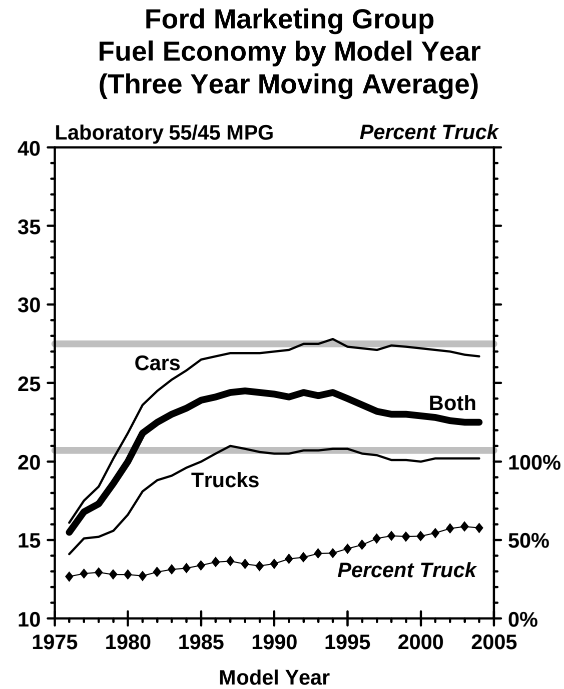


Figure 61



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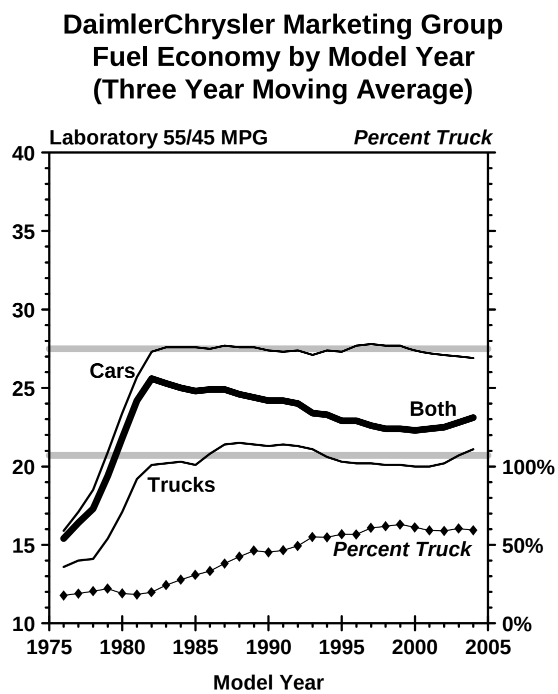

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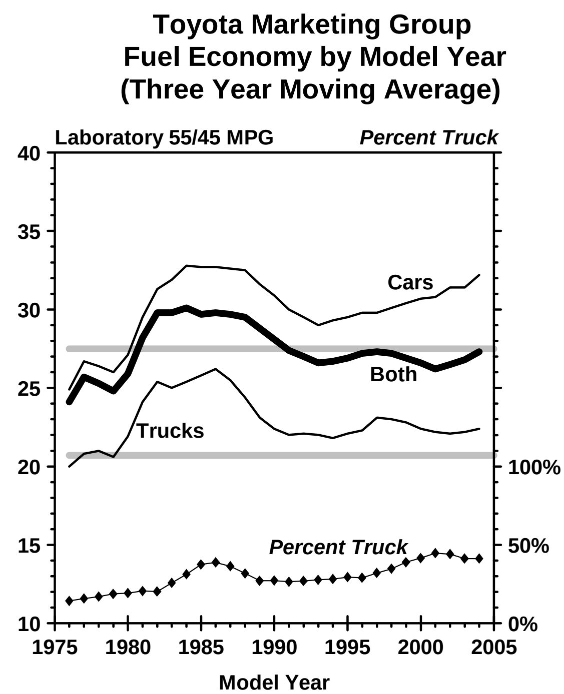

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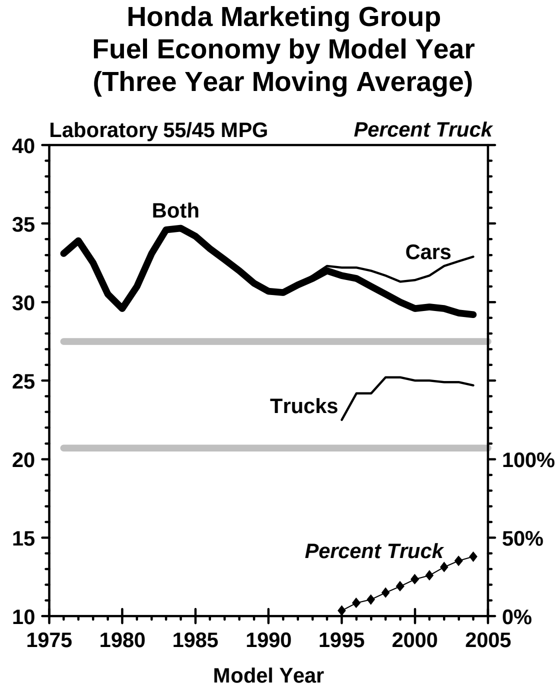

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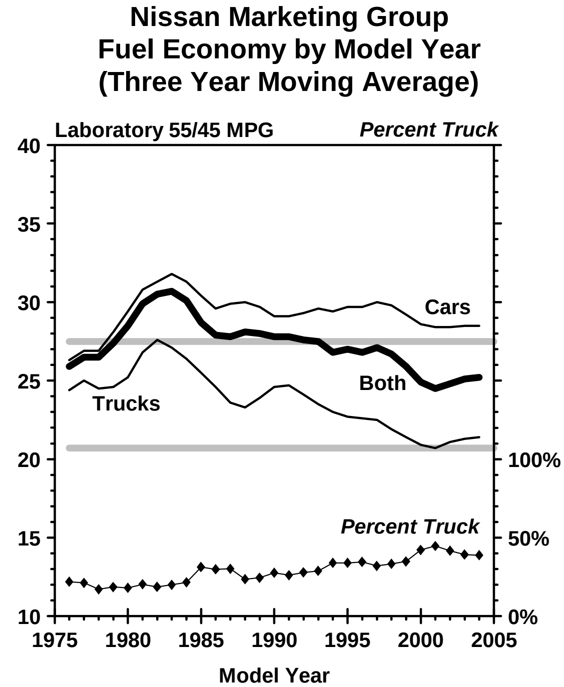

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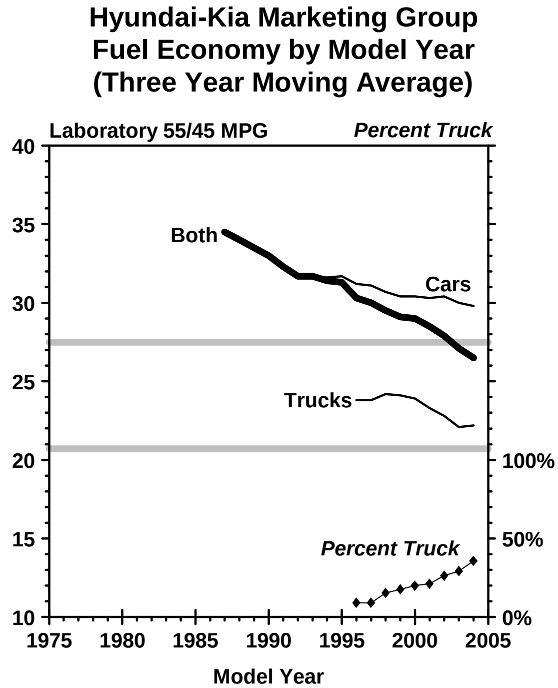

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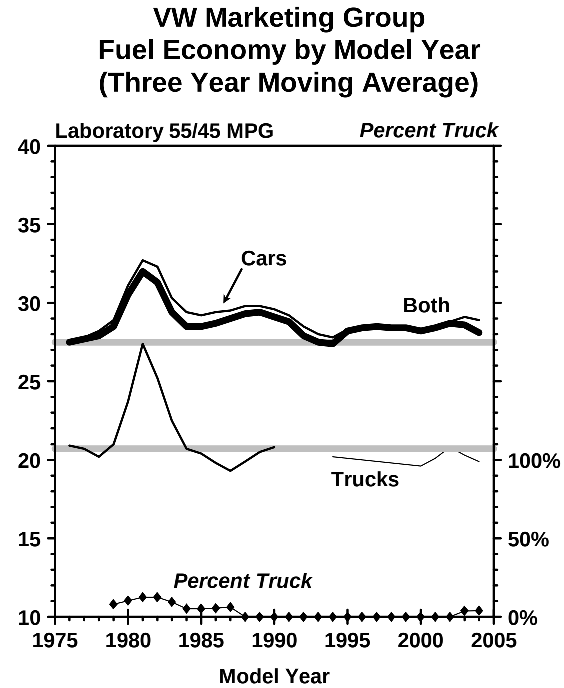

Figure 68

Normalized Fuel Economy
GM Marketing Group
Three Year Moving Average
(Both Cars and Trucks)

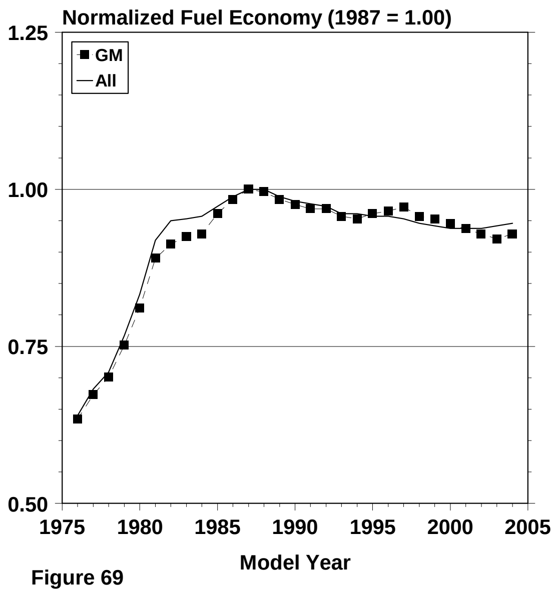

Figure 69

Normalized Fuel Economy
Ford Marketing Group
(Three Year Moving Average)
Both Cars and Trucks

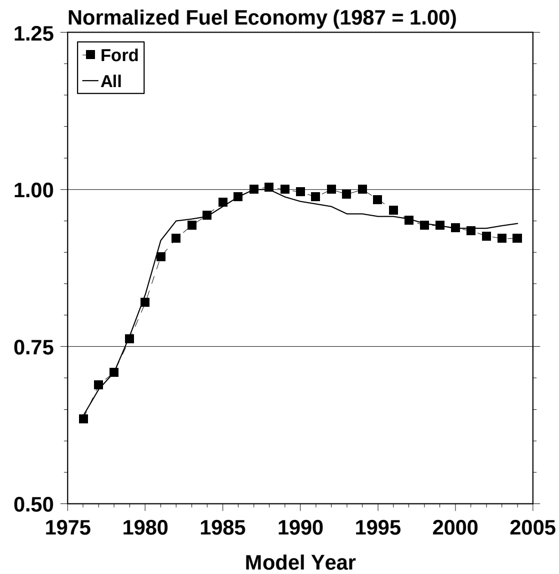

Figure 70

Normalized Fuel Economy
DC Marketing Group
(Three Year Moving Average)
Both Cars and Trucks

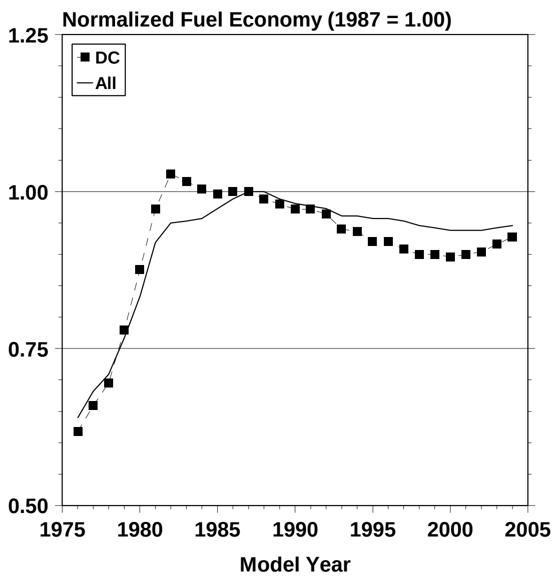

Figure 71

Normalized Fuel Economy
Toyota Marketing Group
(Three Year Moving Average)
Both Cars and Trucks

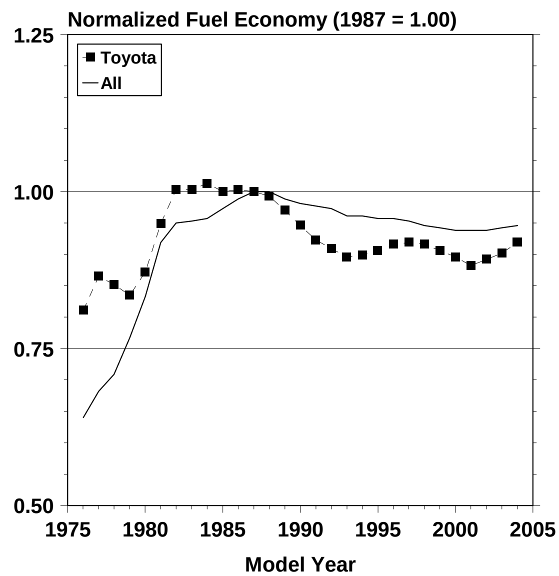

Figure 72

Normalized Fuel Economy
Honda Marketing Group
(Three Year Moving Average)
(Both Cars and Trucks)

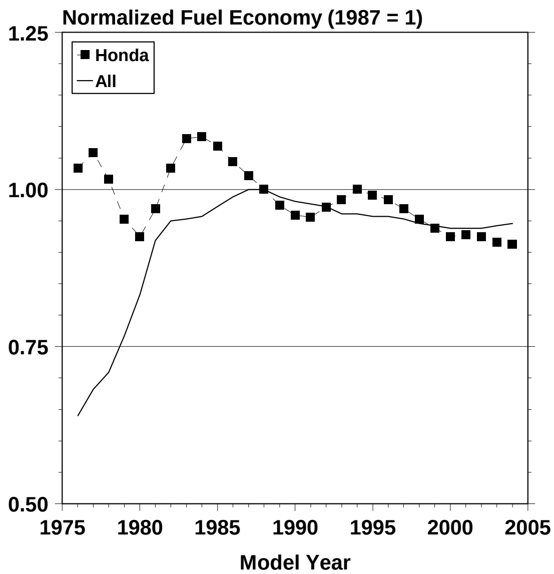

Figure 73

Normalized Fuel Economy
Nissan Marketing Group
Three Year Moving Average
(Both Cars and Trucks)

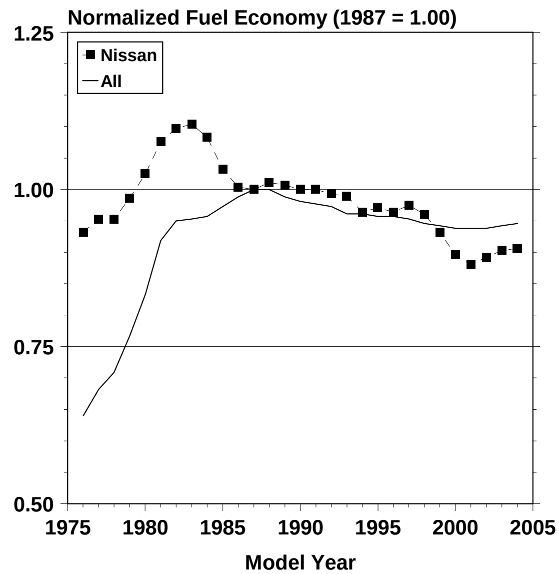

Figure 74

Normalized Fuel Economy
Hyundai Kia Group
(Three Year Moving Average)
Both Cars and Trucks

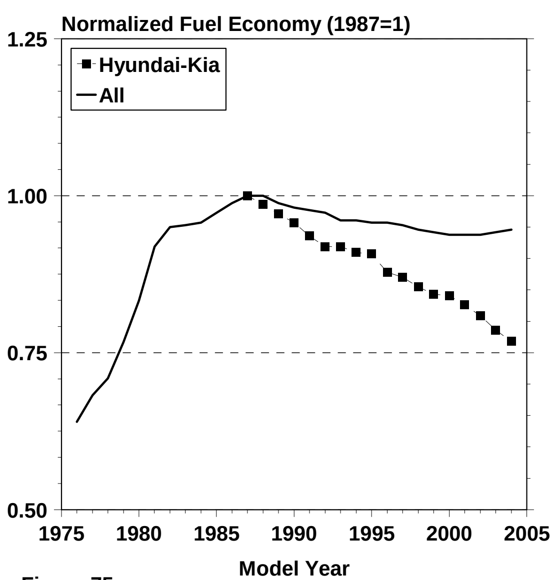

Figure 75

Normalized Fuel Economy
VW Marketing Group
(Three Year Moving Average)
Both Cars and Trucks

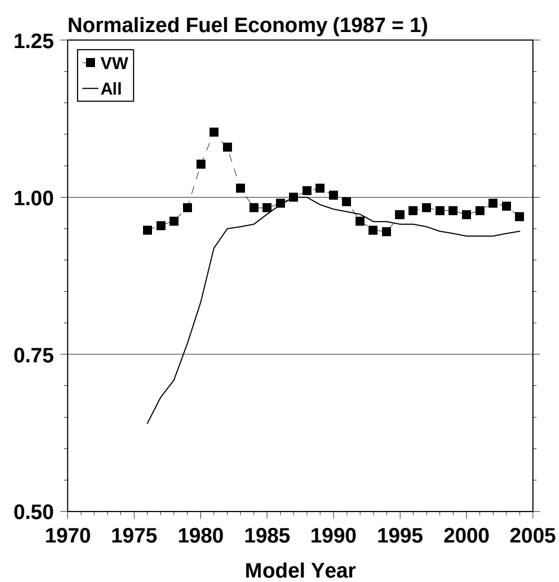

Figure 76

VII. **Characteristics of Fleets Comprised of Existing Fuel-Efficient Vehicles**

This section is limited to a discussion of hypothetical fleets of vehicles comprised of fuel-efficient vehicles and the fuel economy and other characteristics of those fleets. This section includes a discussion of some of the technical and engineering factors that affect fleet fuel economy. It does not attempt to evaluate either the benefits or the costs of achieving various fuel economy levels. In addition, the analysis presented here also does not attempt to evaluate the marketability or the public acceptance of any of the hypothetical fleets that result from the scenarios studied and discussed below.

There are several different ways to look at the potential for improved fuel economy from the light-duty vehicle fleet. Many of these approaches utilize projections of more fuel efficient technologies that are not in the fleet today. As an example, a fleet made up of a large fraction of fuel cell vehicles could be considered. Such projections can be associated with a good deal of uncertainty, since uncertainty in the projections of market share compound with uncertainties about the fuel economy performance of yet uncommercialized technology. These uncertainties can be thought of as a combination of technical risk, i.e., can the technology be developed and mass produced?, and market risk, i.e., will people buy vehicles with the improved fuel economy?

One general approach used in this report is to consider only the fuel economy performance of those technologies which exist in today’s fleet. This eliminates uncertainty about the feasibility and production readiness of the technology and reduces or eliminates the technical risk but does not treat market risk, as mentioned above. Therefore, the analysis can be thought of as the fuel economy potential now in the fleet, with no new technologies added, if the higher mpg choices available were to be selected.

As was shown in Figures 7 and 8, there is a wide distribution of fuel economy. Because of the interest in the high end of this spectrum, this portion of the database was examined in more detail using a “best in class” (BIC) analysis technique. This technique is not new, and in fact was one of the methods used to investigate future fleet fuel economy capability when the original fuel economy standards were set.

In any group or class of vehicles there will be a distribution of fuel economy performance, and the “best in class” method relies on that fact. The analysis involves dividing the fleet of vehicles into classes, selecting a set of representative high mpg “role model” vehicles from each class, and then calculating the average characteristics of the resultant fleet using the same relative sales proportions as in the baseline fleet.

One potential problem with a BIC analysis is that the high mpg cars used in the analysis may be unusual in some way — so unusual that the hypothetical fleet made up of them may be deficient in some other attributes considered desirable by vehicle buyers. Because the BIC analysis is also sensitive to the selection of the best vehicles, three different procedures were used to select the role models.

Two of these selection procedures use the EPA car size classes (which for cars are the same as those used for the EPA/DOE *Fuel Economy Guide*) and the truck type/size classes described previously in this report. Note that this classification system includes nine car and nine truck classes and for this model year one of these eighteen classes is not represented (Small Vans). The third best-in-class role model selection procedure is based on using the vehicle inertia weight classes used for EPA's vehicle testing and certification process.

The advantage of using and analyzing data from the best-in-size class methods is that if the sales proportions of each class are held constant, the sales distribution of the resultant fleet by *vehicle type and size* does not change. This means that the size of the average vehicle does not change a lot, but there can be some fluctuation in interior volume for cars because of the distribution of interior volume within a car class. Similarly, there also is an advantage in using the inertia weight classes to determine the role models, since, if the sales proportions in each inertia weight class are held constant, the sales distribution of the resultant fleet by *weight* does not change, and in this case, the average weight remains the same.

One way of performing a best-in-class (BIC) analysis is to use as role models the four nameplates with the highest fuel economy in each size class. (See Tables R-1 and R-2 in Appendix R.) Under this procedure, all vehicles in a class with the same nameplate are included as role models regardless of vehicle configuration. Each role model nameplate from each class was assigned the same sales weighting factor, but the original sales weighting distribution for different vehicle configurations within a given nameplate (e.g., transmission type, engine size, and/or drive type) was retained. The resulting values were used to recalculate the fleet average values using the same relative proportions in each of the size classes that constitute the fleet. In cases where two identical vehicles differ by only one characteristic but have slightly different nameplates (such as the two-wheel drive Chevrolet C1500 and the four-wheel drive Chevrolet K1500 pickups), both are considered to have the same nameplate, and their average fuel economy was calculated before determining if they should serve as role models in the BIC analysis. Conversely, in the cases where there are technically identical vehicles with different nameplates (e.g., the Buick LeSabre and Pontiac Bonneville sedans), only one representative vehicle nameplate was considered in the BIC analysis.

The second best-in-class role model selection procedure involves selecting as role models the best dozen vehicles in each size class with each vehicle configuration considered separately. Tables R-3 and R-4 in Appendix R give listings of the representative vehicles used in this method. As with the previous procedure, in cases where technically identical vehicle configurations have different nameplates, only one representative vehicle was considered. Under this best-in-class method, the sales data for each role model vehicle in each class was assigned the same value, and the resulting values were used to re-calculate the fleet values again using the same relative proportions in each of the size classes that constitute the fleet.

The third best-in-class procedure involves selecting as role models the best dozen vehicles in each weight class. As with the previous method, each vehicle configuration was considered separately. (See Tables R-5 and R-6 in Appendix R for a listing of the vehicles used in this analysis.) It should be noted that some of the weight classes have less than a dozen representative vehicles. In addition, as in the previous two best-in-class methods, where technically identical vehicle configurations with different nameplates are used, only one representative vehicle was included. As with the two best-in-size class methods, the sales data for each role model vehicle in each class was assigned the same value, and the resulting values were used to recalculate the fleet values again using the same relative proportions in each of the size classes that constitute the fleet.

Tables 20 to 22 compare, for cars, trucks, and both cars and trucks, respectively, the results of the best-in-class analysis with actual average data for model year 2005. As discussed earlier, for the size class scenarios, the percentage of vehicles that are small, midsize, or large are the same as for the baseline fleet, and in the weight class scenarios, the average weight of the BIC data sets is the same as the actual one. Average interior volume for cars in the BIC weight class analysis is within about one percent of the actual average (i.e., 111 vs 112 cu. ft.). The slight difference in interior volume between the size class scenarios and the actual vehicle fleet can be attributed to the fact that, within a size class, there is considerable variation in interior volume (i.e., not all vehicles in each size class have exactly the same interior volume).

Under all of the best-in-class (BIC) scenarios, the vehicles used for the BIC analysis have less powerful engines, have slower 0-to-60 acceleration times, and are more likely to be equipped with manual transmissions than the entire fleet as a whole. For trucks, the BIC data set vehicles make greater use of front-wheel drive.

For both cars and trucks, the “Best 12 Vehicles” in Size Class scenario results in significantly higher fuel economy than the actual fleet, but the vehicles in the BIC size set are lighter than their counterparts from the other scenarios. Depending on the scenario chosen, for model year 2005, cars could have achieved from 21 to 25 percent better fuel economy than they did. Similarly, for trucks the fuel economy improvement ranges from 11 to 21 percent better fuel economy, and the combined car and truck fleet could have been 15 to 21 percent better.

The best-in-class analyses can be thought of as the mpg potential now in the fleet with no new technologies added if the higher mpg choices available were selected. As such, the best-in-class analyses provide a useful reference point indicating the variation in fuel economy levels that results in large part from consumer preferences as opposed to technological availability.

One of the characteristics of the best-in-class analysis is that it typically results in a hypothetical fleet of vehicles which has characteristics which may not be realistic for the U.S. market. For example, as a consequence of the methodology, the BIC analysis results in a larger fraction of manual and CVT transmissions than today’s fleet does. This indicates there may be some potential for CVTs for the U.S. market, where automatic transmissions have dominated for many years.

Table 20

Best in Class Results: Model Year 2005 Cars

Vehicle Characteristic	Selection Basis	Actual Data	Size Class	Size Class	Weight Class
	Selection Criteria	**All Cars**	**Best 4 Nameplates**	**Best 12 Vehicles**	**Best 12 Vehicles**
Fuel Economy	Lab.55/45	28.9	36.3	35.4	35.0
	Adjusted City	21.8	28.0	27.0	26.7
	Adjusted Highway	29.7	35.5	35.2	35.1
	Adjusted 55/45	24.7	30.9	30.2	29.9
Vehicle Size	Weight (lb.)	3496	3137	3210	3496
	Volume (Cu. Ft.)	112	111	110	111
Engine	CID	171	133	134	132
	HP	187	147	144	153
	HP/CID	1.114	1.112	1.088	1.164
	HP/Wt	.053	.046	.045	.043
	Percent Multivalve	79%	79%	72%	72%
	Percent Diesel	.4%	.1%	15.2%	24.5%
Performance	0-60 Time (sec.)	9.8	11.1	11.0	11.2
	Top Speed (mph)	134	124	122	122
	Ton-MPG	43.6	50.8	50.1	53.6
	Cu. Ft. MPG	2822	3601	3450	3442
	Cu. Ft. Ton-MPG	4886	5608	5498	5933
Drive	Front	78%	94%	90%	82%
	Rear	16%	2%	7%	6%
	Four Wheel	6%	4%	3%	14%
Transmission	Lockup	83%	64%	56%	54%
	Manual	13%	20%	35%	38%
	CVT	4%	16%	10%	8%
Hybrid Vehicle		1%	25%	11%	9%
Percent of Car Fleet Included		100%	20%	24%	20%

Table 21

Best in Class Results: Model Year 2005 Trucks

Vehicle Characteristic	Selection Basis	Actual Data	Size Class	Size Class	Weight Class
	Selection Criteria	**All Trucks**	**Best 4 Nameplates**	**Best 12 Vehicles**	**Best 12 Vehicles**
Fuel Economy	Lab. 55/45	21.3	24.9	25.7	23.6
	Adjusted City	16.3	19.3	19.8	18.1
	Adjusted Highway	21.3	24.2	25.3	23.3
	Adjusted 55/45	18.2	21.2	21.9	20.1
Vehicle Size	Weight (lb.)	4687	4153	3984	4687
Engine	CID	247	190	175	216
	HP	237	197	185	219
	HP/CID	.973	1.051	1.061	1.031
	HP/Wt.	.050	.047	.046	.046
	Percent Multivalve	49%	75%	86%	66%
	Percent Diesel	0%	0%	0%	0%
Performance	0-60 Time (sec.)	10.0	10.6	10.7	10.8
	Top Speed (mph)	137	130	128	132
	Ton-MPG	42.7	44.6	44.0	47.3
Drive	Front	24%	36%	46%	26%
	Rear	29%	24%	29%	28%
	Four Wheel	47%	40%	25%	46%
Transmission	Lockup	94%	86%	64%	73%
	Manual	4%	8%	27%	20%
	CVT	2%	6%	9%	7%
Percent Hybrid		.1%	12.5%	4.2%	6.2%
Percent of Truck Fleet Included		100%	18%	21%	22%

Table 22

Best in Class Results: Model Year 2005 Light-Duty Vehicles

Vehicle Characteristic	Selection Basis	Actual Data	Size Class	Size Class	Weight Class
	Selection Criteria	**All Vehicles**	**Best 4 Nameplates**	**Best 12 Vehicles**	**Best 12 Vehicles**
Fuel Economy	Lab. 55/45	24.6	29.5	29.8	28.2
	Adjusted City	18.6	22.8	22.8	21.6
	Adjusted Highway	24.8	28.8	29.5	28.0
	Adjusted 55/45	21.0	25.2	25.4	24.1
Vehicle Size	Weight (lb.)	4089	3642	3595	4089
Engine	CID	209	161	154	174
	HP	212	172	164	186
	HP/CID	1.044	1.082	1.075	1.098
	HP/Wt	.051	.047	.045	.045
	Percent Multivalve	64%	77%	79%	69%
	Percent Diesel	.2%	.1%	7.6%	12.3%
Performance	0-60 Time (sec.)	9.9	10.9	10.9	11
	Top Speed	136	127	125	127
	Ton-MPG	43.2	47.7	47.1	50.5
Drive	Front	51%	65%	68%	54%
	Rear	23%	13%	18%	16%
	Four Wheel	26%	22%	14%	30%
Transmission	Lockup	88%	75%	60%	63%
	Manual	9%	14%	31%	29%
	CVT	3%	11%	9%	8%
	Percent Hybrid	.5%	18.7%	7.5%	7.5%
Percent of Fleet Included		100%	19%	23%	21%

Table 23

Laboratory Fuel Economy, Inertia Weight and 0-to-60 Time For Three Model Years

Vehicle Type	Model Year	55/45 MPG	Inertia Weight	0-to-60 Time
Cars	1975	15.8	4057	14.2
	1987	28.1	3030	13.0
	2005	28.9	3496	9.8
Trucks	1975	13.7	4072	13.6
	1987	21.6	3712	13.3
	2005	21.3	4687	10.0
Both	1975	15.3	4060	14.1
	1987	25.9	3220	13.1
	2005	24.6	4089	9.9

Another general approach for determining potential fuel economy improvement is to study the effects caused by the changes that have occurred in the distributions of vehicle acceleration times, vehicle size, and vehicle weight and fuel economy. Table 23 compares fuel economy, weight and estimated 0-to-60 time of MY2005 vehicles to that for the averages for two baseline years 1981 and 1987. The averages in this table represent just characteristics of vehicles with conventional powertrains, i.e., both hybrids and diesels have been excluded. The comparisons are made by preserving the average characteristics of vehicles by size, weight, and/ or performance strata in today's fleet but re-mixing the sales distributions to match that of the baseline year.

Table 24 shows the results of various ways to examine what the fuel economy of the fleet would be if today's fleet of cars and trucks were "like" those of an earlier year in one or more respects. In this table, for example, if the MY2005 fleet had cars and trucks with the same distribution of weight as the MY1981 did, laboratory 55/45 fuel economy would have been 31.9 mpg for cars and 30.2 mpg for trucks, compared to their actual MY2005 averages of 28.8 and 21.3 mpg, respectively. Under this scenario, the combined car and truck average fuel economy would have been 31.0 mpg compared to an actual value of 24.5 mpg under the assumption that the relative percentages of cars and truck in the fleet remained unchanged.

Mixing today's efficiency characteristics with the baseline year's size, weight, and performance distributions shows an improvement over the 2005 actual values in nearly all cases. This is evidence that today's vehicles are more efficient, vehicle for vehicle, than they were in the baseline years — especially evident when the values are compared to the actual values for the base years, shown as "Ref: 1981 Actuals" and "Ref: 1987 Actuals" in the Table, for which every re-mixed value shows an improvement.

Figures 77 through 80 provide estimates of what the mpg of the car and truck fleet would have been each model year if the distribution of weight and acceleration time were the same as in the base years. A similar comparison on the basis of vehicle size and type is presented in Figures 81 through 84. See Appendix R for additional data for each of the scenarios in Table 24.

Table 24

Effect of Performance, Size, and Weight Distributions on Laboratory 55/45 Fuel Economy

	Laboratory 55/45 Fuel Economy			Percent Change from 2005 Actual Averages		
Scenario	**Cars**	**Trucks**	**Both**	**Cars**	**Trucks**	**Both**
2005 Actual Average	28.8	21.3	24.5			
MY2005 Averages Recalculated using 1981:						
Weight Distribution	31.9	30.2	31.0	10.8%	41.8%	26.6%
Size Distribution	28.4	21.2	24.3	-1.4%	-0.5%	-0.9%
0 to 60 Distribution	29.8	20.9	24.6	3.5%	-1.9%	0.3%
Weight and 0 to 60	36.4	28.5	32.0	26.4%	33.8%	30.5%
Size and 0 to 60	37.1	25.0	29.9	28.8%	17.4%	22.0%
Ref. 1981 Actual Av.	25.1	20.1	24.6	-12.8%	-5.6%	0.4%
MY2005 Averages Recalculated using 1987:						
Weight Distribution	32.8	28.3	30.4	13.9%	32.9%	24.0%
Size Distribution	29.2	22.9	25.7	1.4%	7.5%	4.8%
0 to 60 Distribution	31.3	22.1	25.9	8.7%	3.8%	5.8%
Weight and 0 to 60	34.2	27.3	30.4	18.8%	28.2%	24.0%
Size and 0 to 60	34.7	24.2	28.5	20.5%	13.6%	16.5%
Ref. 1987 Actual Avg.	28.1	21.6	24.6	-2.4%	1.4%	0.4%

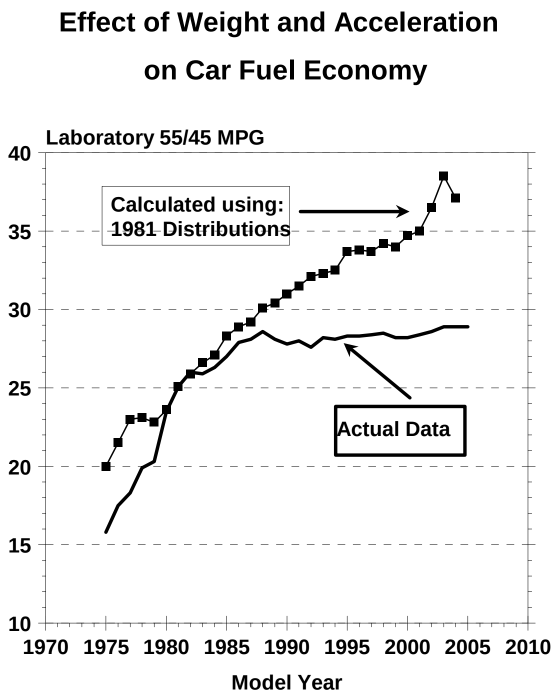

Figure 77

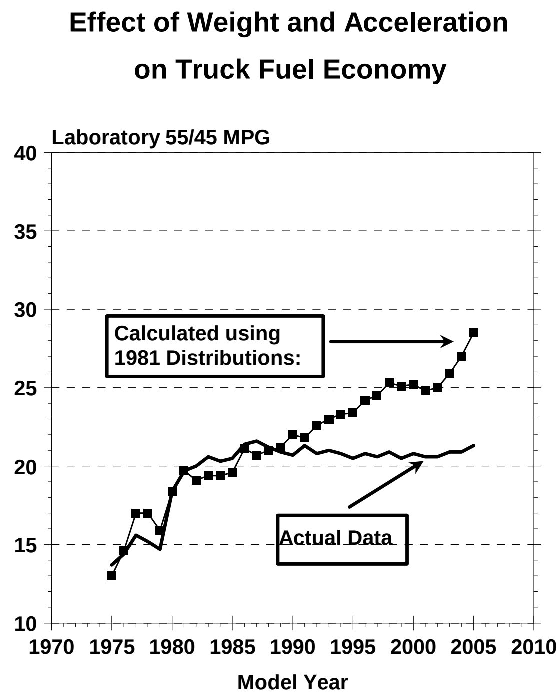

Figure 78

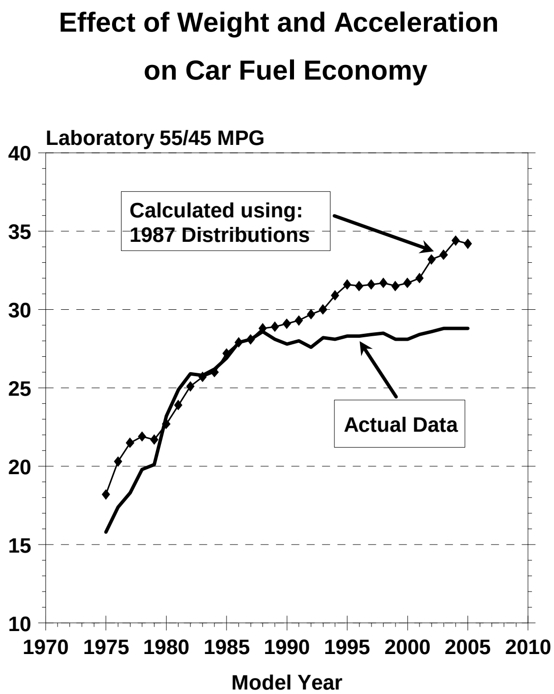

Figure 79

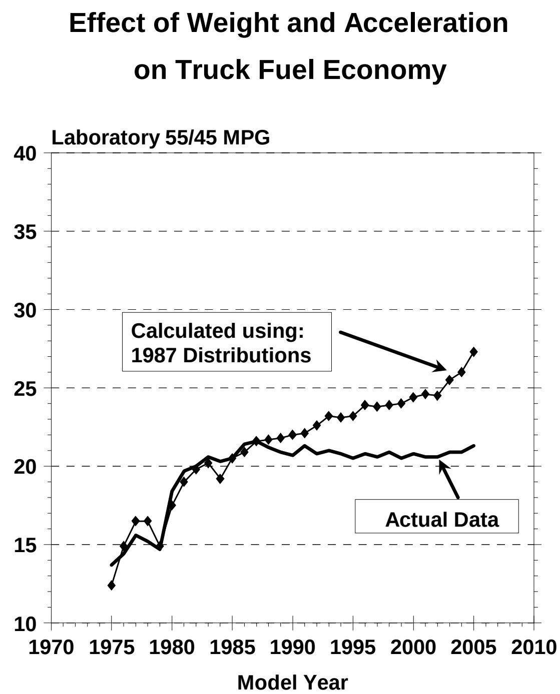

Figure 80

Effect of Vehicle Size, Type & Acceleration on Car Fuel Economy

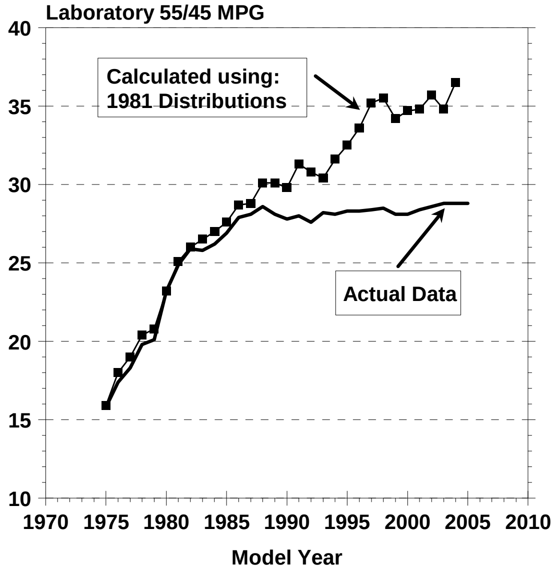

Figure 81

Effect of Vehicle Size, Type & Acceleration on Truck Fuel Economy

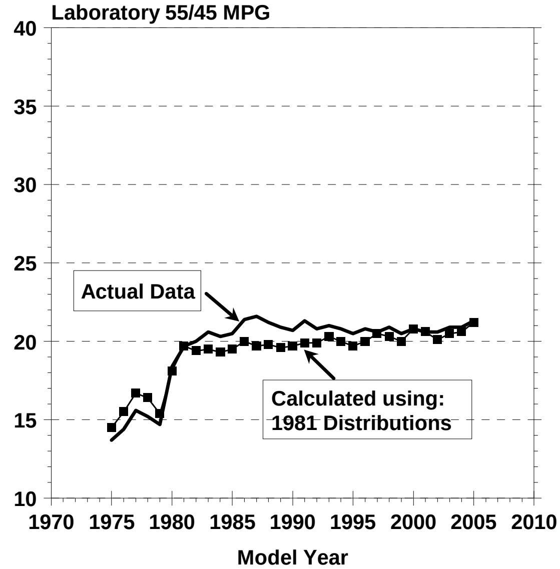

Figure 82

Effect of Vehicle Size, Type & Acceleration on Car Fuel Economy

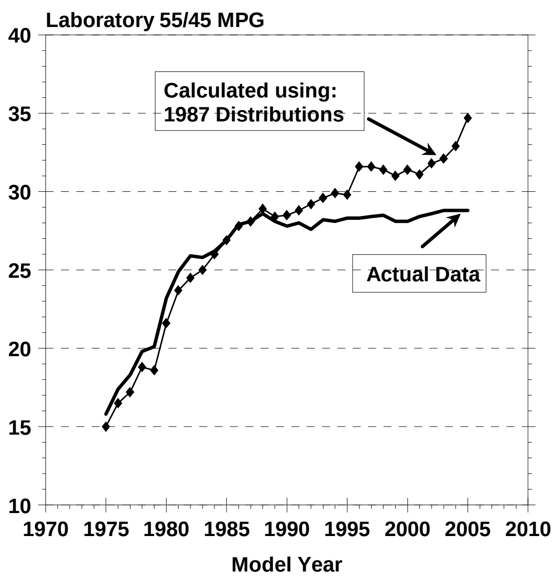

Figure 83

Effect of Vehicle Size, Type & Acceleration on Truck Fuel Economy

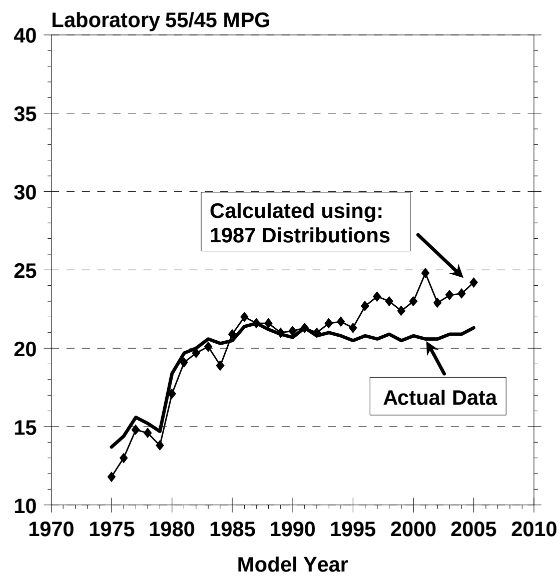

Figure 84

A summary of the different approaches is presented in Table 25. Considering the seven different ways in which fuel economy improvements for the fleet can be estimated, based on the characteristics of the existing fleet, and assuming the relative sales fractions for cars and trucks remains unchanged, the range of improvements for the fleet is from 15 to 30 percent. The average is 21 percent. Different methods and different base years could, of course, yield different results, and as discussed earlier, the hypothetical fleets that have higher fuel economy tend to be different from today's fleet because while they have higher fuel economy, they also are slower and lighter.

Table 25

Comparison of Hypothetical MY2005 Light-Duty Fleets

		Laboratory 55/45 Fuel Economy		
	Scenario	**Cars**	**Trucks**	**Both**
(1)	Actual MY2005 Averages	28.8	21.3	24.5
(2)	1981 Weight and 0 to 60 Time	36.4	28.5	32.0
(3)	1981 Size and 0 to 60 Time	37.1	25.0	29.9
(4)	1987 Weight and 0 to 60 Time	34.2	27.3	30.4
(5)	1987 Size and 0 to 60 Time	34.7	24.2	28.5
(6)	Best 4 Nameplates in Size Class	36.3	24.9	29.5
(7)	Best 12 Vehicles in Size Class	35.4	25.7	29.8
(8)	Best 12 Vehicles in Wt. Class	35.0	23.6	28.2
	Percent Improvement over Actual MY2005 Averages			
(2)	1981 Weight and 0 to 60 Time	26.4%	33.8%	30.5%
(3)	1981 Size and 0 to 60 Time	28.8%	17.4%	22.0%
(4)	1987 Weight and 0 to 60 Time	18.8%	28.2%	24.0%
(5)	1987 Size and 0 to 60 Time	20.5%	13.6%	16.5%
(6)	Best 4 Nameplates in Size Class	26.0%	16.9%	20.4%
(7)	Best 12 Vehicles in Size Class	22.9%	20.7%	21.6%
(8)	Best 12 Vehicles in Wt. Class	21.5%	10.8%	15.1%
	Average (all seven scenarios)	23.6%	20.2%	21.4%

Note: Only Scenarios 6, 7, and 8 include hybrid and diesels.

VIII. **Conclusions**

1. Trends in light-duty vehicle fuel economy have exhibited four stages over the past 30 years:

    A. a rapid increase from 1975 continuing into the mid-1980s,

    B. a slow increase extending into the late 1980s,

    C. a gradual decline from then until the mid 1990s, and

    D. a period of relatively constant fuel economy since then.

2. Model year 2005 cars are estimated to average 24.7 miles per gallon (mpg) the same value as that achieved the previous two years.

3. Model year 2005 trucks are estimated to average 18.2 mpg, 0.3 higher than last year's trucks and the highest since 1987.

4. The combined average for MY2005 cars and trucks is estimated to be 21.0 mpg, 0.2 mpg higher than last year and the highest since 1996, but 1.2 mpg (5.4%) below the peak value achieved in 1987 and 1988. This year's average fuel economy is nearly 60 percent more than the average achieved in 1975.

5. Light truck market share has generally been increasing since 1981. For model year 2005, light trucks are projected to account for almost 50 percent of all light-duty vehicles. Most of this growth in the light truck market has been led by the increase in the popularity of sport utility vehicles (SUVs), which now account for more than one fourth of all new light-duty vehicles.

6. Compared to 1987, this year's fleet is 21 percent heavier, 24 percent faster, and 80 percent more powerful.

7. Hybrid vehicles and diesels engines are both technologies important for improving fuel economy, but total sales for vehicles equipped with these technologies are not yet significant, i.e., neither type of technology is used in a significant portion of the model year 2005 light-duty vehicle fleet.

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