Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2007

United States
Environmental Protection
Agency

Light-Duty Automotive Technology and Fuel Economy Trends: 1995 through 2007

Compliance and Innovative Strategies Division
and
Transportation and Climate Division

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

NOTICE

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

EPA United States Environmental Protection Agency

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I. Executive Summary

Introduction

This report summarizes key trends in fuel economy and technology usage related to model year (MY) 1975 through 2007 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 8500 pounds gross vehicle weight ratings).

Since 1975, overall new light-duty vehicle fuel economy has moved through four phases:

1. a rapid increase from 1975 through the early 1980s,
2. a slower increase until reaching its peak in 1987,
3. a gradual decline until 2004, and
4. an increase in 2005 and 2006, with 2007 levels projected to be similar to 2006.

The projected average MY2007 light-duty vehicle fuel economy, based in large part on pre-model year sales projections from automakers, is 20.2 miles per gallon (mpg). The MY2006 value is also 20.2 mpg. There is greater confidence in the MY2006 value as the database for 2006 includes formal sales data for about 70% of the MY2006 fleet. The 20.2 mpg value for model years 2006 and 2007 represents a 0.9 mpg, or 5%, increase over the 19.3 mpg value for 2004, which was the lowest fuel economy value since 1980.

The fuel economy values in this report are either *adjusted* (ADJ) EPA "real-world" estimates provided to consumers, or unadjusted EPA *laboratory* (LAB) values. Most of the data is presented in adjusted values. Either adjusted or laboratory fuel economy may be reported as city, highway, or, most commonly, as *composite* (combined city/highway, or COMP). In 2006, EPA revised the methodology by which EPA estimates adjusted fuel economy to better reflect changes in driving habits and other factors that affect fuel economy such as higher highway speeds, more aggressive driving, and greater use of air conditioning. This is the first report in this series to reflect this new real-world fuel economy methodology, and every adjusted fuel economy value in this report for 1986 and later model years is lower than previously reported. To reflect the fact that these changes did not occur overnight, these new downward adjustments are phased in, gradually, beginning in 1986, and for 2005 and later model years the new adjusted composite (combined city/highway) values are, on average, about 6% lower than under the methodology used by EPA in previous reports in this series. See Appendix A for more details.

Because the underlying methodology for generating unadjusted laboratory fuel economy values has not changed since this series began in the mid-1970s, they provide an excellent basis for comparing long-term fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world fuel economy that are reflected in the adjusted fuel economy values. For 2005 and later model years, unadjusted laboratory composite fuel economy values are, on average, about 25% greater than adjusted composite fuel economy values.

The Department of Transportation's National Highway Traffic Safety Administration (NHTSA) has the overall responsibility for the Corporate Average Fuel Economy (CAFE) program. For 2007, the CAFE standards are 27.5 mpg for cars and 22.2 mpg for light trucks. EPA provides laboratory composite 55/45 fuel economy data, along with alternative fuel vehicle credits and test procedure adjustments, to NHTSA for CAFE enforcement. Accordingly, current NHTSA CAFE values are a minimum of 25% higher than EPA adjusted fuel economy values.

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 (i.e., carbon dioxide). Light-duty vehicles contribute about 20 percent of all U.S. carbon dioxide emissions.

Characteristics of Light Duty Vehicles for Four Model Years

	1975	1987	1997	2007
Adjusted Fuel Economy (mpg)	13.1	22.0	20.1	20.2
Weight (lbs.)	4060	3221	3727	4144
Horsepower	137	118	169	223
0 to 60 Time (sec.)	14.1	13.1	11.0	9.6
Percent Truck Sales	19%	28%	42%	49%
Percent Front-Wheel Drive	5%	58%	56%	51%
Percent Four-Wheel Drive	3%	10%	19%	28%
Percent Multi-Valve Engine	-	-	40%	70%
Percent Variable Valve Timing	-	-	-	59%
Percent Cylinder Deactivation	-	-	-	8%
Percent Turbocharger	-	-	0.5%	3%
Percent Manual Transmission	23%	29%	14%	8%
Percent Continuously Variable Trans	-	-	-	7%
Percent Hybrid	-	-	-	2.2%
Percent Diesel	0.2%	0.3%	0.1%	0.1%

Highlight #1: Fuel Economy Increases in 2005 and 2006 Reverse the Long-Term Trend of Declining Fuel Economy From 1987 Through 2004.

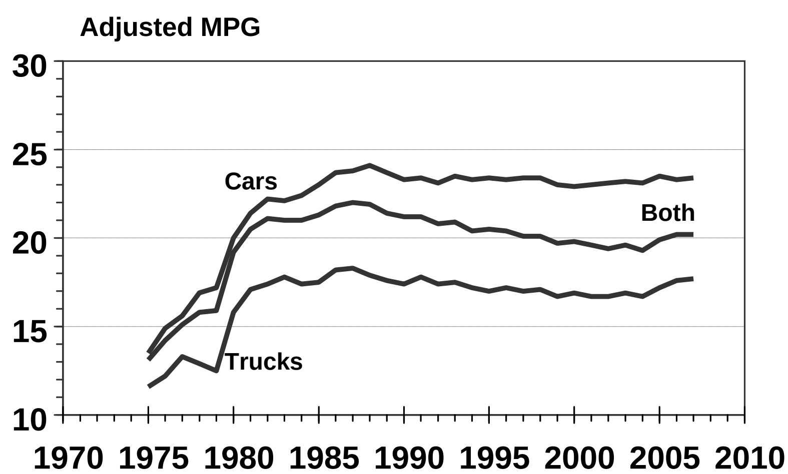
Overall fuel economy increased 0.9 mpg, or 5%, from 19.3 mpg in MY2004 to 20.2 mpg in MY2006. Fuel economy for both cars and trucks is projected to increase for MY2007. However, due to a slight increase in projected truck market share, the overall value for MY2007 is also projected to be 20.2 mpg. The increases in 2005 and 2006 are the first consecutive annual increases in fuel economy since the mid-1980s. This reverses a long trend of slowly declining fuel economy since the 1987 peak.

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 early 1980s, (2) a slow increase extending to the fuel economy peak of 22.0 mpg in 1987, (3) a gradual decline from the peak to 19.3 mpg in 2004, and (4) consecutive annual increases in 2005 and 2006, growing to 20.2 mpg in 2006, with the same value projected for 2007.

The 20.2 mpg value for model years 2006 and 2007 is 1.8 mpg below the peak of 22.0 mpg in MY1987. But, it is important to note that two-thirds of this difference is due to the new methodology for calculating adjusted fuel economy values that is gradually phased in over the 1986 to 2005 timeframe. Based on the laboratory composite 55/45 fuel economy values, which are not affected by the new methodology for calculating adjusted fuel economy values, the MY2006 and MY2007 value of 25.3 mpg is 0.6 mpg below the peak of 25.9 mpg in 1987.

MY2007 cars are projected to average 23.4 mpg and MY2007 light trucks are estimated to average 17.7 mpg, both 0.1 mpg higher than MY2006. Most of the increase in overall fuel economy since 2004 has been due to higher truck fuel economy, as truck fuel economy has increased by 1.0 mpg since 2004 while car fuel economy has increased by 0.3 mpg (prior to MY2007, the overall fleetwide fuel economy increase had also been aided by a slightly higher car market share). The recent increase in truck fuel economy is due, in part, to higher truck CAFE standards, which have risen from 20.7 mpg in 2004 to 22.2 mpg in 2007.

Adjusted Fuel Economy by Model Year
(Annual Data)

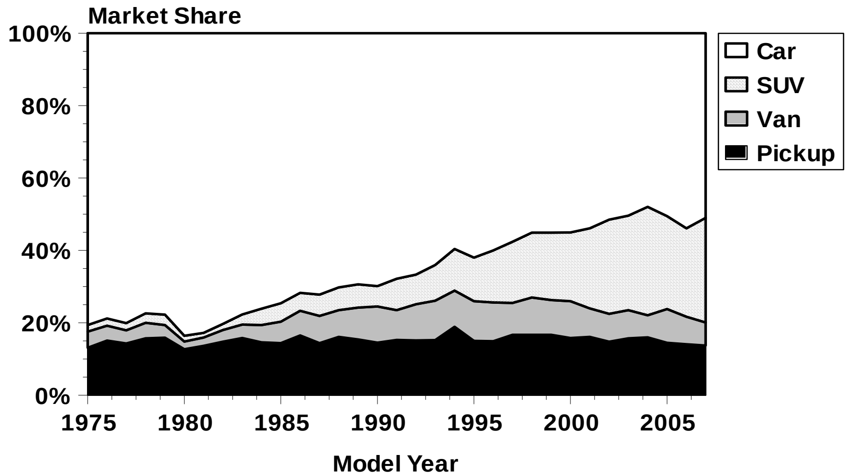


Highlight #2: Trucks Continue To Represent About Half of New Vehicle Sales.

Sales of light trucks, which include sport utility vehicles (SUVs), vans, and pickup trucks, have accounted for about 50 percent of the U.S. light-duty vehicle market since MY2002. After two decades of constant growth, light truck market share has been relatively stable for the last six years.

Historically, growth in the light truck market was primarily driven by the explosive increase in the market share of SUVs. The SUV market share increased from less than 10 percent of the overall new light-duty vehicle market in MY1990 to about 30 percent of vehicles built each year since 2003. By comparison, market shares for both vans and pickup trucks have declined slightly since 1990. The increased overall market share of light trucks, which in recent years have averaged 5-7 mpg lower than cars, accounted for much of the decline in fuel economy of the overall new light-duty vehicle fleet from MY1987 through MY2004.

Sales Fraction by Vehicle Type (Annual Data)

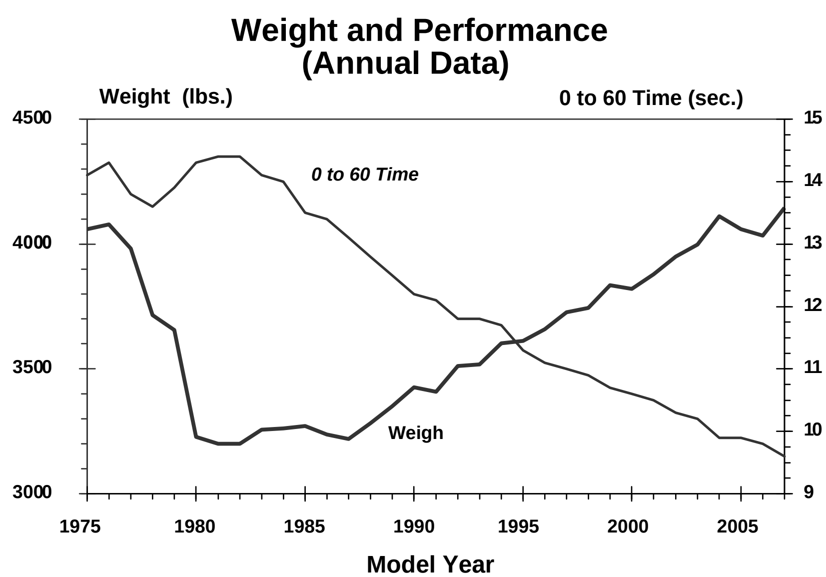


Highlight #3: Technological Innovation in 2005 and 2006 Was Utilized for Higher Fuel Economy, Reversing the Long-Term Trend of Increasing Vehicle Attributes Such as Weight and Performance.

Automotive engineers are constantly developing more advanced and efficient vehicle technologies. From 1987 through 2004, on a fleetwide basis, this technology innovation was utilized to support market-driven attributes other than fuel economy, such as vehicle weight (which supports vehicle content and features), performance, and utility. This long-term trend was reversed in model years 2005 and 2006, as technology was used to increase fuel economy by 0.9 mpg. The current projection for MY2007 is an increase in market-driven attributes with no change in fuel economy, but this is subject to change when EPA obtains formal 2007 sales data.

Vehicle weight and performance are two of the most important engineering parameters that determine a vehicle's fuel economy. All other factors being equal, higher vehicle weight (which supports new options and features) and faster acceleration performance (e.g., lower 0-to-60 mile-per-hour acceleration time), both decrease a vehicle's fuel economy. Average vehicle weight and performance had increased steadily from the mid-1980s through 2004.

Average light-duty vehicle weight dropped in both model years 2005 and 2006, with a slight increase in weight of cars more than offset by a larger decrease in truck weight and a decrease in truck market share. Average weight is projected to grow again in MY2007 to the highest level ever. Average fleetwide performance was essentially unchanged in both 2005 and 2006, but is also projected to increase to record levels in MY2007. The validity of these projections will be confirmed when EPA obtains formal vehicle sales data after the end of MY2007.



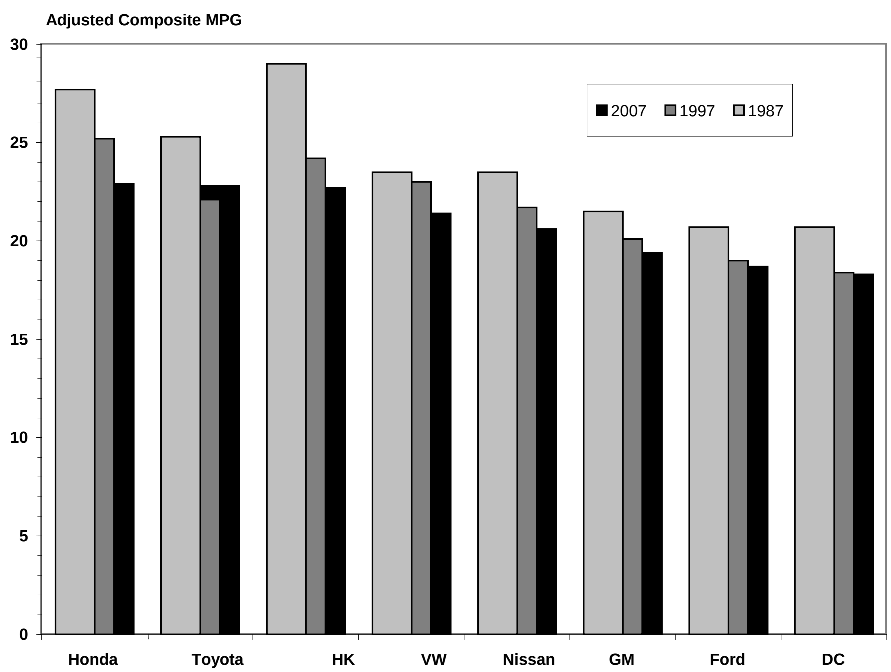
Highlight #4: Differences Between Marketing Group Fuel Economies are Narrowing.

In 1987, when industry-wide fuel economy peaked, some major marketing groups had average fuel economies 6 to 8 mpg higher than other top marketing groups. For MY2007, the maximum difference between major marketing groups is estimated to be 4.6 mpg, with a typical difference between higher and lower fuel economy marketing groups being 3 to 4 mpg.

For MY2007, the eight highest-selling marketing groups (that account for over 95 percent of all sales) fall into three fuel economy groupings: Honda, Toyota, and Hyundai-Kia (HK) have estimated fuel economies of 22.7 to 22.9 mpg; Volkswagen and Nissan have projected fuel economies of 20.6 to 21.4 mpg; and General Motors, Ford, and DaimlerChrysler have estimated fuel economies of 18.3 to 19.4 mpg. Note that these adjusted fuel economy values for marketing groups can not be directly compared to those in last year's report, since this year's report uses the new methodology where adjusted fuel economy values since 2005 are, on average, about 6% lower than in previous reports.

Each of these marketing groups has lower average fuel economy today than in 1987. Since then, the differences between marketing group fuel economies have narrowed considerably, with some of the higher mpg marketing groups in 1987 showing larger fuel economy decreases since 1987. Only one marketing group, Toyota, shows a slight increase in average fuel economy since 1997. For MY2007, Volkswagen is the only one of the eight highest-selling marketing groups to have a truck market share of less than 40 percent.

Marketing Group Fuel Economy for Three Model Years



Important Notes With Respect to the Data Used in This Report

Most of the fuel economy values in this report are a single *adjusted* composite (combined city/highway) fuel economy value, based on the real-world estimates for city and highway fuel economy provided to consumers on new vehicle labels, in the EPA/DOE *Fuel Economy Guide*, and in EPA's *Green Vehicle Guide*.

It is important to note that EPA revised the methodology for estimating real-world fuel economy values in December 2006. This is the first report in this series to reflect this new real-world fuel economy methodology, and every adjusted (ADJ) fuel economy value in this report for 1986 and later model years is lower than given in previous reports in this series. Accordingly, adjusted fuel economy values for 1986 and later model years should not be compared with the corresponding values from previous reports. These new downward adjustments are phased in, linearly, beginning in 1986, and for 2005 and later model years the new adjusted composite (combined city/highway) values are, on average, about 6% lower than under the methodology previously used by EPA. See Appendix A for more in-depth discussion of this new methodology and how it affects both the adjusted fuel economy values for individual models and the historical fuel economy trends database.

In some tables and figures in this report, a single *laboratory* composite (combined city/highway) 55/45 value is also shown. Because the underlying methodology for generating and reporting laboratory fuel economy values has not changed since this series began in the mid-1970s, these laboratory fuel economy values provide an excellent basis for comparing long-term fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world fuel economy that are reflected in the adjusted fuel economy values. For 2005 and later model years, laboratory composite fuel economy values are, on average, about 25% greater than adjusted composite fuel economy values.

Formal Corporate Average Fuel Economy (CAFE) compliance data as reported by the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) does not correlate precisely with either the adjusted or laboratory fuel economy values in this report. While EPA's laboratory composite 55/45 fuel economy data forms the cornerstone of the CAFE compliance database, NHTSA must also include credits for alternative fuel vehicles and test procedure adjustments (for cars only) in the official CAFE calculations. Accordingly, NHTSA CAFE values are at least 25% higher than EPA adjusted fuel economy values for model years 2005 through 2007.

In general, car/truck classifications in this database parallel classifications made by NHTSA for CAFE purposes and EPA for vehicle emissions standards. However, this report relies on engineering judgment, and typically there are a few cases each model year where the methodology used for classifying vehicles for this report results in differences in the determination of whether a given vehicle is classified as a car or a light truck. See Appendix A for a list of these exceptions.

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 that effectively smooth the trends, and these three-year moving averages are tabulated at the midpoint. For example, the midpoint for model years 2005, 2006, and 2007 is MY2006. Figures are based on annual data unless otherwise noted.

All average fuel economy values were calculated using harmonic, rather than arithmetical, averaging, in order to maintain mathematical integrity. See Appendix A.

The EPA fuel economy database used to generate the fuel economy trends database in this report was frozen in February 2007, yielding additional data beyond that used in last year's report for model years 2004 through 2007, although additional data for MY2006 was added in April 2007.

Through MY2005, the fuel economy, vehicle characteristics, and sales data used for this report were from the formal end-of-year submissions from automakers obtained from EPA's fuel economy database that is used for CAFE compliance purposes. Accordingly, values for all model years up to 2005 can be considered final.

For MY2006, the data used in this report is based on a database where about 70% of the total sales are from formal end-of-year CAFE submissions by automakers, and about 30% are from confidential pre-model year sales projections submitted to the Agency by the automakers, with these latter projections updated based on actual 2006 sales data reported in trade publications. EPA has a high level of confidence in the data for MY2006, given that 70% of the 2006 data is based on actual CAFE reports. It is noteworthy that the 25.3 mpg laboratory fuel economy value for MY2006 in this report is 0.7 mpg higher than the projected 24.6 mpg laboratory fuel economy value for MY2006 in the 2006 report. This suggests that sustained, higher gasoline prices have led to actual 2006 sales that differ from the projected 2006 sales provided to EPA by automakers in 2005.

For MY2007, EPA has exclusively used confidential pre-model year sales projections, updated based on actual sales for the first 7 months of model year 2007 (October 2006 through April 2007). MY2007 projections are more uncertain, particularly given the changes in the automotive marketplace driven by higher fuel prices and other factors. For model years 1998 through 2005, the final laboratory fuel economy values for a given model year have varied from 0.4 mpg lower to 0.3 mpg higher compared to original estimates for the same model year that were based exclusively on projected sales.

For More Information

Light-Duty Automotive Technology and Fuel Economy Trends: 1975 through 2007 (EPA420-R-07-008) is available on the Office of Transportation and Air Quality's (OTAQ) Web site at:

http://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:

http://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:

http://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:

http://www.nhtsa.dot.gov/ and click on "Fuel Economy"

II. Introduction

Light-duty automotive technology and fuel economy trends are examined here, as in the preceding reports in this series [1-33][*], using the latest and most complete EPA data available.

When comparing data in this and previous reports, please note that revisions are made for some prior model years for which more complete and accurate sales and fuel economy data have become available. In addition, changes have been made periodically in the way EPA calculates adjusted fuel economy values which means it is not appropriate to compare adjusted fuel economy values from this report with others in this series.

The EPA fuel economy database used to generate the fuel economy trends database in this report was frozen in February 2007, yielding additional data beyond that used in last year's report for model years 2004 through 2007, though additional data for MY2006 was added in April 2007.

Through MY2005, the fuel economy, vehicle characteristics, and sales data used for this report were from the formal end-of-year submissions from automakers obtained from EPA's fuel economy database that is used for CAFE compliance purposes. For MY2006, the data used in this report is based on a database where about 70% of the total sales are from formal end-of-year CAFE submissions by automakers, and about 30% of the total sales are based on confidential pre-model year sales projections submitted to the Agency by the automakers, with these latter projections updated based on actual 2006 sales data reported in trade publications. For MY2007, EPA has exclusively used confidential pre-model year sales projections, updated based on actual sales for the first 7 months of model year 2007 (October 2006 through April 2007).

Accordingly, values for all model years up to 2005 can be considered final. EPA has a high level of confidence in the data for MY2006, given that 70% of the 2006 data is based on actual CAFE reports. MY2007 projections are more uncertain, particularly given the changes in the automotive marketplace driven by higher fuel prices and other factors. Over the last several years, the final fuel economy values for a given model year have varied from 0.4 mpg lower to 0.3 mpg higher compared to original estimates for the same model year that were based exclusively on projected sales.

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 only fuel economy values used in this series were the laboratory-based city, highway, and composite (combined city/highway) mpg values — the same ones that are used as the basis for compliance with the fuel economy

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

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.*

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" and "Adjusted MPG," and abbreviated "LAB" MPG and "ADJ" MPG.

Where only one mpg value is presented in this report, it is the "adjusted composite" fuel economy value. This value represents a combined city/highway fuel economy value, and is based on equations (see Appendix A) that allow a computation of adjusted city and highway fuel economy values based on laboratory city and highway fuel economy test values.

It is important to note that EPA revised the methodology by which EPA estimates real-world fuel economy values in December 2006. This is the first report in this series to reflect this new real-world fuel economy methodology, and every adjusted (ADJ) fuel economy value in this report for 1986 and later model years is lower than given in previous reports in this series. Accordingly, adjusted fuel economy values for 1986 and later model years should not be compared with corresponding values from previous reports. These new downward adjustments are phased in, linearly, beginning in 1986, and for 2005 and later model years the new adjusted composite values are, on average, about 6% lower than under the methodology previously used by EPA. See Appendix A for more in-depth discussion of this new methodology and how it affects both the adjusted fuel economy values for individual models and the historical fuel economy trends database.

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-2, Appendix A). Use of the three-year moving averages results in an improvement in distinguishing real trends from what might be relatively small year-to-year variations in the data.

To facilitate comparison with data in previous reports in this series, most data tables include laboratory 55/45 fuel economy values as well as the adjusted city, highway, and composite 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 values reported by the Department of Transportation (DOT) for compliance with the Corporate Average Fuel Economy (CAFE) compliance purposes are higher than the data in this report for four reasons:

(1) the CAFE data do not include the EPA real world fuel economy labeling adjustment factors for city and highway mpg,

(2) the CAFE data are increased by special procedures for calculating the fuel economy of dedicated alternative fueled vehicles (the fuel economy of all dedicated alternative fuel vehicles is calculated based on the assumption that the alternative fuel has a fuel content of .15 gallon of fuel) and dual fueled vehicles (a manufacturer's CAFE for each of its fleets can be increased up to 1.2 mpg).

(3) the CAFE data reflect adjustments made to account for changes to test procedures for cars, and

(4) there are some slight differences in the way that vehicles are classified as cars and trucks for this report compared to the way they are classified by DOT.

Accordingly, the fuel economy values in this series of reports are always lower than those reported by DOT. Table A-6, Appendix A, compares CAFE data reported by DOT with EPA-adjusted and laboratory fuel economy 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 combines 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 8500 pounds (lb). Vehicles with GVWR above 8500 lb 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 would have 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 a few 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 [34]. Other authors [35, 36, and 37] 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 authors' 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-3, 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 are combined into the “Small Car” class. 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.

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 authors’ engineering judgment and is not a replacement for definitions used in implementing automotive standards legislation.

Published data is also used for two other vehicle characteristics for which data is not currently being submitted to EPA by the automotive manufacturers: (1) engines with variable valve timing (VVT) that use either cams or electric solenoids to provide variable intake and/ or exhaust valve timing and in some cases valve lift; and (2) engines with cylinder deactivation, which involves allowing the valves of selected cylinders of the engine to remain closed under certain driving conditions.

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 through the early1980s,

2. a slow increase until reaching its peak in 1987,

3. a gradual decline until 2004, and

4. an increase in 2005 and 2006, with 2007 levels projected to be similar to 2006.

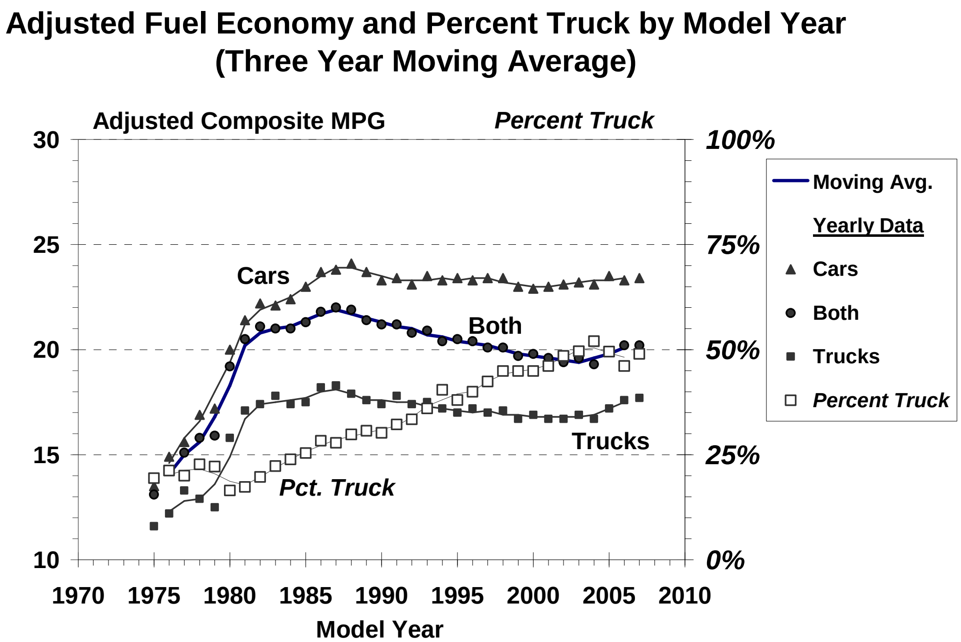

Figure 1

As shown in Table 1, the MY2006 and projected MY2007 fleetwide fuel economy value of 20.2 mpg is the highest value since 1996 and is 0.9 mpg higher than the 2004 value of 19.3 mpg, which was the lowest value since 1980. The back-to-back annual increases in 2005 and 2006 are the first such increases since the mid-1980s. These increases reverse the longer term trend of declining fuel economy since its peak in 1987. Most of the increase in overall fuel economy since 2004 is due to higher truck fuel economy, as truck fuel economy has increased by 1.0 mpg since 2004, while car fuel economy has increased by 0.3 mpg. The 20.2 mpg adjusted fuel economy value for 2006-2007 is 1.8 mpg below the peak in 1987, but much of this difference is due to the new methodology for calculating adjusted fuel economy values that is phased in over the 1986-2005 timeframe. As shown in Table 1, based on laboratory 55/45 fuel economy values, the 2006-2007 value of 25.3 mpg is 0.6 mpg lower than the peak of 25.9 mpg in 1987.

Figure 1 shows that the estimated light truck share of the market, based on the three-year moving average trend, has leveled off at about 50 percent. Figure 2 compares laboratory 55/45 fuel economy for the combined car and truck fleet and the sales fraction for trucks.

MY2007 cars are estimated to average 23.4 mpg and are near the high end of their mpg range since 1996. For MY2007, light trucks are estimated to average 17.7 mpg, their highest level since 1991. Fuel economy standards were unchanged for MY1996 through MY2004. In 2003 DOT raised the truck CAFE standards for 2005-2007, and in 2006 DOT raised the truck CAFE standards for 2008-2011.. The recent fuel economy improvement for trucks is likely due, in part, to these higher standards. The CAFE standard for cars has not been changed since 1990.

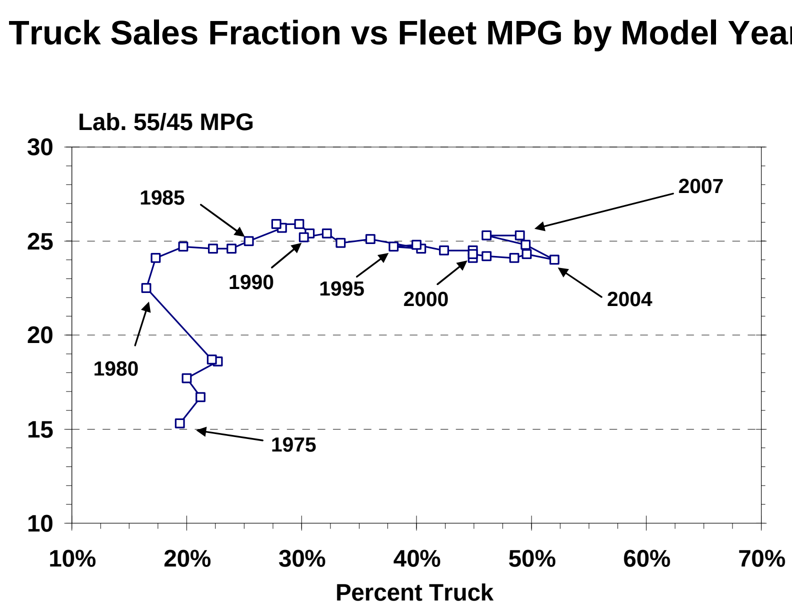

Figure 2

Table 1

Fuel Economy Characteristics of 1975 to 2007 Light Duty Vehicles

Cars

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY LAB 55/45	ADJ CITY	ADJ HWY	----> ADJ COMP	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	21.2	27.6	23.7	36.2	2598	3899
1987	10731	.722	28.1	21.2	27.7	23.8	36.2	2584	3872
1988	10736	.702	28.6	21.4	28.2	24.1	36.9	2631	3963
1989	10018	.693	28.1	20.9	27.9	23.7	36.8	2591	3977
1990	8810	.698	27.8	20.5	27.5	23.3	37.1	2528	3984
1991	8524	.678	28.0	20.5	27.6	23.4	37.0	2540	3970
1992	8108	.666	27.6	20.0	27.5	23.1	37.4	2534	4071
1993	8456	.640	28.2	20.3	27.9	23.5	37.7	2580	4098
1994	8415	.596	28.0	20.0	27.7	23.3	37.9	2554	4108
1995	9396	.620	28.3	20.0	28.1	23.4	38.3	2584	4171
1996	7890	.600	28.3	19.8	28.0	23.3	38.3	2572	4186
1997	8335	.576	28.4	19.8	28.0	23.4	38.3	2565	4168
1998	7972	.551	28.5	19.7	28.0	23.4	38.7	2565	4210
1999	8379	.551	28.2	19.4	27.5	23.0	38.7	2531	4237
2000	9128	.551	28.2	19.3	27.3	22.9	38.6	2534	4246
2001	8408	.539	28.4	19.4	27.3	23.0	39.1	2551	4280
2002	8304	.515	28.6	19.4	27.2	23.1	39.3	2561	4311
2003	7951	.504	28.9	19.5	27.5	23.2	40.0	2582	4378
2004	7538	.480	28.9	19.3	27.4	23.1	40.3	2601	4464
2005	8025	.505	29.5	19.6	27.6	23.5	41.0	2677	4590
2006	8109	.539	29.2	19.4	27.5	23.3	41.5	2660	4646
2007	7580	.510	29.4	19.5	27.6	23.4	42.6	2689	4762

Table 1 (continued)

Fuel Economy Characteristics of 1975 to 2007 Light Duty Vehicles

Trucks

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY ----> LAB 55/45	ADJ CITY	ADJ HWY	ADJ COMP	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	16.8	20.2	18.2	34.3
1987	4134	.278	21.6	16.8	20.5	18.3	34.2
1988	4559	.298	21.2	16.2	20.2	17.9	34.5
1989	4435	.307	20.9	15.9	19.8	17.6	34.7
1990	3805	.302	20.7	15.6	19.8	17.4	35.1
1991	4049	.322	21.3	15.9	20.3	17.8	35.3
1992	4064	.334	20.8	15.5	19.9	17.4	35.4
1993	4754	.360	21.0	15.5	20.1	17.5	35.7
1994	5710	.404	20.8	15.3	19.7	17.2	35.7
1995	5749	.380	20.5	15.0	19.5	17.0	35.7
1996	5254	.400	20.8	15.1	19.9	17.2	36.6
1997	6124	.424	20.6	14.8	19.5	17.0	36.9
1998	6485	.449	20.9	14.9	19.8	17.1	36.8
1999	6839	.449	20.5	14.6	19.2	16.7	37.0
2000	7447	.449	20.8	14.7	19.4	16.9	37.1
2001	7202	.461	20.6	14.6	19.1	16.7	37.4
2002	7815	.485	20.6	14.4	19.1	16.7	38.0
2003	7824	.496	20.9	14.6	19.3	16.9	38.7
2004	8173	.520	20.8	14.3	19.2	16.7	39.4
2005	7866	.495	21.4	14.6	19.8	17.2	40.2
2006	6932	.461	21.9	15.0	20.2	17.6	40.8
2007	7290	.490	22.1	15.1	20.4	17.7	42.0

Table 1 (continued)

Fuel Economy Characteristics of 1975 to 2007 Light Duty Vehicles

Cars and Trucks

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY ----> LAB 55/45	ADJ CITY	ADJ HWY	ADJ COMP	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	19.8	25.0	21.8	35.7
1987	14865	1.000	25.9	19.8	25.3	22.0	35.7
1988	15295	1.000	25.9	19.6	25.2	21.9	36.2
1989	14453	1.000	25.4	19.1	24.8	21.4	36.2
1990	12615	1.000	25.2	18.7	24.6	21.2	36.5
1991	12573	1.000	25.4	18.8	24.7	21.2	36.5
1992	12172	1.000	24.9	18.2	24.4	20.8	36.8
1993	13211	1.000	25.1	18.2	24.4	20.9	37.0
1994	14125	1.000	24.6	17.8	23.8	20.4	37.0
1995	15145	1.000	24.7	17.7	24.1	20.5	37.3
1996	13144	1.000	24.8	17.6	24.0	20.4	37.6
1997	14459	1.000	24.5	17.4	23.6	20.1	37.7
1998	14458	1.000	24.5	17.2	23.6	20.1	37.9
1999	15218	1.000	24.1	16.9	23.0	19.7	38.0
2000	16574	1.000	24.3	16.9	23.0	19.8	37.9
2001	15610	1.000	24.2	16.8	22.8	19.6	38.3
2002	16119	1.000	24.1	16.6	22.5	19.4	38.7
2003	15775	1.000	24.3	16.7	22.7	19.6	39.4
2004	15711	1.000	24.0	16.3	22.4	19.3	39.9
2005	15890	1.000	24.8	16.8	23.1	19.9	40.6
2006	15041	1.000	25.3	17.1	23.5	20.2	41.2
2007	14871	1.000	25.3	17.1	23.6	20.2	42.3

The distribution of fuel economy in any model year is of interest. In Figure 3, highlights of the distribution of car mpg are shown. Since 1975, 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 MY2000, the range once again approached 50 mpg. The increased market share of hybrid cars also accounts for the increase in the fuel economy of the best 1% of cars with the cutpoint for this strata now over 40 mpg. The ratio of the highest to lowest has increased from about three to one in 1975 to nearly five 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 4) is narrower than that for cars, 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. The fuel economy range for trucks then narrowed, but with the introduction of the hybrid Escape SUV in MY2005, it is nearly 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 C contains additional fuel economy distribution data.

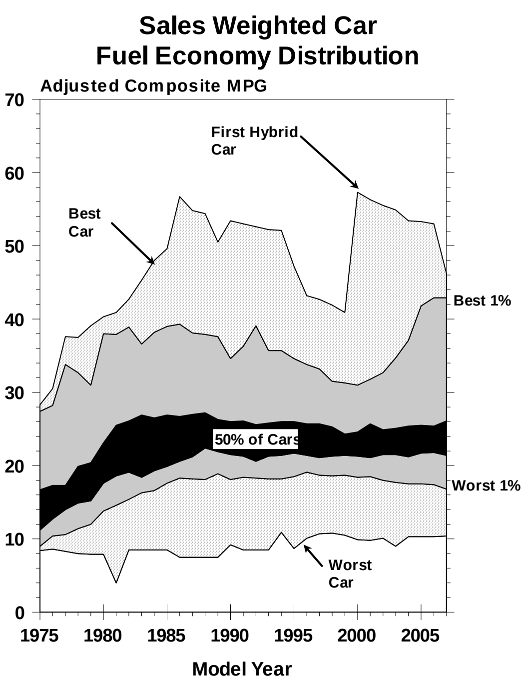

Figure 3

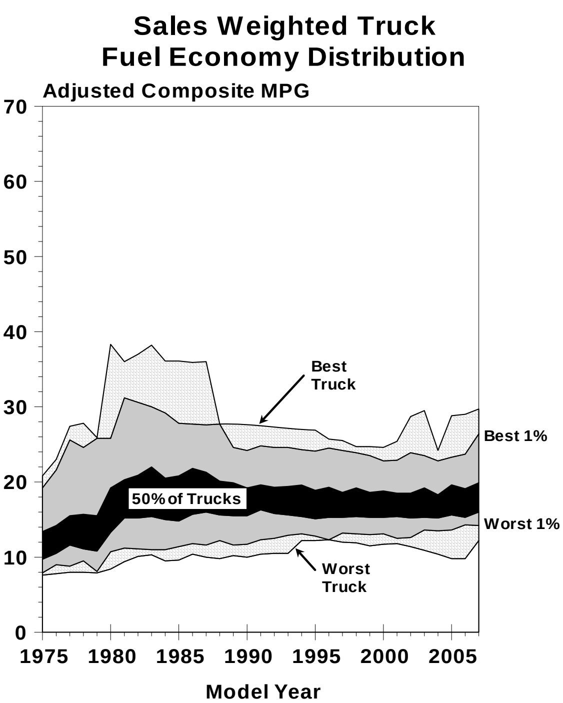

Figure 4

Table 2

Vehicle Size and Design Characteristics of 1975 to 2007

Cars

		<------ Vehicle Characteristics:					---------->		<- Percent By: ->		
MODEL YEAR	**FRAC**	**ADJ COMP MPG**	**VOL CU-FT**	**WGHT LB**	**ENG HP**	**HP/ WT**	**0-60 TIME**	**TOP SPD**	**VEHICLE SIZE SMALL**	**MID**	**LARGE**
1975	.806	13.5		4058	136	.0331	14.2	111	55.4	23.3	21.3
1976	.788	14.9		4059	134	.0324	14.4	110	55.4	25.2	19.4
1977	.800	15.6	110	3944	133	.0335	14.0	111	51.9	24.5	23.5
1978	.773	16.9	109	3588	124	.0342	13.7	111	44.7	34.4	21.0
1979	.778	17.2	109	3485	119	.0338	13.8	110	43.7	34.2	22.1
1980	.835	20.0	104	3101	100	.0322	14.3	107	54.4	34.4	11.3
1981	.827	21.4	106	3076	99	.0320	14.4	106	51.5	36.4	12.2
1982	.803	22.2	106	3054	99	.0320	14.4	106	56.5	31.0	12.5
1983	.777	22.1	109	3112	104	.0330	14.0	108	53.1	31.8	15.1
1984	.761	22.4	108	3099	106	.0339	13.8	109	57.4	29.4	13.2
1985	.746	23.0	108	3093	111	.0355	13.3	111	55.7	28.9	15.4
1986	.717	23.7	107	3041	111	.0360	13.2	111	59.5	27.9	12.6
1987	.722	23.8	107	3031	112	.0365	13.0	112	63.5	24.3	12.2
1988	.702	24.1	107	3047	116	.0375	12.8	113	64.8	22.3	12.8
1989	.693	23.7	108	3099	121	.0387	12.5	115	58.3	28.2	13.5
1990	.698	23.3	107	3176	129	.0401	12.1	117	58.6	28.7	12.8
1991	.678	23.4	107	3154	132	.0413	11.8	118	61.5	26.2	12.3
1992	.666	23.1	108	3240	141	.0428	11.5	120	56.5	27.8	15.6
1993	.640	23.5	108	3207	138	.0425	11.6	120	57.2	29.5	13.3
1994	.596	23.3	108	3250	143	.0432	11.4	121	58.5	26.1	15.4
1995	.620	23.4	109	3263	152	.0460	10.9	125	57.3	28.6	14.0
1996	.600	23.3	109	3282	154	.0464	10.8	125	54.3	32.0	13.6
1997	.576	23.4	109	3274	156	.0469	10.7	126	55.1	30.6	14.3
1998	.551	23.4	109	3306	159	.0475	10.6	127	49.4	39.1	11.4
1999	.551	23.0	109	3365	164	.0481	10.5	128	47.7	39.7	12.6
2000	.551	22.9	110	3369	168	.0492	10.4	129	47.5	34.3	18.2
2001	.539	23.0	109	3380	168	.0492	10.3	129	50.9	32.3	16.8
2002	.515	23.1	109	3391	173	.0504	10.2	131	48.6	36.3	15.1
2003	.504	23.2	109	3421	176	.0510	10.0	132	50.8	33.4	15.9
2004	.480	23.1	110	3462	182	.0521	9.8	133	47.4	35.5	17.0
2005	.505	23.5	111	3463	182	.0519	9.8	133	44.2	38.9	16.9
2006	.539	23.3	112	3527	192	.0537	9.6	136	46.0	33.7	20.3
2007	.510	23.4	111	3588	200	.0548	9.5	138	42.2	38.3	19.5

Table 2 (Continued)

Vehicle Size and Design Characteristics of 1975 to 2007

Trucks

		<-- Vehicle Characteristics:					-------->	<-- Percent By: -->		
								VEHICLE TYPE		
MODEL YEAR	**SALES FRAC**	**ADJ COMP MPG**	**WGHT LB**	**ENG HP**	**HP/ WT**	**0-60 TIME**	**TOP SPD**	**VAN**	**SUV**	**PICKUP**
1975	.194	11.6	4072	142	.0349	13.6	114	23.0	9.4	67.6
1976	.212	12.2	4155	141	.0340	13.8	113	19.2	9.3	71.4
1977	.200	13.3	4135	147	.0356	13.3	115	18.2	10.0	71.8
1978	.227	12.9	4151	146	.0351	13.4	114	19.1	11.6	69.3
1979	.222	12.5	4252	138	.0325	14.3	111	15.6	13.0	71.5
1980	.165	15.8	3869	121	.0313	14.5	108	13.0	9.9	77.1
1981	.173	17.1	3806	119	.0311	14.6	108	13.5	7.5	79.1
1982	.197	17.4	3806	120	.0317	14.5	109	16.2	8.5	75.3
1983	.223	17.8	3763	118	.0313	14.5	108	16.6	12.6	70.8
1984	.239	17.4	3782	118	.0310	14.7	108	20.2	18.7	61.1
1985	.254	17.5	3795	124	.0326	14.1	110	23.3	20.0	56.6
1986	.283	18.2	3738	123	.0330	14.0	110	24.0	17.8	58.2
1987	.278	18.3	3713	131	.0351	13.3	113	26.9	21.1	51.9
1988	.298	17.9	3841	141	.0366	12.9	115	24.8	21.2	53.9
1989	.307	17.6	3921	146	.0372	12.8	116	28.8	20.9	50.3
1990	.302	17.4	4005	151	.0377	12.6	117	33.2	18.6	48.2
1991	.322	17.8	3948	150	.0379	12.6	117	25.5	27.0	47.4
1992	.334	17.4	4056	155	.0382	12.5	118	30.0	24.7	45.3
1993	.360	17.5	4073	162	.0398	12.1	120	30.3	27.6	42.1
1994	.404	17.2	4125	166	.0403	12.0	121	24.8	28.4	46.7
1995	.380	17.0	4184	168	.0401	12.0	121	28.9	31.6	39.5
1996	.400	17.2	4225	179	.0423	11.5	124	26.8	36.0	37.2
1997	.424	17.0	4344	187	.0429	11.4	126	20.7	40.0	39.3
1998	.449	17.1	4283	187	.0435	11.2	126	23.0	39.8	37.2
1999	.449	16.7	4412	197	.0446	11.0	128	21.4	41.4	37.2
2000	.449	16.9	4375	197	.0448	11.0	128	22.7	42.2	35.1
2001	.461	16.7	4463	209	.0466	10.6	131	17.1	47.9	35.0
2002	.485	16.7	4546	219	.0482	10.4	134	15.9	53.6	30.5
2003	.496	16.9	4586	221	.0481	10.4	134	15.7	52.6	31.6
2004	.520	16.7	4710	236	.0501	10.0	137	11.7	57.7	30.7
2005	.495	17.2	4668	237	.0505	10.0	137	18.8	51.9	29.2
2006	.461	17.6	4628	234	.0504	10.0	137	16.6	52.9	30.6
2007	.490	17.7	4723	247	.0521	9.7	140	13.1	59.0	27.9

Table 2 (Continued)

Vehicle Size and Design Characteristics of 1975 to 2007

Cars and Trucks

<--- Vehicle Characteristics: -------->

MODEL YEAR	SALES FRAC	ADJ COMP MPG	WGHT LB	ENG HP	HP/ WT	0-60 TIME	TOP SPD
1975	1.000	13.1	4060	137	.0335	14.1	112
1976	1.000	14.2	4079	135	.0328	14.3	111
1977	1.000	15.1	3982	136	.0339	13.8	112
1978	1.000	15.8	3715	129	.0344	13.6	112
1979	1.000	15.9	3655	124	.0335	13.9	110
1980	1.000	19.2	3228	104	.0320	14.3	107
1981	1.000	20.5	3202	102	.0318	14.4	107
1982	1.000	21.1	3202	103	.0320	14.4	107
1983	1.000	21.0	3257	107	.0327	14.1	108
1984	1.000	21.0	3262	109	.0332	14.0	109
1985	1.000	21.3	3271	114	.0347	13.5	110
1986	1.000	21.8	3238	114	.0351	13.4	111
1987	1.000	22.0	3221	118	.0361	13.1	112
1988	1.000	21.9	3283	123	.0372	12.8	114
1989	1.000	21.4	3351	129	.0382	12.5	115
1990	1.000	21.2	3426	135	.0394	12.2	117
1991	1.000	21.2	3410	138	.0402	12.1	118
1992	1.000	20.8	3512	145	.0413	11.8	120
1993	1.000	20.9	3519	147	.0416	11.8	120
1994	1.000	20.4	3603	152	.0420	11.7	121
1995	1.000	20.5	3613	158	.0438	11.3	123
1996	1.000	20.4	3659	164	.0447	11.1	125
1997	1.000	20.1	3727	169	.0452	11.0	126
1998	1.000	20.1	3744	171	.0457	10.9	126
1999	1.000	19.7	3835	179	.0465	10.7	128
2000	1.000	19.8	3821	181	.0472	10.6	129
2001	1.000	19.6	3879	187	.0480	10.5	130
2002	1.000	19.4	3951	195	.0493	10.3	132
2003	1.000	19.6	3999	199	.0496	10.2	133
2004	1.000	19.3	4111	211	.0511	9.9	135
2005	1.000	19.9	4060	209	.0512	9.9	135
2006	1.000	20.2	4034	212	.0522	9.8	136
2007	1.000	20.2	4144	223	.0534	9.6	139

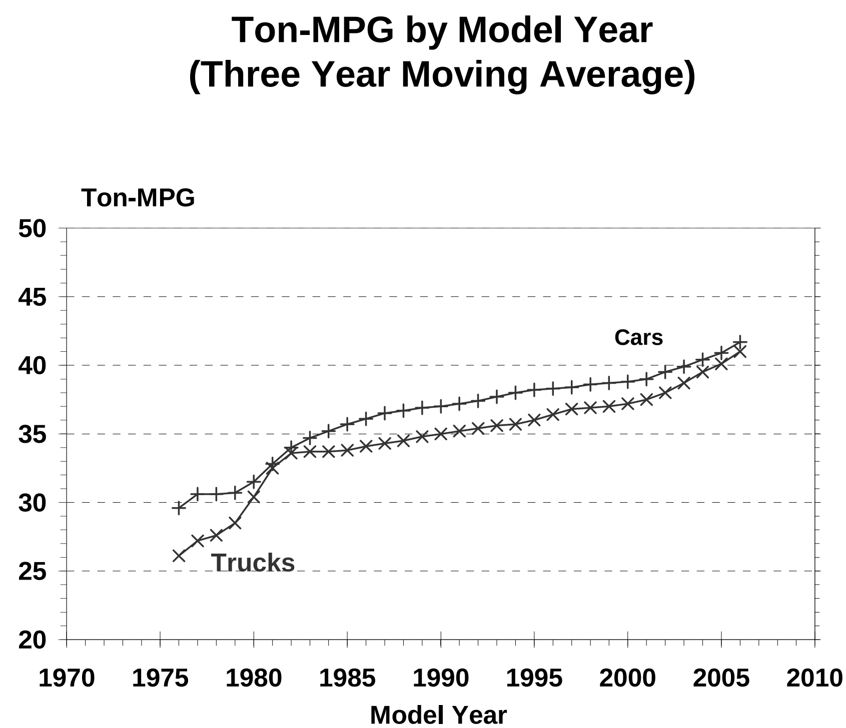

Figure 5

As shown in Table 2, the average weight of the overall fleet declined slightly in both MY2005 and MY2006, with a slight increase in car weight more than offset by a larger decrease in truck weight. Overall average horsepower and 0-60 acceleration time were basically unchanged in MY2005-2006. Average weight and performance are projected to increase in MY2007, and the projected levels would be the highest for the 1975-2007 timeframe. The projected 2007 weight has increased by over 900 pounds and the average horsepower level has more than doubled since the early 1980s.

The long term trends for both weight and performance have been steady increases. As shown in Figure 5, since 1975 Ton-MPG for both cars and trucks increased substantially; i.e. over 60% for cars and 80% for trucks. Typically, Ton-MPG for both vehicle types has increased at a rate of about one or two percent a year.

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 6 (for cars) and Figure 7 (for light trucks) which are plots of fuel economy versus performance, with model years as indicated. Both graphs show the same story: in the late 1970s and early 1980s, 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 8 and 9 are similar to Figures 6 and 7, 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 until 2005.

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

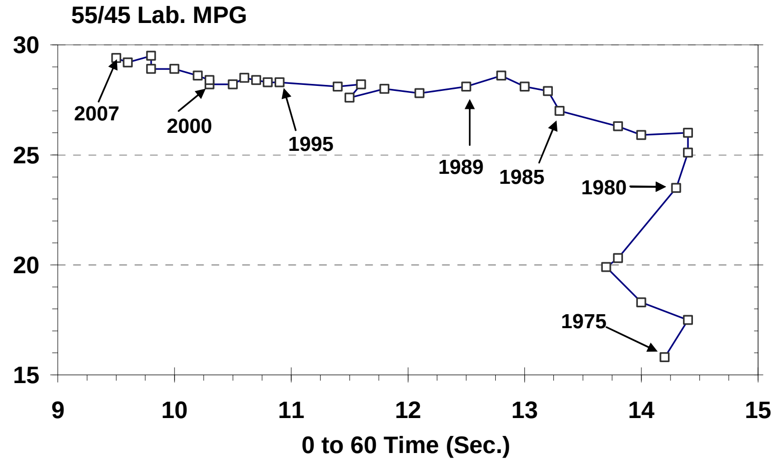

Figure 6

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

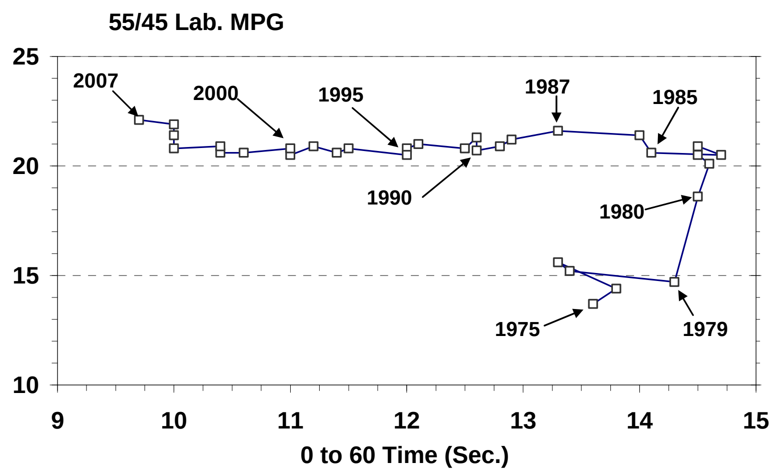

Figure 7

Car 55/45 Laboratory MPG vs Inertia Weight by Model Year

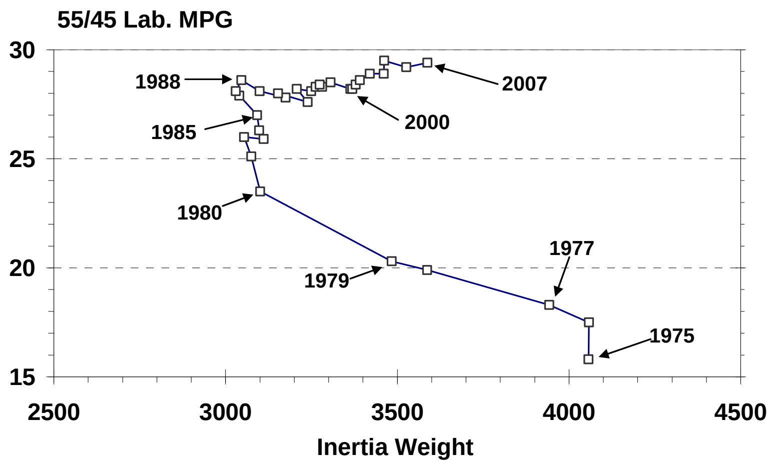

Figure 8

Truck 55/45 Laboratory MPG vs Inertia Weight by Model Year

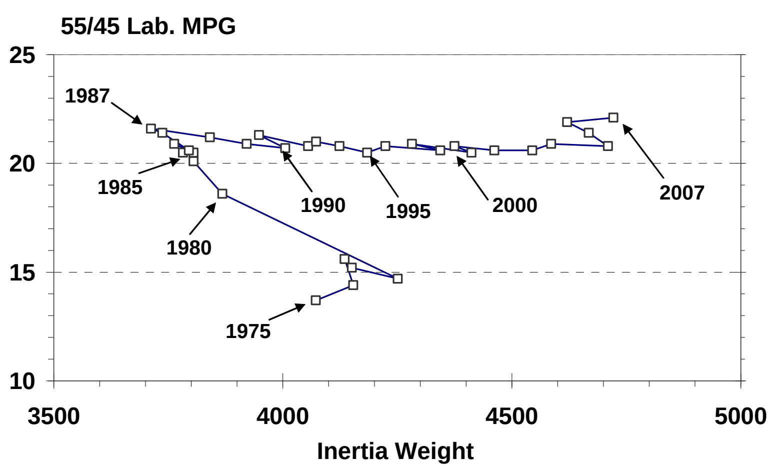

Figure 9

IV. **Trends by Vehicle Type, Size, and Weight**

Table 1 showed that for the past several years trucks have accounted for about 50 percent of the light-duty vehicles produced each year. MY2004 was the peak year for trucks with 52 percent market share, and trucks have been between 46 and 50 percent since. Considering the five classes: cars, wagons, sports utility vehicles (SUVs), vans, and pickups, since 1975 the biggest overall increase in market share has been for SUVs, up from less than two percent in 1975 to 29 percent this year (see Figure 10 and Table 3). The biggest overall decrease has been for cars, down from over 70 percent of the fleet in 1975 to about 50 percent. By comparison the sales fraction for pickup trucks has remained constant at about 15 percent of the market.

Figures 11 to 15 compare sales fractions by vehicle type and size with the fleet again stratified into five vehicle types: cars (i.e., coupes, sedans, and hatchbacks), station wagons, vans, SUVs, and pickup trucks; and three vehicle sizes: small, midsize, and large. As shown in Figure 15, large cars accounted for about 20 percent of all car sales in the late 1970s, but their share of the car market dropped in the early 1980s to about 12 percent of the market where it remained for about two decades, but has since increased. Within the car segment, the market share for small cars peaked in the late 1980s at about 65 percent and is now lower than at anytime since 1975.

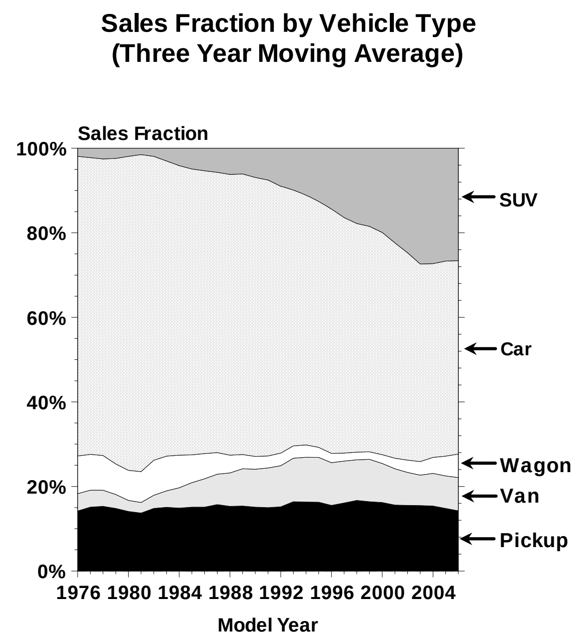

Figure 10

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 when they reemerged. They now account for about 15 percent of all wagons, but less than one percent of all light vehicles. Similarly (see Figure 13), large vehicles accounted for nearly 40 percent of all vans through the early 1980s compared to less than 10 percent the past five years. Small vans have never had a significant market share, and none have been produced in recent years. Figures 14 and 15 show that there have been an overall and significant trend towards increased market share for both large SUVs and pickups, but there has been a recent decrease in large SUV sales fraction.

Table 3 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 over 25 percent of all light vehicles built this year, compared to combined totals of about 1.3 and 4.5 percent in 1975 and 1988, 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 1988, but less than 20 percent this year. For MY2007, it is projected that the market share for midsize cars will exceed that for small cars. 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 1988, their sales fraction dropped to less than 10 percent of the total market.

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

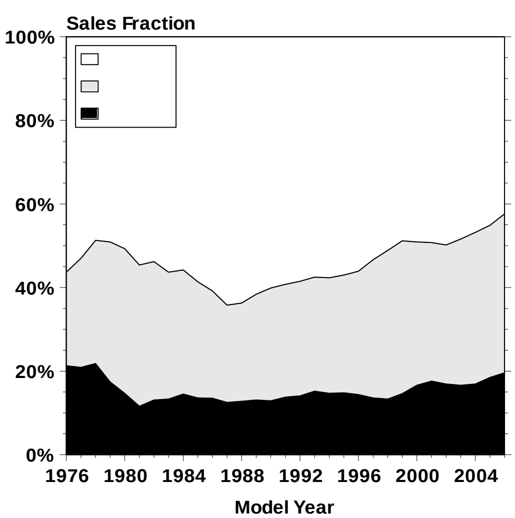

Figure 11

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

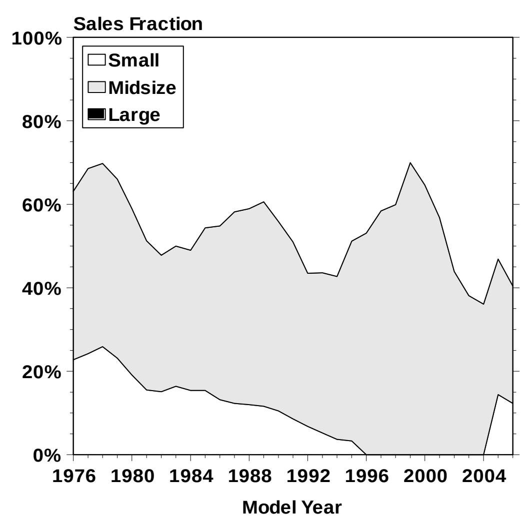

Figure 12

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

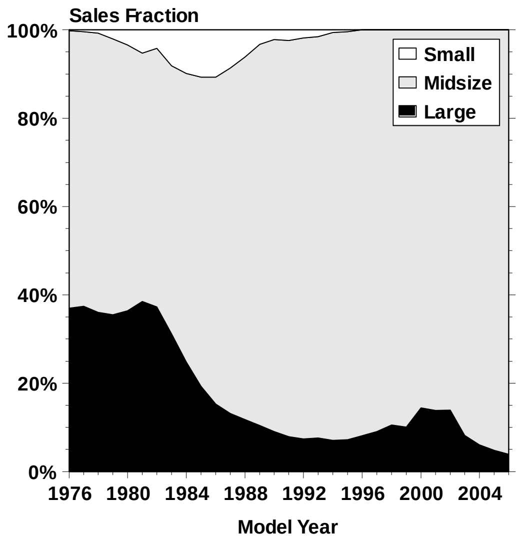

Figure 13

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

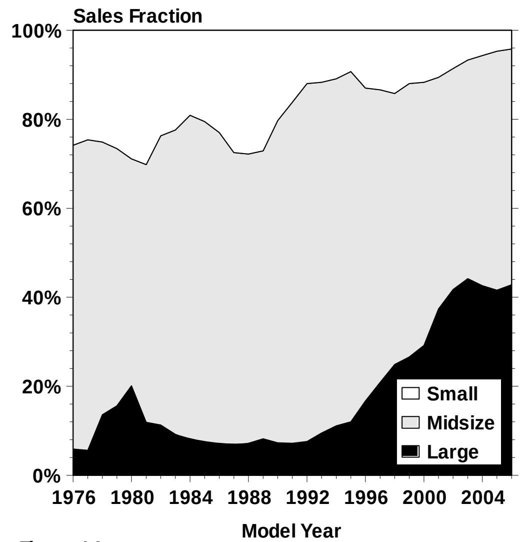

Figure 14

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

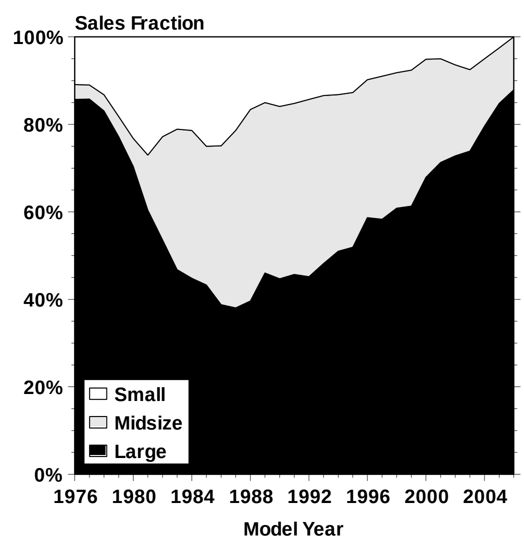

Figure 15

Table 3

Sales Fractions of MY1975, MY1988 and MY2007
Light-Duty Vehicles by Vehicle Size and Type

Vehicle Type	Size	Sales Fraction 1975	Sales Fraction 1988	Sales Fraction 2007	Differences in Sales Fraction: From 1975 To 2007	From 1975 To 1988	From 1988 To 2007
Car	Small	40.0%	43.8%	17.2%	-22.8%	3.9%	-26.6%
	Midsize	16.0%	13.8%	18.5%	2.5%	-2.1%	4.7%
	Large	15.2%	8.5%	9.3%	-5.9%	-6.7%	.8%
	All	71.1%	66.2%	45.1%	-26.1%	-5.0%	-21.1%
Wagon	Small	4.7%	1.7%	4.3%	-0.4%	-3.0%	2.6%
	Midsize	2.8%	1.9%	1.0%	-1.8%	-1.0%	-0.8%
	Large	1.9%	.5%	.6%	-1.3%	-1.4%	.1%
	All	9.4%	4.0%	5.9%	-3.5%	-5.4%	1.9%
Van	Small	.0%	.4%	.0%	.0%	.3%	-0.4%
	Midsize	3.0%	6.2%	6.2%	3.3%	3.2%	.1%
	Large	1.5%	.9%	.2%	-1.3%	-0.6%	-0.7%
	All	4.5%	7.4%	6.4%	2.0%	2.9%	-1.0%
SUV	Small	.5%	1.9%	1.2%	.7%	1.4%	-0.7%
	Midsize	1.2%	4.0%	14.8%	13.6%	2.8%	10.8%
	Large	.1%	.5%	13.0%	12.9%	.3%	12.5%
	All	1.8%	6.3%	28.9%	27.1%	4.5%	22.6%
Pickup	Small	1.6%	2.2%	.0%	-1.6%	.7%	-2.2%
	Midsize	.5%	6.9%	1.9%	1.3%	6.3%	-5.0%
	Large	11.0%	7.0%	11.8%	.8%	-4.1%	4.8%
	All	13.1%	16.1%	13.7%	.5%	2.9%	-2.4%
All	Trucks	19.4%	29.8%	49.0%	29.6%	10.4%	19.2%

Figures 16 through 20 show trends in performance, weight, and adjusted fuel economy for cars, wagons, vans, SUVs, and pickups. For all five vehicle types, there has been a clear long term trend towards increased weight, moderating since 2005 for wagons, vans, and SUVs.

Table 4 shows the lowest, average, and highest adjusted mpg performance by vehicle class and size for three selected years. For both 1988 and 2007, the mpg performance is such that the midsize vehicles in all classes have better fuel economy than the corresponding entry for small vehicles in 1975. In Table 5, the percentage changes obtainable from the entries in Table 4 are presented. Average mpg for four classes (midsize cars, large cars, midsize wagons and midsize SUVs) have improved over 80 percent since 1975. The average fuel economy improvements between 1975 and 2007 for the truck classes range from 5 percent for midsize pickups to 91 percent for midsize SUVs. Since 1988, average fuel economy has decreased for small cars, all wagons, small SUVs, and midsize pickups and the largest improvements in average mpg has been 18 and 20 percent for midsize and large SUVs, respectively.

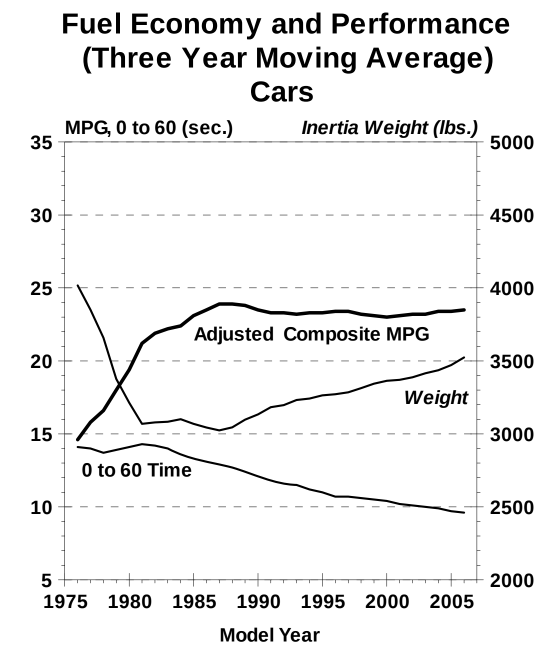

Figure 16

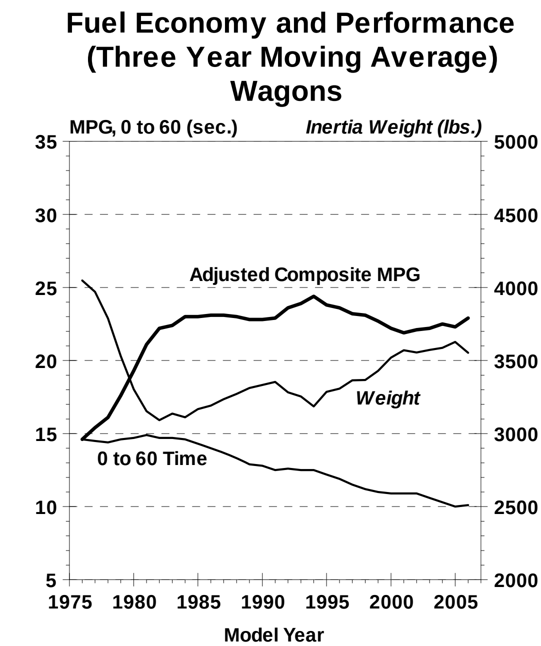

Figure 17

Fuel Economy and Performance (Three Year Moving Average) Vans

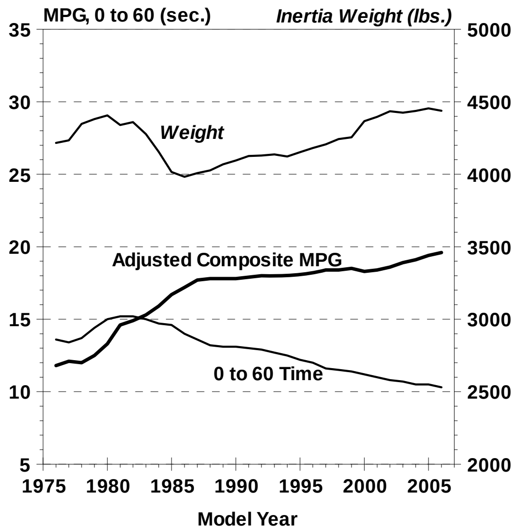

Figure 18

Fuel Economy and Performance (Three Year Moving Average) SUVs

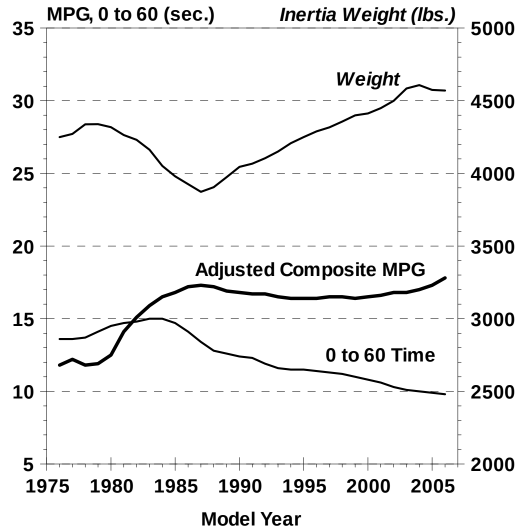

Figure 19

Fuel Economy and Performance (Three Year Moving Average) Pickups

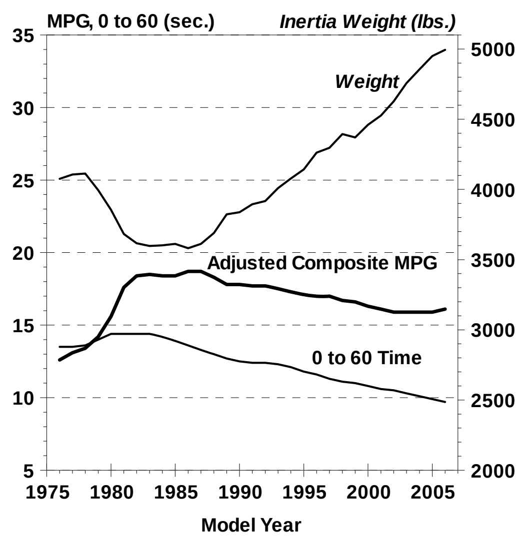

Figure 20

Table 4

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

Vehicle		**1975**			**1988**			**2007**		
Type	**Size**	**Low**	**Avg.**	**High**	**Low**	**Avg.**	**High**	**Low**	**Avg.**	**High**
Car	Small	8.6	15.6	28.3	7.5	25.7	54.4	10.4	24.0	42.9
	Midsize	8.6	11.6	18.4	10.5	22.6	27.7	12.0	24.5	46.2
	Large	8.4	11.2	14.6	10.0	20.6	26.0	11.8	20.5	26.0
	All	8.4	13.4	28.3	7.5	24.2	54.4	10.4	23.4	46.2
Wagon	Small	11.8	19.1	24.1	17.1	26.3	33.2	16.2	25.9	31.3
	Midsize	8.4	11.3	25.0	17.5	22.2	27.7	15.0	21.4	28.3
	Large	8.4	10.2	12.8	19.2	19.4	19.4	12.7	18.1	22.4
	All	8.4	13.8	25.0	17.1	23.3	33.2	12.7	24.0	31.3
Van	Small	16.2	17.5	18.5	15.5	20.6	25.0			
	Midsize	8.2	11.3	18.4	11.3	18.4	23.4	17.9	19.9	23.0
	Large	8.9	10.7	14.5	9.9	14.3	16.8	14.4	15.8	17.0
	All	8.2	11.1	18.5	9.9	17.9	25.0	14.4	19.8	23.0
SUV	Small	10.2	13.7	16.3	15.6	20.4	27.7	16.1	17.9	22.8
	Midsize	8.2	10.2	18.4	10.2	16.5	23.6	12.7	19.5	29.7
	Large	7.9	10.3	13.7	12.2	14.0	18.8	12.2	16.8	21.7
	All	7.9	11.0	18.4	10.2	17.2	27.7	12.2	18.1	29.7
Pickup	Small	13.0	19.2	20.8	13.3	21.0	24.6			
	Midsize	17.8	17.9	18.0	15.3	21.3	25.9	15.4	18.8	23.7
	Large	7.6	11.1	18.5	9.8	15.2	21.0	12.2	15.8	21.2
	All	7.6	11.9	20.8	9.8	18.1	25.9	12.2	16.2	23.7
All	Cars	8.4	13.5	28.3	7.5	24.1	54.4	10.4	23.4	46.2
All	Trucks	7.6	11.6	20.8	9.8	17.9	27.7	12.2	17.7	29.7
All	Vehicles	7.6	13.1	28.3	7.5	21.9	54.4	10.4	20.2	46.2

Table 5

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

Vehicle Type	**Size**	**From 1975 to 2007 Low**	**Avg**	**High**	**From 1975 to 1988 Low**	**Avg.**	**High**	**From 1988 to 2007 Low**	**Avg.**	**High**
Car	Small	21%	54%	52%	-12%	65%	92%	39%	-6%	-20%
	Midsize	40%	111%	151%	22%	95%	51%	14%	8%	67%
	Large	40%	83%	78%	19%	84%	78%	18%	0%	0%
	All	24%	75%	63%	-10%	81%	92%	39%	-2%	-14%
Wagon	Small	37%	36%	30%	45%	38%	38%	-4%	-1%	-5%
	Midsize	79%	89%	13%	108%	96%	11%	-13%	-3%	2%
	Large	51%	77%	75%	129%	90%	52%	-33%	-6%	15%
	All	51%	74%	25%	104%	69%	33%	-25%	3%	-5%
Van	Small				-3%	18%	35%			
	Midsize	118%	76%	25%	38%	63%	27%	58%	8%	-1%
	Large	62%	48%	17%	11%	34%	16%	45%	10%	1%
	All	76%	78%	24%	21%	61%	35%	45%	11%	-7%
SUV	Small	58%	31%	40%	53%	49%	70%	3%	-11%	-17%
	Midsize	55%	91%	61%	24%	62%	28%	25%	18%	26%
	Large	54%	63%	58%	54%	36%	37%	0%	20%	15%
	All	54%	65%	61%	29%	56%	51%	20%	5%	7%
Pickup	Small				2%	9%	18%			
	Midsize	-12%	5%	32%	-13%	19%	44%	1%	-11%	-7%
	Large	61%	42%	15%	29%	37%	14%	24%	4%	1%
	All	61%	36%	14%	29%	52%	25%	24%	-9%	-7%
All	Cars	24%	73%	63%	-10%	79%	92%	39%	-2%	-14%
All	Trucks	61%	53%	43%	29%	54%	33%	24%	0%	7%
All	Vehicles	37%	54%	63%	0%	67%	92%	39%	-7%	-14%

Cars and light trucks with conventional drivetrains have a fuel consumption and weight relationship which is well known and is shown on Figures 21 and 22. Fuel consumption increases linearly 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 data for hybrid and diesel vehicles are plotted separately and excluded from the regression lines shown on the graphs. At constant weight, MY2007 cars 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 50 percent better. Similarly, at constant weight this year's conventionally powered trucks achieve about 40 percent better fuel consumption than MY1975 vehicles did.

Figures 23 and 24 show that the relationship between interior volume and fuel consumption is currently not as important as it used to be. The data points on both of these graphs exclude two seaters and represent sales weighted average fuel consumption calculated at increments of 1.0 cu. ft. As was done for Figures 21 and 22, the data points for hybrid and diesel vehicles were plotted separately from that for the conventionally powered vehicles.

Figures 25 and 26 show the improvement that occurred between 1975 and 2007 for fuel consumption as a function of 0-to-60 time for cars and trucks. Figures 27 and 28 compare Ton-MPG data versus 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.

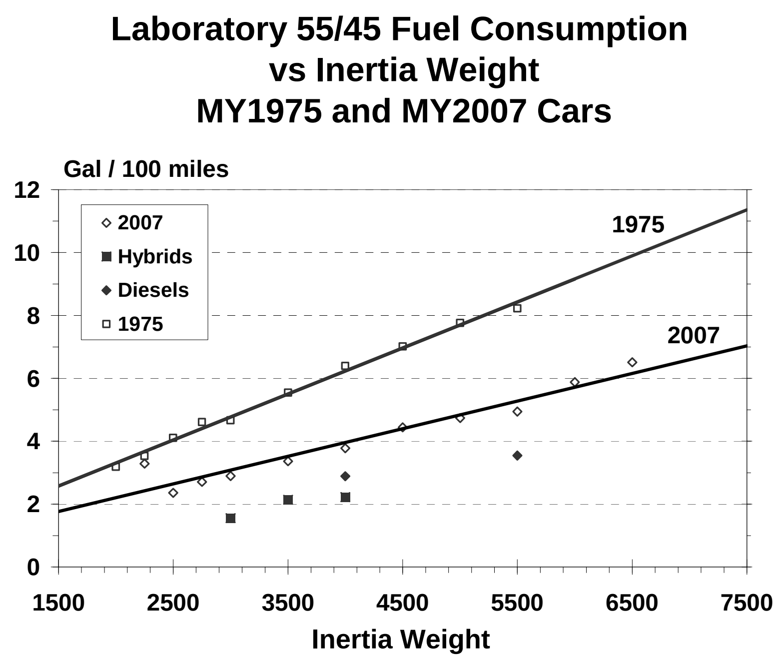

Figure 21

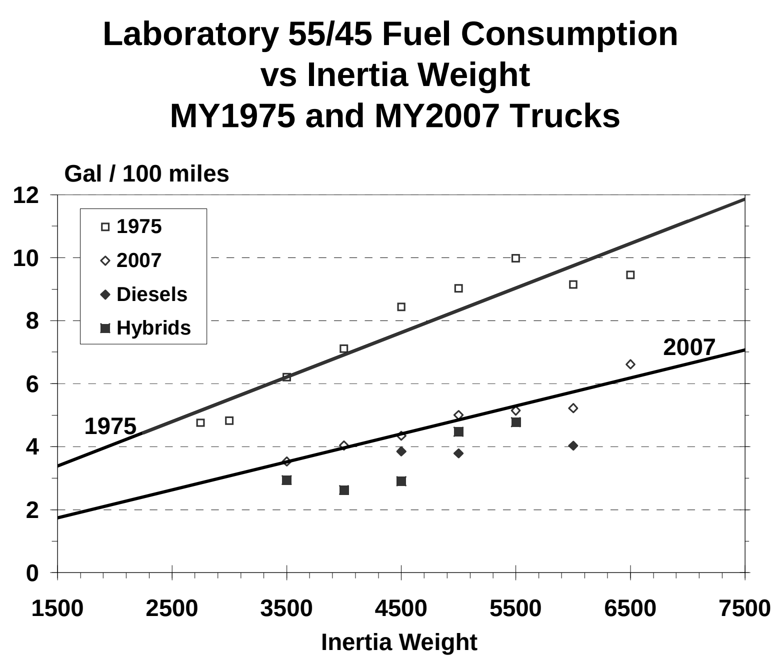

Figure 22

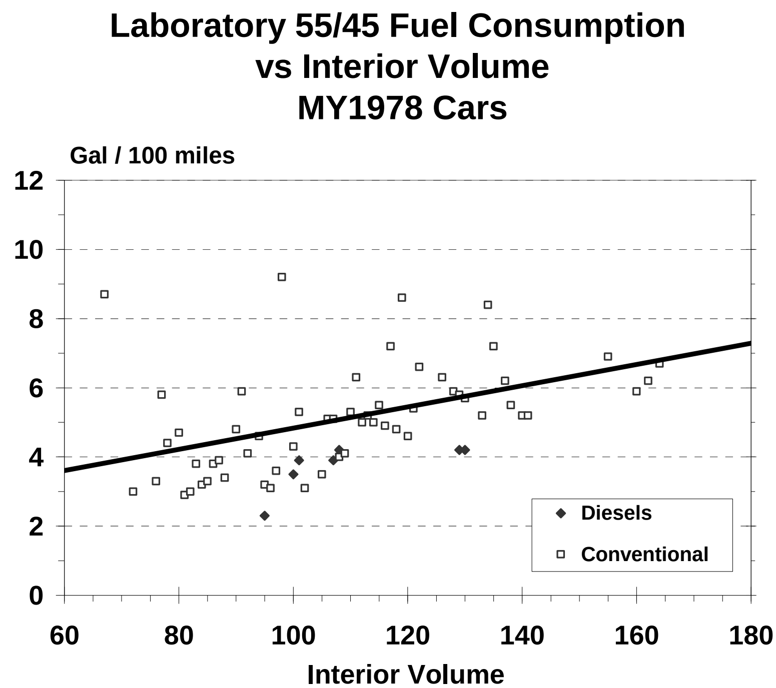

Figure 23

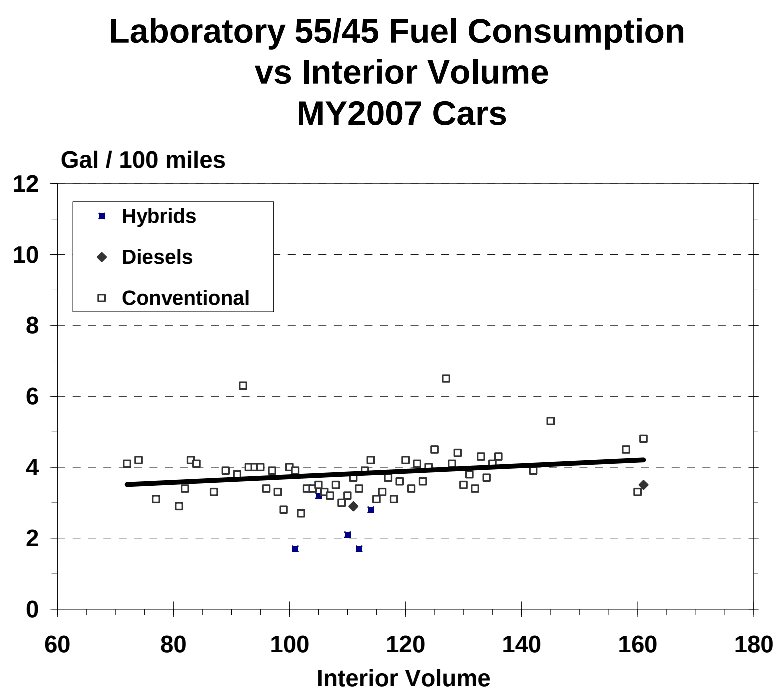

Figure 24

Table 6

Adjusted Fuel Consumption (Gal./100 miles) by Vehicle Type and Size

Vehicle Type	Size	1975 Low	1975 Avg.	1975 High	1988 Low	1988 Avg.	1988 High	2007 Low	2007 Avg.	2007 High
Car	Small	11.6	6.4	3.5	13.3	3.9	1.8	9.6	4.2	2.3
	Midsize	11.6	8.6	5.4	9.5	4.4	3.6	8.3	4.1	2.2
	Large	11.9	8.9	6.8	10.0	4.9	3.8	8.5	4.9	3.8
	All	11.9	7.5	3.5	13.3	4.1	1.8	9.6	4.3	2.2
Wagon	Small	8.5	5.2	4.1	5.8	3.8	3.0	6.2	3.9	3.2
	Midsize	11.9	8.8	4.0	5.7	4.5	3.6	6.7	4.7	3.5
	Large	11.9	9.8	7.8	5.2	5.2	5.2	7.9	5.5	4.5
	All	11.9	7.2	4.0	5.8	4.3	3.0	7.9	4.2	3.2
Van	Small	6.2	5.7	5.4	6.5	4.9	4.0			
	Midsize	12.2	8.8	5.4	8.8	5.4	4.3	5.6	5.0	4.3
	Large	11.2	9.3	6.9	10.1	7.0	6.0	6.9	6.3	5.9
	All	12.2	9.0	5.4	10.1	5.6	4.0	6.9	5.1	4.3
SUV	Small	9.8	7.3	6.1	6.4	4.9	3.6	6.2	5.6	4.4
	Midsize	12.2	9.8	5.4	9.8	6.1	4.2	7.9	5.1	3.4
	Large	12.7	9.7	7.3	8.2	7.1	5.3	8.2	6.0	4.6
	All	12.7	9.1	5.4	9.8	5.8	3.6	8.2	5.5	3.4
Pickup	Small	7.7	5.2	4.8	7.5	4.8	4.1			
	Midsize	5.6	5.6	5.6	6.5	4.7	3.9	6.5	5.3	4.2
	Large	13.2	9.0	5.4	10.2	6.6	4.8	8.2	6.3	4.7
	All	13.2	8.4	4.8	10.2	5.5	3.9	8.2	6.2	4.2
All	Cars	11.9	7.5	3.5	13.3	4.1	1.8	9.6	4.3	2.2
All	Trucks	13.2	8.6	4.8	10.2	5.6	3.6	8.2	5.6	3.4
All	Vehicles	13.2	7.6	3.5	13.3	4.6	1.8	9.6	5.0	2.2

Table 7

Percent Change* in Adjusted Fuel Consumption by Vehicle Type and Size

Vehicle Type	Size	From 1975 to 2007 Low	Avg.	High	From 1975 to 1988 Low	Avg.	High.	From 1988 to 2007 Low	Avg.	High
Car	Small	17%	34%	34%	-15%	39%	49%	28%	-8%	-28%
	Midsize	28%	52%	59%	18%	49%	33%	13%	7%	38%
	Large	29%	45%	44%	16%	45%	44%	15%	0%	0%
	All	19%	43%	37%	-12%	45%	49%	28%	-5%	-22%
Wagon	Small	27%	25%	22%	32%	27%	27%	-7%	-3%	-7%
	Midsize	44%	47%	13%	52%	49%	10%	-18%	-4%	3%
	Large	34%	44%	42%	56%	47%	33%	-52%	-6%	13%
	All	34%	42%	20%	51%	40%	25%	-36%	2%	-7%
Van	Small	--	--	--	-5%	14%	26%	--	--	--
	Midsize	54%	43%	20%	28%	39%	20%	36%	7%	0%
	Large	38%	32%	14%	10%	25%	13%	32%	10%	2%
	All	43%	43%	20%	17%	38%	26%	32%	9%	-8%
SUV	Small	37%	23%	28%	35%	33%	41%	3%	-14%	-22%
	Midsize	35%	48%	37%	20%	38%	22%	19%	16%	19%
	Large	35%	38%	37%	35%	27%	27%	0%	15%	13%
	All	35%	40%	37%	23%	36%	33%	16%	5%	6%
Pickup	Small	--	--	--	3%	8%	15%	--	--	--
	Midsize	-16%	5%	25%	-16%	16%	30%	0%	-13%	-8%
	Large	38%	30%	13%	23%	27%	11%	20%	5%	2%
	All	38%	26%	13%	23%	35%	19%	20%	-13%	-8%
All	Cars	19%	42%	37%	-12%	45%	49%	28%	-5%	-22%
All	Trucks	38%	35%	29%	23%	35%	25%	20%	0%	6%
All	Vehicles	27%	34%	37%	-1%	39%	49%	28%	-9%	-22%

*Note: A Negative Change indicates that the fuel consumption has increased.

Laboratory 55/45 Fuel Consumption vs 0 to 60 Time MY1975 and MY2007 Cars

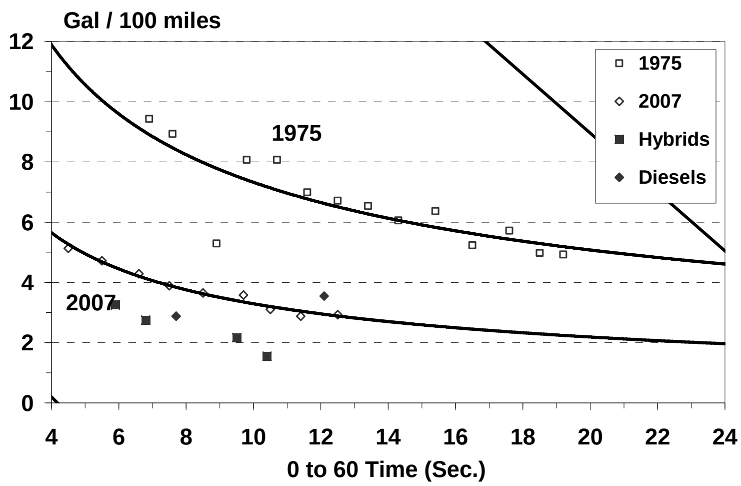

Figure 25

Laboratory 55/45 Fuel Consumption vs 0 to 60 Time MY1975 and MY2007 Trucks

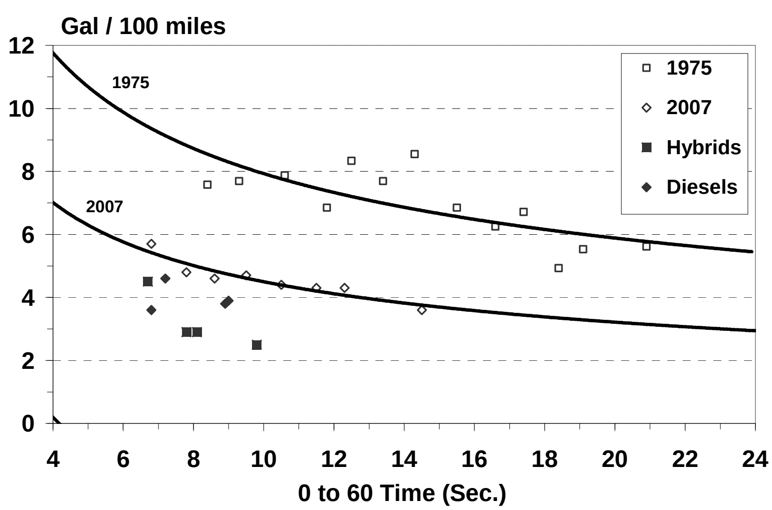

Figure 26

MY1975 and MY2007 Cars

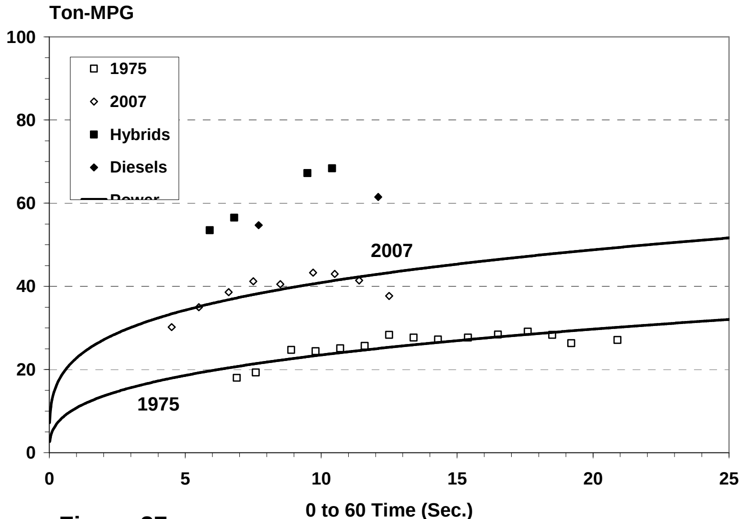

Figure 27

Ton-MPG vs 0 to 60 Time MY1975 and MY2007 Trucks

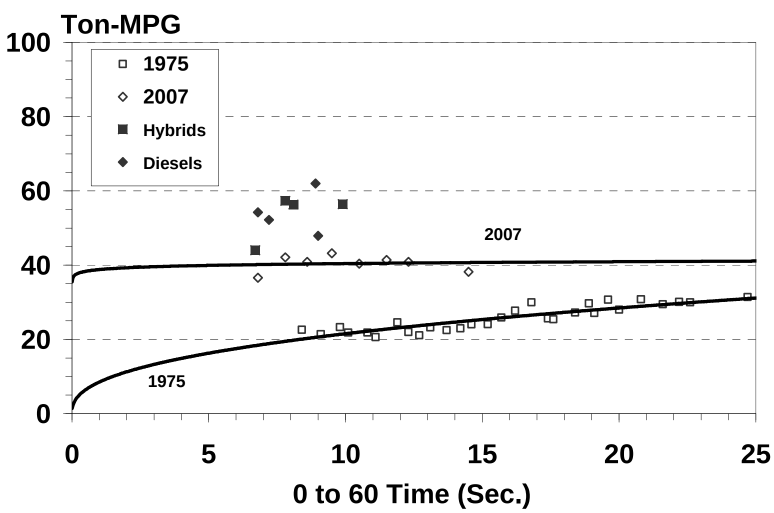

Figure 28

Figure 29 and Table 8 show some of the changes in the distribution of inertia weight that have occurred over the years for the light-duty fleet. In 1975, 13 percent of all light-duty vehicles had inertia weights of less than 3000 lb compared to two percent in 2007. Since 1988, market share for vehicles with weight of 5000 pounds or more has increased from three percent to 21 percent.

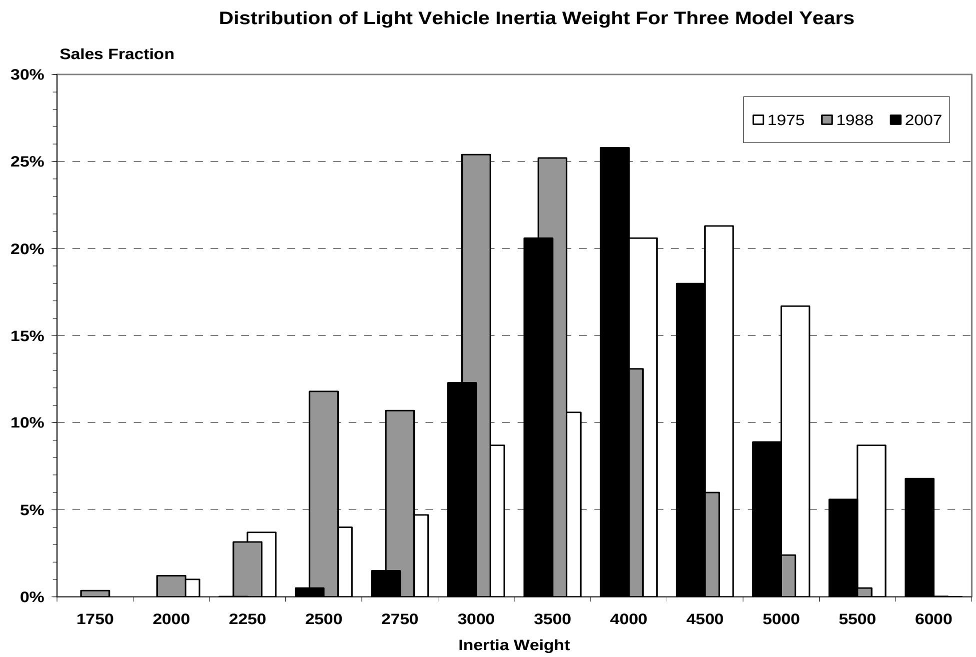

Figure 29

Table 8

Light Vehicle Sales Fraction by Inertia Weight Class for Three Model Years

Inertia Weight	<---- 1975	Model Year 1988	----> 2007
<3000	13.4%	27.2%	2.1%
3000	8.7%	25.4%	12.3%
3500	10.6%	25.2%	20.6%
4000	20.6%	13.2%	25.8%
4500	21.3%	6.0%	18.0%
5000	16.7%	2.4%	8.9%
5500	8.7%	.5%	5.6%
>5500	.0%	.0%	6.8%
Avg Wt.	4060	3283	4144

Figures 30 through 34 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 fleet as a whole. In 1975, about 40 percent of the cars had an inertia weight of 4500 lb or more compared to about 5 percent this year. For MY2007, three weight classes (3000, 3500 and 4000 lbs) account for nearly 90 percent of all cars. Conversely, the market share of trucks in the inertia weight classes of 4500 lb or more have increased substantially, and these vehicles currently account for over 70 percent of all trucks, compared to about 30 percent in 1975. Figures 32, 33, and 34 provide additional details of the truck data presented in Figure 31 for vans, SUVs, and pickups respectively. Appendixes D, E, and F contain a series of tables describing light-duty vehicles at the vehicle size/type level of stratification in more detail; Appendix G provides similar data by vehicle type and inertia weight class.

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

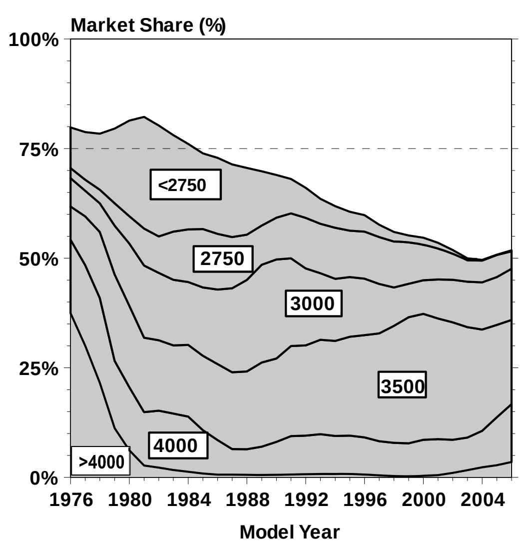

Figure 30

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

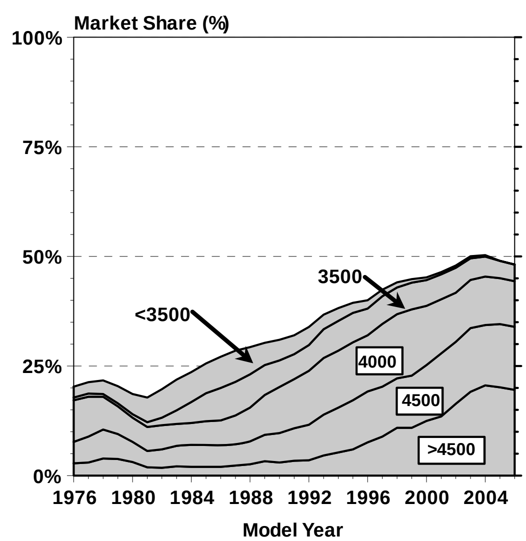

Figure 31

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

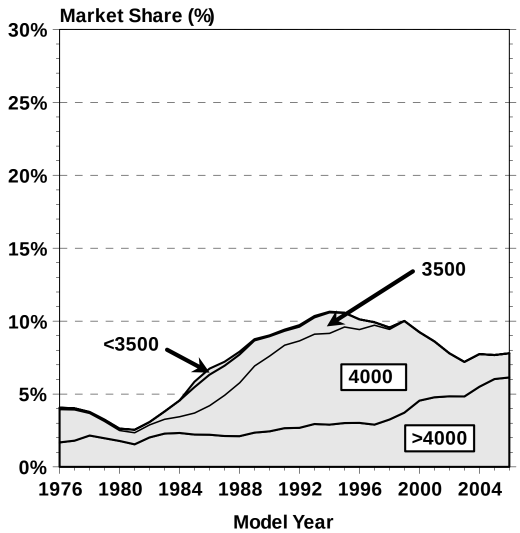

Figure 32

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

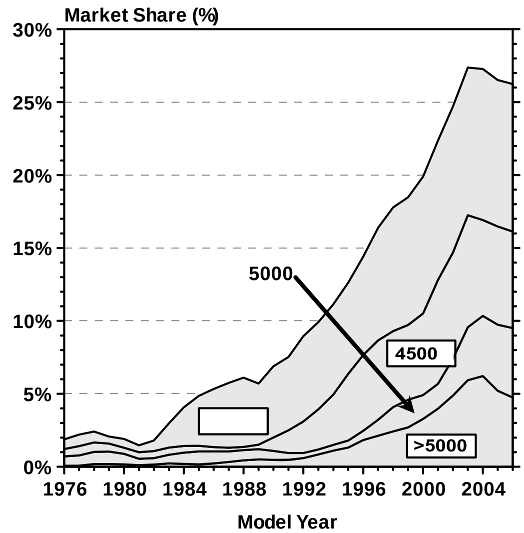

Figure 33

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

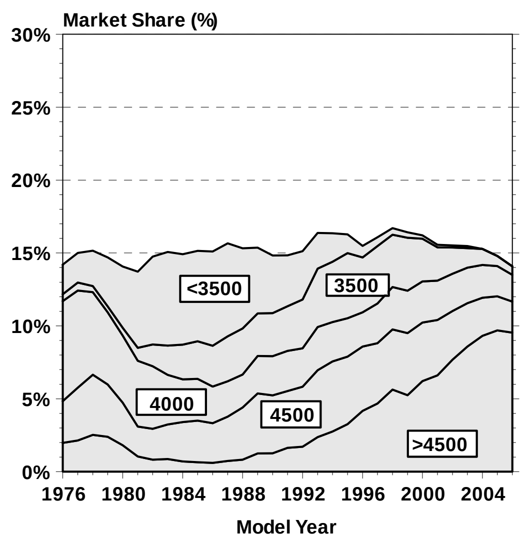

Figure 34

V. **Technology Trends**

Table 9 repeats the sales fraction and adjusted composite fuel economy data from Tables 1 and 2 and adds three measures of powertrain information: engine displacement (CID), horsepower (HP), and specific power (HP/CID). This table also includes sales fraction data giving the percent of vehicles that: have front- (FWD) or four-wheel drive (4wd); have manual, lockup, or continuously variable (CVT) transmissions; have port or throttle body fuel injection (TBI) or are Diesels; are equipped with engines that have more than two valves per cylinder; use variable valve timing (VVT); and use hybrid vehicle technology.

For the overall MY2007 fleet, FWD continues to account for about one-half of the market and 4wd for about 30 percent. With transmissions, manuals remain less than 10 percent of the market, while CVTs have grown to seven percent. Over 70 percent of the MY2007 fleet have multi-valve engines, and nearly 60 percent use VVT, an all-time high. Hybrids are over two percent of the fleet for the first time, while diesels represent just 0.1 percent of the MY2007 sales. Appendix K contains additional data on fuel metering and number of valves per cylinder.

Table 10 compares technology usage for MY2007 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 and small pickups, because none have been produced for several years.

Front-wheel drive (FWD) is used heavily in all of the car classes, in small wagons and in midsize vans. By comparison, none of this year's pickups or large vans 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. A large portion 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 primarily in small vehicles and midsize pickups. Similarly, usage of engines with more than two valves per cylinder is more prevalent on small and midsize vehicles than on larger ones.

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

Table 9

Powertrain Characteristics of 1975 to 2007 Cars (Percentage Basis)

MODEL YEAR	SALES FRAC	ADJ COMP MPG	ENGINE CID	ENGINE HP	HP/ CID	DRIVETRAIN Front	DRIVETRAIN 4wd	TRANSMISSION Manual	TRANSMISSION Lock	TRANSMISSION CVT	FUEL METERING Port	FUEL METERING TBI	FUEL METERING Dsl	Multi-Valve	VVT	Hybrid
1975	.806	13.5	288	136	.515	6.5		19.9			5.1		.2			
1976	.788	14.9	287	134	.502	5.8		17.1			3.2		.3			
1977	.800	15.6	279	133	.516	6.8		16.8			4.2		.5			
1978	.773	16.9	251	124	.538	9.6		20.2	6.7		5.1		.9			
1979	.778	17.2	238	119	.545	11.9	.3	22.3	8.0		4.7		2.1			
1980	.835	20.0	188	100	.583	29.7	.9	31.9	16.5		6.2	.7	4.4			
1981	.827	21.4	182	99	.594	37.0	.7	30.4	33.3		6.1	2.6	5.9			
1982	.803	22.2	175	99	.609	45.6	.8	29.7	51.4		7.2	9.8	4.7			
1983	.777	22.1	182	104	.615	47.3	3.1	26.5	56.7		9.5	18.9	2.1			
1984	.761	22.4	179	106	.637	53.7	1.0	24.1	58.3		15.0	24.4	1.7			
1985	.746	23.0	177	111	.671	61.6	2.1	22.8	58.7		21.4	32.0	.9			
1986	.717	23.7	167	111	.701	71.1	1.1	24.8	58.0		36.7	28.4	.3			
1987	.722	23.8	162	112	.732	77.0	1.1	24.9	59.5		42.5	30.5	.3			
1988	.702	24.1	160	116	.759	81.7	.8	24.3	66.1		53.7	30.0				
1989	.693	23.7	163	121	.783	82.5	1.0	21.0	69.3	.1	62.4	27.8	.0			
1990	.698	23.3	163	129	.829	84.6	1.0	19.6	72.9	.0	77.5	21.1	.0		.6	
1991	.678	23.4	163	132	.851	83.2	1.4	20.5	73.5	.0	78.0	21.8	.1		2.4	
1992	.666	23.1	170	141	.868	80.8	1.1	17.4	76.4		89.5	10.4	.1		4.6	
1993	.640	23.5	166	138	.865	85.1	1.2	17.8	77.0		91.6	8.4			4.8	
1994	.596	23.3	168	143	.884	84.4	.4	16.7	79.3		94.9	5.1			8.0	
1995	.620	23.4	167	152	.945	82.0	1.2	16.3	81.9		98.8	1.2	.1		9.8	
1996	.600	23.3	165	154	.958	86.5	1.5	14.8	83.6	.0	98.8	1.1	.1		11.7	
1997	.576	23.4	164	156	.974	86.5	1.7	13.5	85.8	.1	99.1	.8	.1	58.6	11.3	
1998	.551	23.4	164	159	.993	87.0	2.3	12.3	87.3	.1	99.7	.1	.2	61.4	18.4	
1999	.551	23.0	166	164	1.009	87.2	2.2	10.9	88.4	.0	99.7	.1	.2	64.6	17.1	
2000	.551	22.9	165	168	1.032	84.9	2.1	11.2	87.7	.0	99.7	.1	.2	65.1	23.4	.1
2001	.539	23.0	165	168	1.042	84.1	3.2	11.4	87.5	.2	99.7		.3	67.2	28.3	.0
2002	.515	23.1	166	173	1.066	84.9	3.8	11.2	88.1	.4	99.6		.4	69.9	33.9	.3
2003	.504	23.2	166	176	1.086	81.7	3.8	11.1	87.9	.9	99.6		.4	73.5	41.2	.6
2004	.480	23.1	168	182	1.106	80.8	5.4	10.2	88.2	1.4	99.7		.3	77.2	44.2	.9
2005	.505	23.5	166	182	1.116	79.7	5.8	9.3	88.0	2.6	99.6		.4	78.2	51.7	2.1
2006	.539	23.3	171	192	1.142	76.8	5.7	9.8	87.5	2.4	99.4		.6	80.5	61.1	1.5
2007	.510	23.4	176	200	1.157	75.4	7.6	11.5	77.0	10.3	99.9		.1	82.1	67.9	3.0

Table 9 (continued)

Powertrain Characteristics of 1975 to 2007 Trucks (Percentage Basis)

MODEL YEAR	SALES FRAC	ADJ COMP MPG	ENGINE CID	ENGINE HP	HP/ CID	DRIVETRAIN Front	DRIVETRAIN 4wd	TRANSMISSION Manual	TRANSMISSION Lock	TRANSMISSION CVT	FUEL METERING Port	FUEL METERING TBI	FUEL METERING Dsl	Multi-Valve	VVT	Hybrid
1975	.194	11.6	311	142	.476		17.1	37.0				.1				
1976	.212	12.2	319	141	.458		22.9	34.8				.1				
1977	.200	13.3	318	147	.482		23.6	32.0				.1				
1978	.227	12.9	314	146	.481		29.0	32.4				.1	.8			
1979	.222	12.5	298	138	.486		18.0	35.2	2.1			.3	1.8			
1980	.165	15.8	248	121	.528	1.4	25.0	53.0	24.6			1.7	3.5			
1981	.173	17.1	247	119	.508	1.9	20.1	51.6	31.1			1.1	5.6			
1982	.197	17.4	243	120	.524	1.7	20.0	45.7	33.2			.7	9.3			
1983	.223	17.8	231	118	.543	1.4	25.8	45.9	36.1			.6	4.7			
1984	.239	17.4	224	118	.557	4.9	31.0	42.1	35.1		1.9	.6	2.3			
1985	.254	17.5	224	124	.586	7.1	30.6	37.1	42.2		8.7	3.5	1.1			
1986	.283	18.2	211	123	.621	5.9	30.3	42.7	42.0		21.8	18.7	.7			
1987	.278	18.3	210	131	.654	7.4	31.5	39.9	44.8		33.3	33.6	.3			
1988	.298	17.9	227	141	.650	9.0	33.3	35.5	53.1		43.3	44.4	.2			
1989	.307	17.6	234	146	.653	9.9	32.0	32.7	56.8		45.9	47.6	.2			
1990	.302	17.4	237	151	.668	15.5	31.3	28.1	67.4		55.2	40.8	.2			
1991	.322	17.8	228	150	.681	9.7	35.3	31.0	67.4		55.0	43.2	.1			
1992	.334	17.4	234	155	.685	13.6	31.4	27.3	71.5		65.9	32.5	.1			
1993	.360	17.5	235	162	.710	15.1	29.4	23.3	75.7		73.4	25.7				
1994	.404	17.2	239	166	.717	13.1	36.9	23.5	75.1		77.2	22.5				
1995	.380	17.0	244	168	.715	17.7	40.7	20.5	78.6		79.8	20.2				
1996	.400	17.2	243	179	.757	20.1	37.1	15.6	83.5		99.9		.1			
1997	.424	17.0	248	187	.775	13.9	43.2	14.6	85.0		100.0		.0			
1998	.449	17.1	242	187	.795	18.7	42.0	13.4	86.0		100.0		.0			
1999	.449	16.7	249	197	.814	17.4	44.6	9.1	90.5		100.0					
2000	.449	16.9	242	197	.832	19.4	42.4	8.0	91.7		100.0				4.7	
2001	.461	16.7	243	209	.882	18.5	43.8	6.3	93.4		100.0				9.3	
2002	.485	16.7	244	219	.918	18.5	47.6	4.9	94.7	.0	100.0				16.2	
2003	.496	16.9	243	221	.927	19.2	46.5	4.8	93.7	1.2	100.0				19.8	
2004	.520	16.7	252	236	.953	17.2	52.3	3.7	95.0	1.0	100.0			48.4	33.3	
2005	.495	17.2	245	237	.983	25.7	48.3	3.0	95.0	2.0	99.9		.1	52.8	39.8	.1
2006	.461	17.6	240	234	.990	25.5	47.5	3.1	93.2	3.5	99.9		.1	62.1	49.9	1.5
2007	.490	17.7	245	247	1.023	24.5	48.8	3.6	92.5	3.9	99.8		.2	58.3	50.0	1.4

Table 9 (continued)

Powertrain Characteristics of 1975 to 2007 Cars and Trucks (Percentage Basis)

MODEL YEAR	SALES FRAC	ADJ COMP MPG	ENGINE CID	ENGINE HP	HP/ CID	DRIVETRAIN Front	DRIVETRAIN 4wd	TRANSMISSION Manual	TRANSMISSION Lock	TRANSMISSION CVT	FUEL METERING Port	FUEL METERING TBI	FUEL METERING Dsl	Multi-Valve	VVT	Hybrid
1975	1.000	13.1	293	137	.507	5.3	3.3	23.2			4.1		.2			
1976	1.000	14.2	294	135	.493	4.6	4.8	20.9			2.5	.0	.2			
1977	1.000	15.1	287	136	.510	5.5	4.7	19.8			3.4	.0	.4			
1978	1.000	15.8	266	129	.525	7.4	6.6	23.0	5.2		3.9	.0	.9			
1979	1.000	15.9	252	124	.532	9.2	4.3	25.1	6.7		3.7	.1	2.0			
1980	1.000	19.2	198	104	.574	25.0	4.9	35.4	17.8		5.2	.8	4.3			
1981	1.000	20.5	193	102	.580	31.0	4.0	34.1	33.0		5.1	2.4	5.9			
1982	1.000	21.1	188	103	.593	37.0	4.6	32.8	47.8		5.8	8.0	5.6			
1983	1.000	21.0	193	107	.599	37.0	8.1	30.8	52.1		7.3	14.8	2.7			
1984	1.000	21.0	190	109	.618	42.1	8.2	28.4	52.8		11.9	18.7	1.8			
1985	1.000	21.3	189	114	.650	47.8	9.3	26.5	54.5		18.2	24.8	.9			
1986	1.000	21.8	180	114	.678	52.6	9.3	29.8	53.5		32.5	25.7	.4			
1987	1.000	22.0	175	118	.710	57.7	9.6	29.1	55.4		39.9	31.4	.3			
1988	1.000	21.9	180	123	.726	60.0	10.5	27.6	62.2		50.6	34.3	.1			
1989	1.000	21.4	185	129	.743	60.2	10.5	24.6	65.5	0.1	57.3	33.9	.1			
1990	1.000	21.2	185	135	.781	63.8	10.1	22.2	71.2		70.8	27.0	.1			
1991	1.000	21.2	184	138	.796	59.6	12.3	23.9	71.6		70.6	28.7	.1			
1992	1.000	20.8	191	145	.807	58.4	11.2	20.7	74.8		81.6	17.8	.1			
1993	1.000	20.9	191	147	.809	59.9	11.3	19.8	76.5		85.0	14.6				
1994	1.000	20.4	197	152	.816	55.6	15.2	19.5	77.6		87.7	12.1				
1995	1.000	20.5	196	158	.857	57.6	16.2	17.9	80.7		91.6	8.4	.0			
1996	1.000	20.4	197	164	.878	60.0	15.7	15.1	83.5		99.3	.7	.1			
1997	1.000	20.1	199	169	.890	55.8	19.3	14.0	85.5		99.5	.5	.1	39.6		
1998	1.000	20.1	199	171	.904	56.4	20.1	12.8	86.7		99.8	.1	.1	40.9		
1999	1.000	19.7	203	179	.921	55.8	21.3	10.1	89.4		99.9	.1	.1	43.4		
2000	1.000	19.8	200	181	.942	55.5	20.2	9.7	89.5		99.8	.0	.1	44.8	15.0	
2001	1.000	19.6	201	187	.968	53.8	21.9	9.0	90.2	0.1	99.9		.1	49.0	19.6	
2002	1.000	19.4	203	195	.994	52.7	25.0	8.1	91.3	0.2	99.8		.2	53.3	25.3	
2003	1.000	19.6	204	199	1.007	50.7	25.0	8.0	90.8	1.1	99.8		.2	55.5	30.6	
2004	1.000	19.3	212	211	1.026	47.7	29.8	6.8	91.8	1.1	99.9		.1	62.3	38.5	.5
2005	1.000	19.9	205	209	1.050	53.0	26.8	6.2	91.5	2.3	99.7		.3	65.6	45.8	1.1
2006	1.000	20.2	203	212	1.072	53.1	25.0	6.7	90.1	2.9	99.6		.4	72.0	56.0	1.5
2007	1.000	20.2	210	223	1.091	50.5	27.8	7.7	84.6	7.1	99.9		.1	70.4	59.1	2.2

Table 10

MY2007 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	Variable Valve
Car	Small	70%	7%	23%	91%	65%
	Midsize	86%	5%	6%	90%	85%
	Large	61%	7%	1%	41%	47%
	All	75%	6%	11%	80%	69%
Wagon	Small	94%	5%	16%	100%	70%
	Midsize	31%	53%	8%	84%	30%
	Large	57%	43%	0%	80%	15%
	All	79%	18%	13%	95%	57%
Van	Small					
	Midsize	95%	5%	0%	53%	48%
	Large	0%	11%	0%	0%	0%
	All	92%	5%	0%	51%	46%
SUV	Small	0%	89%	26%	29%	2%
	Midsize	30%	59%	3%	83%	61%
	Large	12%	57%	0%	53%	48%
	All	21%	60%	3%	67%	53%
Pickup	Small					
	Midsize	0%	27%	27%	70%	77%
	Large	0%	50%	4%	38%	77%
	All	0%	47%	7%	43%	46%

Figures 35 through 39 show trends in drive use for the five vehicle classes. Cars used to be nearly all rear-wheel drive; from 1988 to 2004 they were over 80 percent front-wheel drive with a small four-wheel (4WD) drive fraction. In recent years, there has been an increase in the use of rear wheel drive from less than 12 percent in 1998 to 17 percent this year, and a slight increase in the use of four wheel drive in cars with use of this technology increasing from about two percent in the late 1990s to eight 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.

The trend towards increased use of front wheel drive for vans is very similar to that for cars, except it started a few years later and appears to be continuing. Over 90 percent of vans currently use front-wheel drive, compared to essentially none before 1984. SUVs are mostly 4WD; but a trend toward front-wheel drive SUVs started in 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.

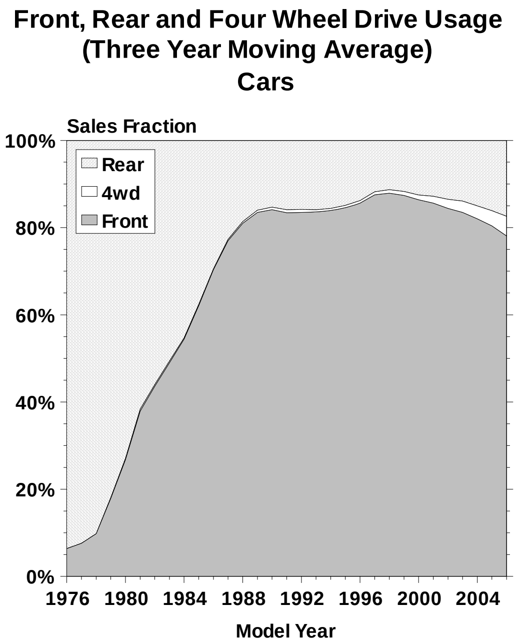

Figure 35

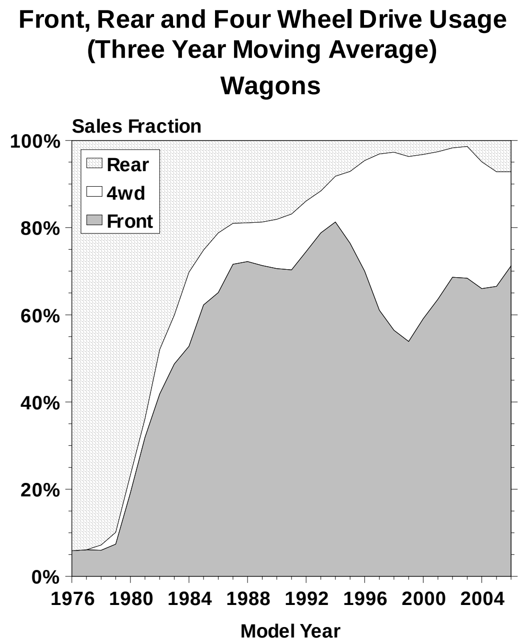

Figure 36

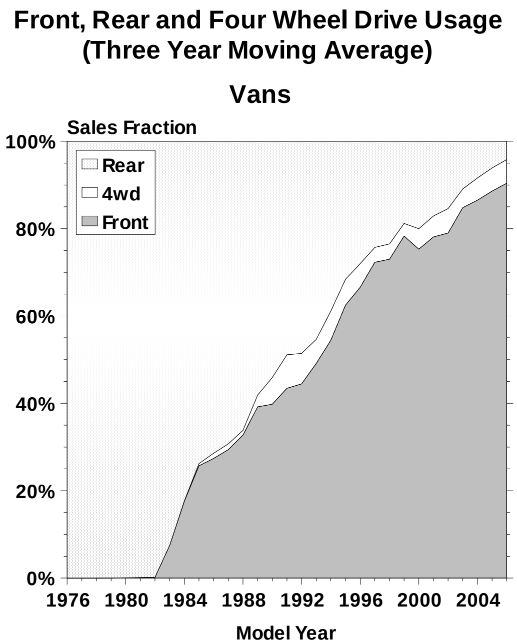

Figure 37

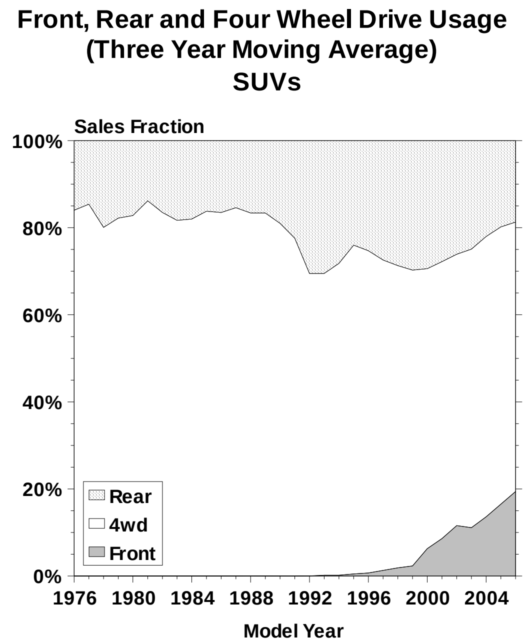

Figure 38

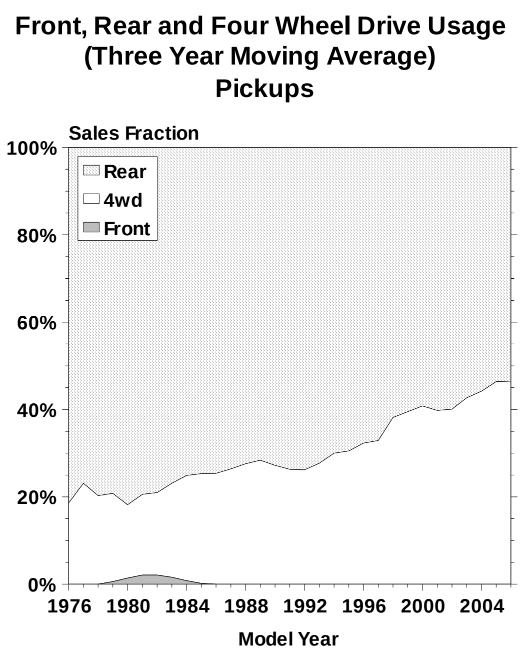

Figure 39

Laboratory 55/45 MPG vs 0 to 60 Time
MY2007 Cars

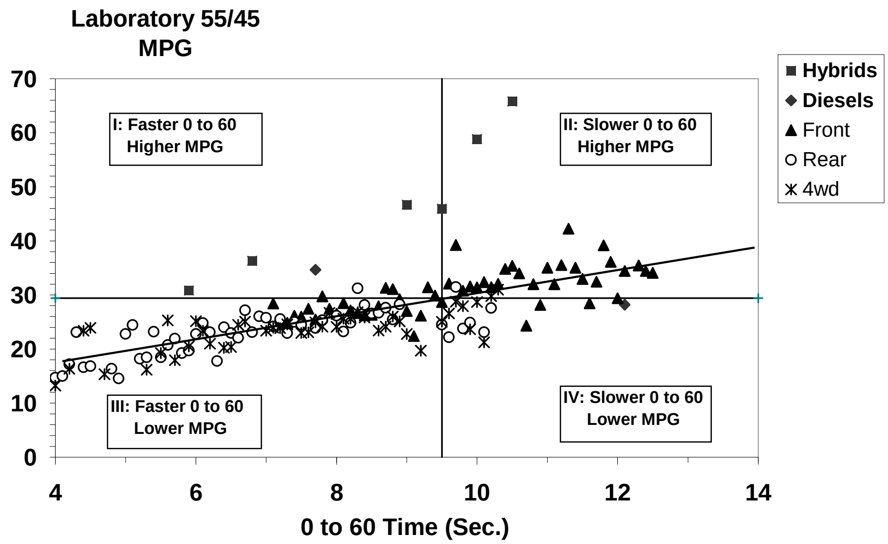

Figure 40

Figures 40 and 41 and Tables 11 and 12 give, as an indication of how the different drive types are currently used, plots of fuel economy and performance for cars and trucks. The data points in these graphs represent sales-weighted averages calculated at estimated 0-to-60 time increments of 0.1 sec. The trend lines in these two figures reflect the fuel economy/ performance tradeoff for conventionally powered vehicles, 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

Table 11

Distribution of MY2007 Car Sales
By technology, 0-to-60 time and Lab 55/45 MPG

0 to 60 time **Lab 55/45 MPG**	**<9.5 Sec** **>29.4 MPG**	**>9.5 sec** **>29.4 MPG**	**<9.5 sec** **<29.4 MPG**	**>9.5 sec** **<29.4 MPG**
Vehicle Technology	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
Front Drive	7%	62%	24%	7%
Rear Drive	1%	2%	78%	19%
4wd	0%	2%	54%	44%
Hybrids	3%	97%	0%	0%
Diesels	60%	0%	0%	40%
All Cars	6%	47%	35%	12%

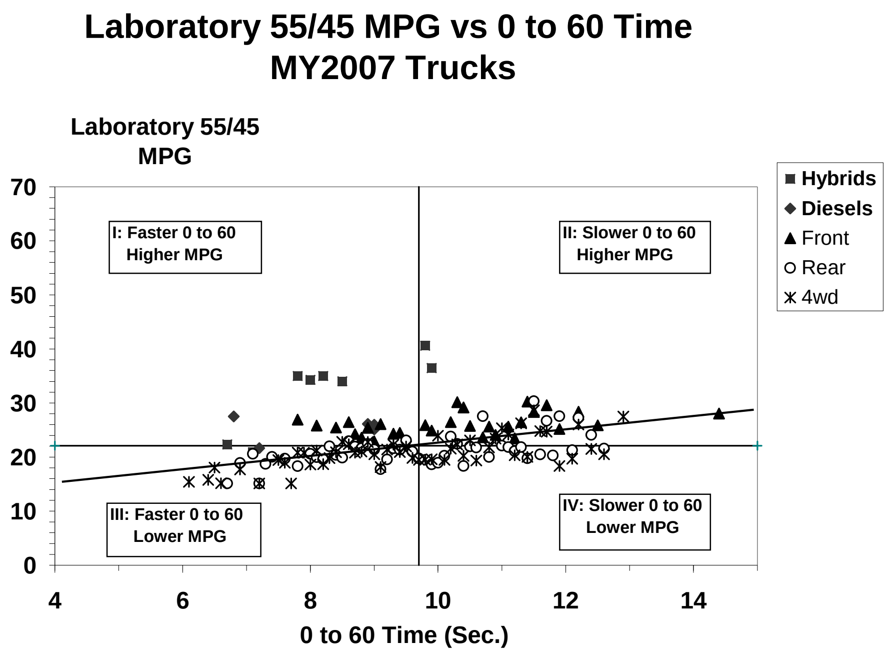

Figure 41

compared to the average 0 to 60 time and mpg. The vehicles in Quadrant I, for example, have faster than average 0- to-60 time and higher than average fuel economy, but this quadrant accounts for only six percent of all 2007 car sales and 18 percent of all truck sales. Over 60 percent of all front wheel drive car sales are in Quadrant II (the Slower/Higher one), as are one-half of the FWD truck sales, but only two percent of the rear drive and two percent of 4wd cars. Over three fourths of the rear drive cars and over half of the 4wd cars are in Quadrant III (the Faster/Lower one) as are half of the rear and four wheel drive trucks. Similar data for 0-to-60 time and Laboratory Ton MPG are presented in Figures 42 and 43 and Tables 13 and 14.

Table 12

Distribution of MY2007 Truck Sales
By technology, 0-to-60 time and Lab 55/45 M

0 to 60 time **Lab 55/45 MPG**	**<9.7 Sec** **>22.1 MPG**	**>9.7 sec** **>22.1 MPG**	**<9.7 sec** **<22.1 MPG**	**>9.7 sec** **<22.1 MPG**
Vehicle Technology	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
Front Drive	49%	51%	0%	0%
Rear Drive	6%	9%	50%	35%
4wd	9%	15%	51%	24%
Hybrids	80%	20%	0%	0%
Diesels	98%	0%	0%	2%
All Trucks	18%	22%	39%	21%

Laboratory Ton-MPG vs 0 to 60 Time
MY2007 Cars

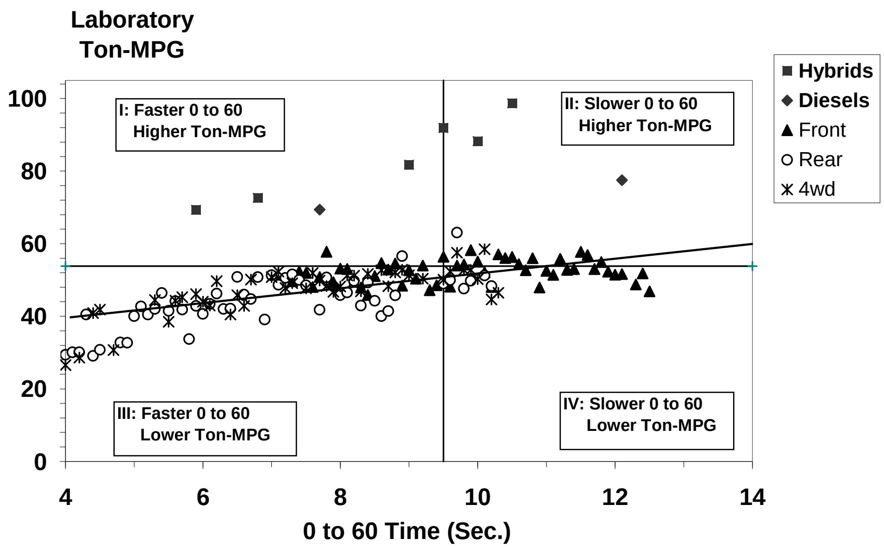

Figure 42

Laboratory Ton-MPG vs 0 to 60 Time
MY2007 Trucks

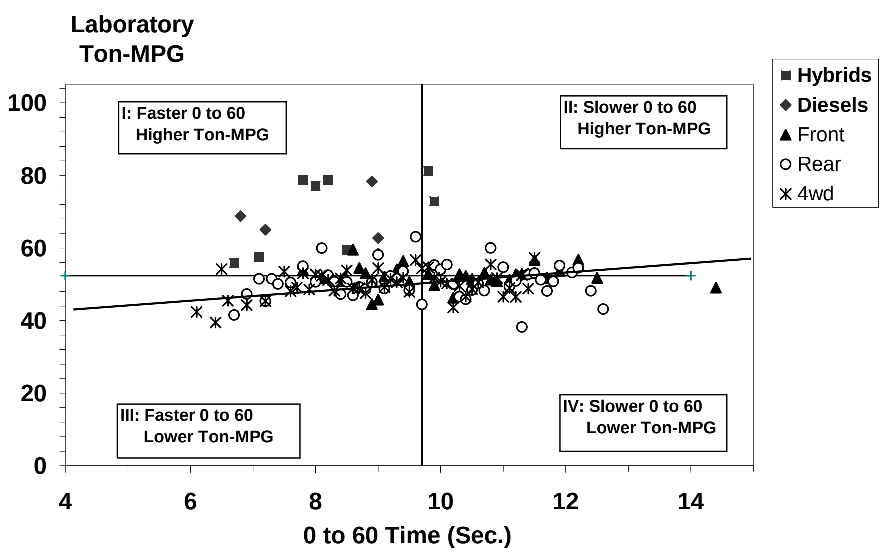

Figure 43

Table 13

Distribution of MY2007 Car Sales
By technology, 0-to-60 time and Lab Ton-MPG

0 to 60 time Lab Ton-MPG Ton-MPG	**<9.5 Sec >53.8 Ton-MPG**	**>9.5 sec >53.8 Ton-MPG**	**<9.5 sec <53.8 Ton-MPG**	**>9.5 sec <53.8**
Vehicle Technology	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
Front Drive	6%	46%	25%	23%
Rear Drive	1%	2%	78%	19%
4wd	0%	5%	54%	41%
Hybrids	3%	97%	0%	0%
Diesels	60%	40%	0%	0%
All Cars	4%	36%	37%	23%

Table 14

Distribution of MY2007 Truck Sales
By technology, 0-to-60 time and Lab Ton-MPG

0 to 60 time Lab Ton-MPG	**<9.5 Sec >53.8 Ton-MPG**	**>9.5 sec >53.8 Ton-MPG Ton-MPG**	**<9.5 sec <53.8 Ton-MPG**	**>9.5 sec <53.8**
Vehicle Technology	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
Front Drive	39%	27%	10%	24%
Rear Drive	20%	19%	36%	25%
4wd	19%	9%	41%	31%
Hybrids	80%	20%	0%	0%
Diesels	100%	0%	0%	0%
All Trucks	25%	16%	32%	27%

The increasing trend in Ton-MPG shown in Table 1 can be attributed to better vehicle design, including more efficient engines, better transmission designs, 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. 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).

Table 15 compares Ton-MPG by transmission and vehicle type for 1988, the peak year for passenger car fuel economy, and this year. In 1988, every transmission type shown in the table achieved less than 40 Ton-MPG. This year, nearly every transmission type achieves at least 40 Ton-MPG. Figures 44 to 47 indicate that the L4 transmission is losing its position as the predominant transmission type for all vehicle classes. Use of the L4 transmission for cars peaked at about 80 percent in 1999 and is now down to 45 percent. Similarly, its use peaked at over 90 percent in 1996 for SUVs and has dropped below the 40 percent level. Over half of this year's pickups will still have L4 transmissions, as will about 60 percent of the vans. Where manual transmissions are used, the 5-speed (M5) transmission now predominates.

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, but for a CVT, the ratio is continuous. These transmissions differ from conventional automatic transmissions and manual transmissions in that CVTs do not have a fixed number of gears with the advantage 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.

More data stratified by transmission type can be found in Appendix I.

Transmission Sales Fraction
(Three Year Moving Average)
Cars

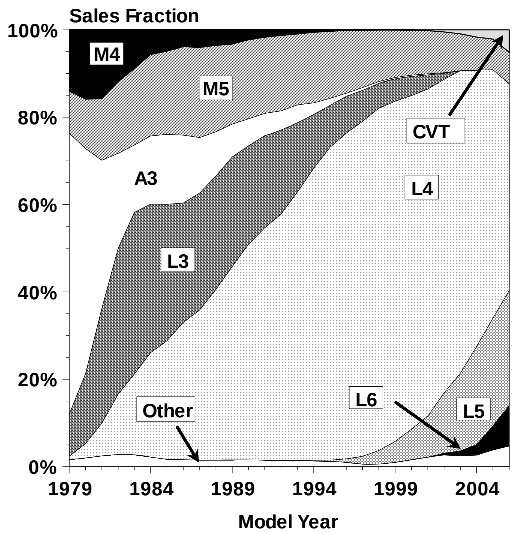

Figure 44

Transmission Sales Fraction
(Three Year Moving Average)
Vans

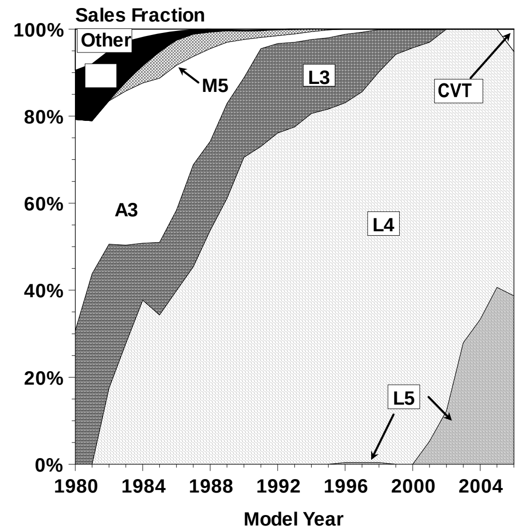

Figure 45

Transmission Sales Fraction
(Three Year Moving Average)
SUVs

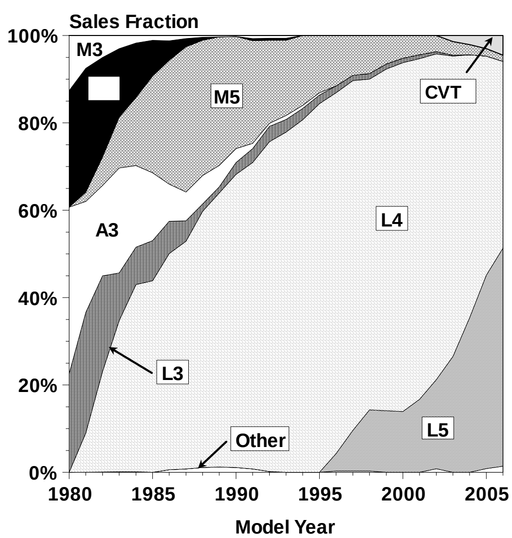

Figure 46

Transmission Sales Fraction
(Three Year Moving Average)
Pickups

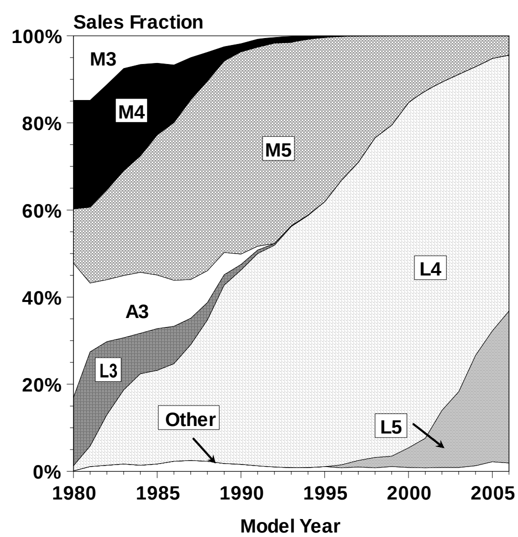

Figure 47

Table 15

Ton-MPG by Transmission and Vehicle Type

(Conventionally Powered Vehicles)

	Car		**Van**		**SUV**		**Pickup**	
Trans	**1988**	**2007**	**1988**	**2007**	**1988**	**2007**	**1988**	**2007**
M4	37.0	--	33.6	--	38.0	--	32.4	--
M5	37.7	40.8	37.7	--	33.1	41.2	35.3	39.9
M6	--	38.9	--	--	--	36.5	--	37.7
CVT	--	44.3	--	42.9	--	41.6	--	--
L3	36.1	--	37.1	--	33.5	--	31.4	--
L4	37.9	41.3	36.6	42.7	33.8	41.8	33.8	42.5
L5	--	42.6	--	45.1	--	40.9	--	38.4
L6	--	42.3	--	--	--	44.1	--	44.0

Table 16 and Figures 48 through 51 compare 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 has been increasing for two decades 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., 268 versus 115 HP). Light-duty vehicle engines, thus, have also improved in specific power with the highest specific power being for engines used in passenger cars.

Table 16

MY2007 Engine Characteristics by Vehicle Type

Vehicle Type	HP	CID	HP/ CID	Multi-Valve	Variable Valve	Cylinder Deactivation
Car	200	176	1.16	82%	68%	3%
Van	224	217	1.04	51%	46%	12%
SUV	242	232	1.06	67%	53%	11%
Pickup	268	287	0.93	42%	46%	14%
All	223	210	1.09	70%	59%	8%

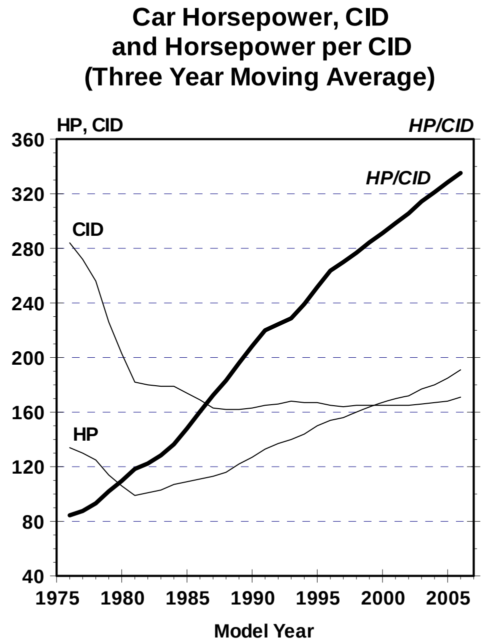

Figure 48

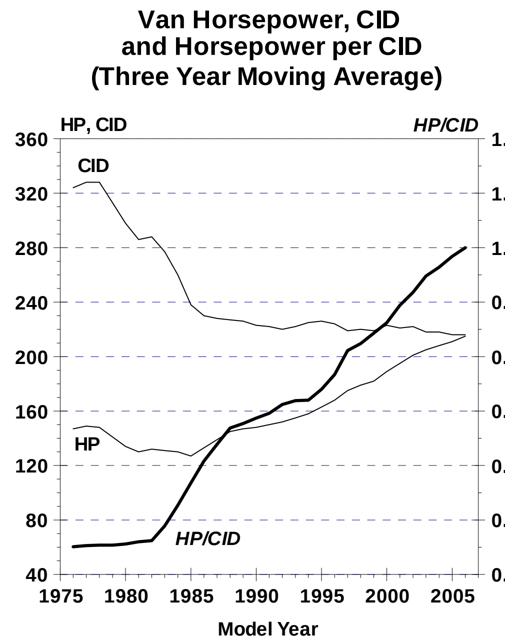

Figure 49

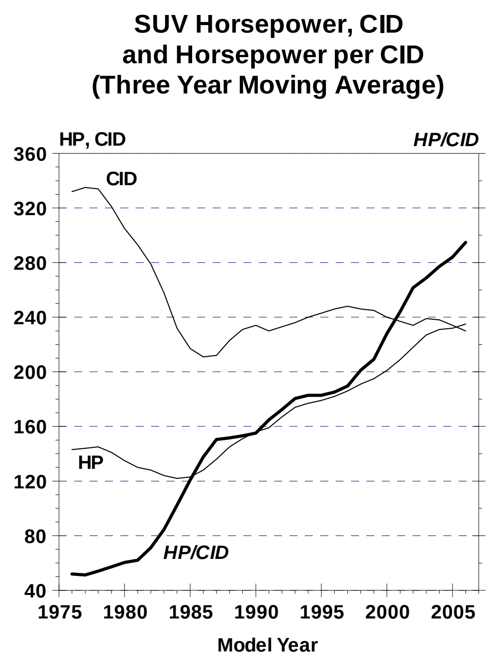

Figure 50

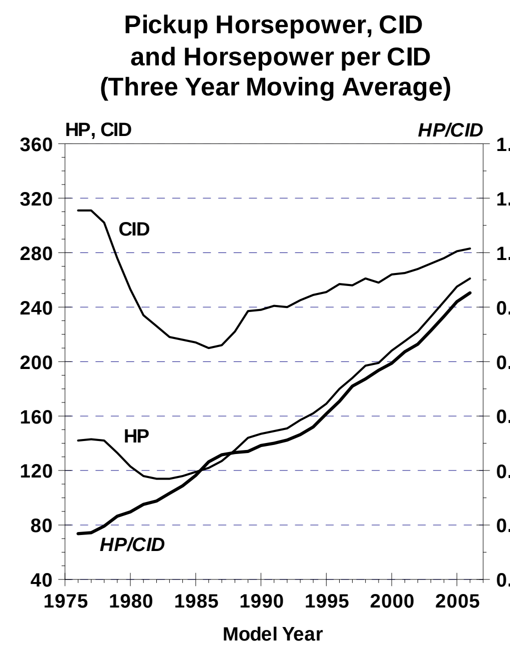

Figure 51

Table 17 compares CID, HP, and HP/CID by vehicle type and number of cylinders for model years 1988 and 2007. Table 17 shows that the increase in horsepower shown for the fleet in Table 9 extends to all vehicle type and cylinder number strata. These increases in horsepower range from 50 to over 90% . Because displacement has remained relatively constant, it can be seen that the primary reason for the horsepower increase is increased specific power — up between 44 and 88% from 1988 to 2007.

At the number-of-cylinders level of stratification, model year 2007 cars consistently achieve higher specific power than vans, SUVs or pickups. One 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 drivability. Engines equipped with four valves per cylinder typically have inherently lower torque rise than two valve engines with lower specific power.

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Table 17

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

Vehicle Type	Cyl.	HP 1988	HP 2007	Percent Change	CID 1988	CID 2007	Percent Change	HP/CID 1988	HP/CID 2007	Percent Change
Cars	4	95	151	59%	118	127	8%	0.805	1.186	47%
	6	142	236	66%	193	206	7%	0.744	1.152	55%
	8	164	316	93%	301	310	3%	0.544	1.021	88%
Vans	4	98	150	53%	145	148	2%	0.678	1.014	50%
	6	149	224	50%	213	216	1%	0.722	1.039	44%
	8	168	295	76%	322	325	1%	0.520	0.908	75%
SUVs	4	94	163	73%	122	142	16%	0.773	1.146	48%
	6	147	233	59%	211	216	2%	0.706	1.081	53%
	8	183	308	68%	338	317	-6%	0.541	0.971	80%
Pickups	4	97	165	70%	142	163	15%	0.685	1.009	47%
	6	142	221	56%	229	236	3%	0.644	0.943	46%
	8	180	299	66%	329	321	-2%	0.544	0.928	71%

Table 18

Improvement in Horsepower and Specific Power by Vehicle Type and Inertia Weight

Inertia Weight	HP 1988	HP 2007	Percent Change	CID 1988	CID 2007	Percent Change	HP/CID 1988	HP/CID 2007	Percent Change
Cars									
2250	73	199	173%	90	110	22%	0.808	1.810	124%
2500	78	106	36%	100	91	-9%	0.785	1.165	48%
2750	97	116	20%	123	101	-18%	0.804	1.145	43%
3000	114	135	18%	145	118	-19%	0.797	1.141	43%
3500	151	191	26%	212	163	-23%	0.732	1.185	62%
4000	160	245	53%	289	211	-27%	0.569	1.179	107%
4500	144	304	111%	305	302	-1%	0.474	1.007	113%
5000	207	296	43%	408	268	-34%	0.509	1.093	115%
5500	205	299	46%	412	236	-43%	0.498	1.258	153%
6000	205	449	119%	412	329	-20%	0.498	1.326	167%

Inertia Weight	HP 1988	HP 2007	Percent Change	CID 1988	CID 2007	Percent Change	HP/CID 1988	HP/CID 2007	Percent Change
Vans									
4000	149	181	21%	214	196	-8%	0.717	0.929	30%
4500	169	233	38%	320	219	-32%	0.528	1.070	103%
5000	156	210	35%	312	272	-13%	0.500	0.769	54%
5500	195	295	51%	346	325	-6%	0.562	0.908	61%
6000	126	295	134%	379	325	-14%	0.332	0.908	173%

Inertia Weight	HP 1988	HP 2007	Percent Change	CID 1988	CID 2007	Percent Change	HP/CID 1988	HP/CID 2007	Percent Change
SUVs									
3500	147	164	12%	210	148	-30%	0.712	1.109	56%
4000	135	203	50%	190	190	0%	0.723	1.081	50%
4500	147	243	65%	311	224	-28%	0.494	1.094	122%
5000	181	259	43%	330	256	-22%	0.545	1.027	89%
5500	200	315	58%	350	295	-16%	0.572	1.085	90%
6000	162	321	98%	368	329	-11%	0.445	0.979	120%

Inertia Weight	HP 1988	HP 2007	Percent Change	CID 1988	CID 2007	Percent Change	HP/CID 1988	HP/CID 2007	Percent Change
Pickups									
3500	129	156	21%	183	163	-11%	0.719	0.964	34%
4000	154	201	31%	282	216	-23%	0.555	0.936	68%
4500	174	235	35%	322	238	-26%	0.539	0.995	85%
5000	193	262	36%	342	294	-14%	0.565	0.886	57%
5500	178	302	70%	363	323	-11%	0.495	0.932	88%
6000	140	318	127%	379	330	-13%	0.369	0.960	160%

Table 18 shows similar data to that in Table 17, but the stratification is based on inertia weight. This table clearly shows that, for every case for which a comparison can be made between 1988 and 2007, there were increases in HP, substantial increases in specific power ranging from 30 to 170%, and with just minor exceptions, substantial decreases in CID.

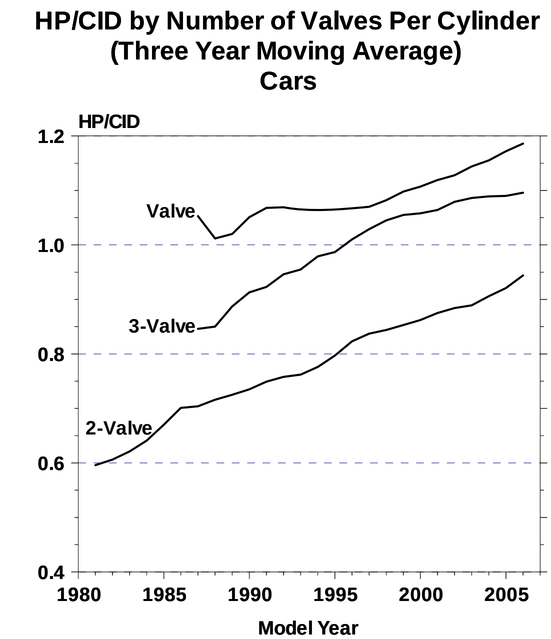


Figure 52

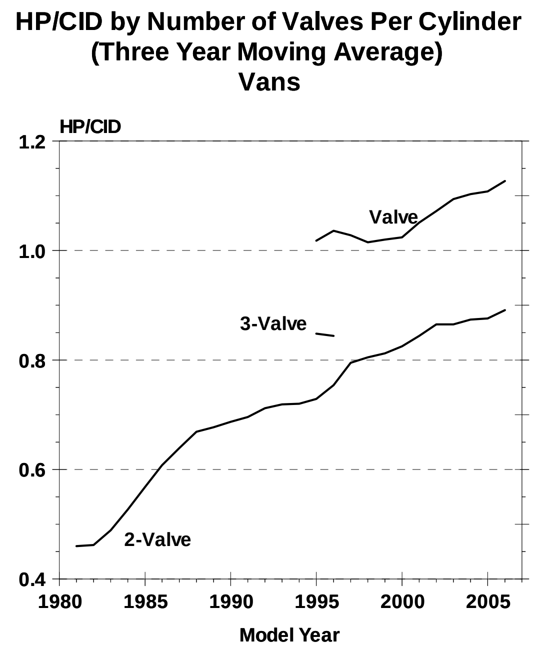


Figure 53

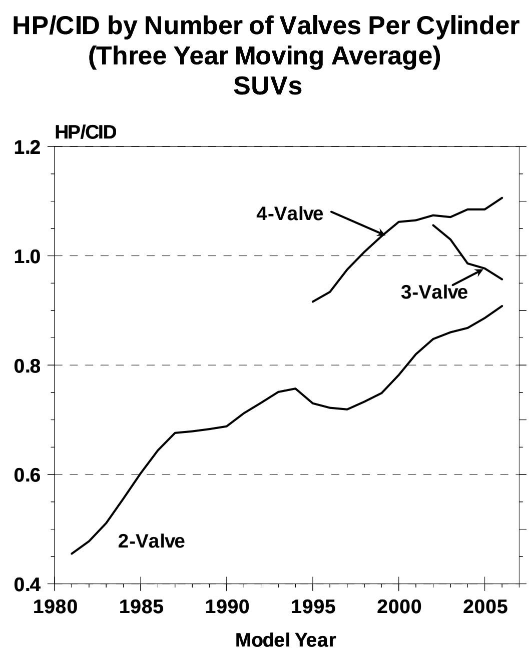


Figure 54

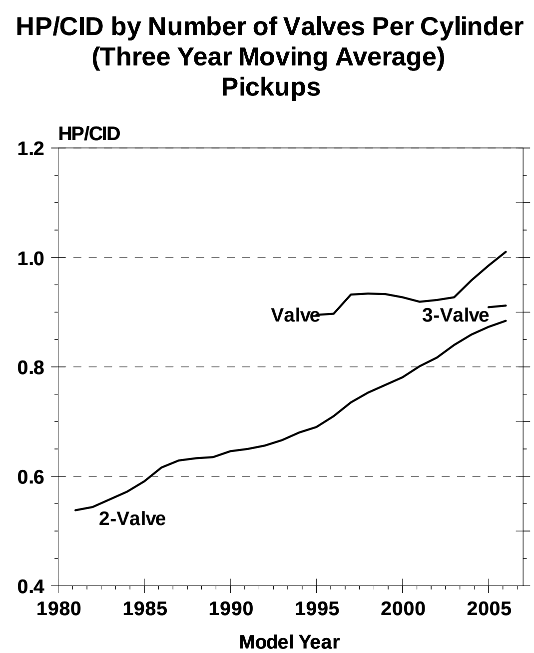


Figure 55

Number of Valves per Cylinder
(Three Year Moving Average)
Cars

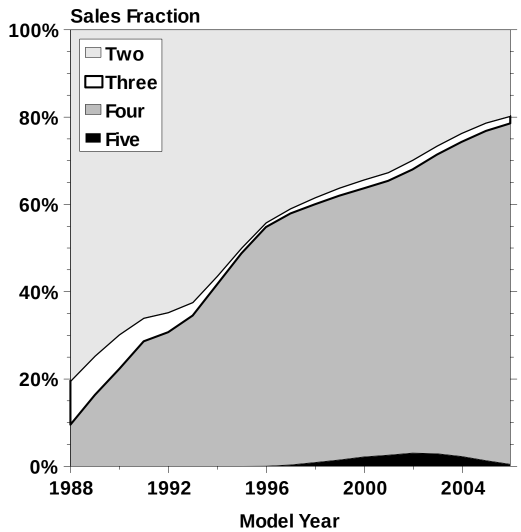


Figure 56

Number of Valves per Cylinder
(Three Year Moving Average)
Vans

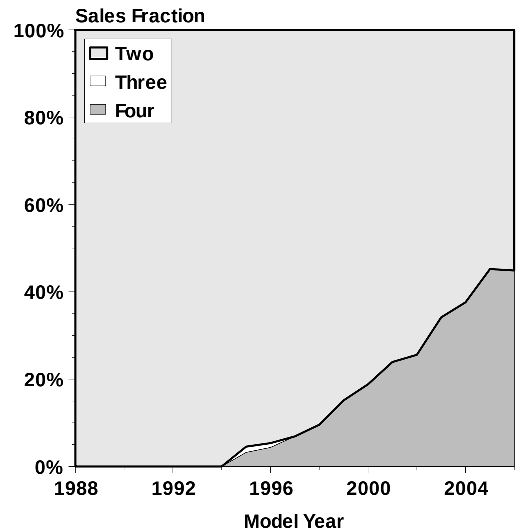


Figure 57

Number of Valves per Cylinder
(Three Year Moving Average)
SUVs

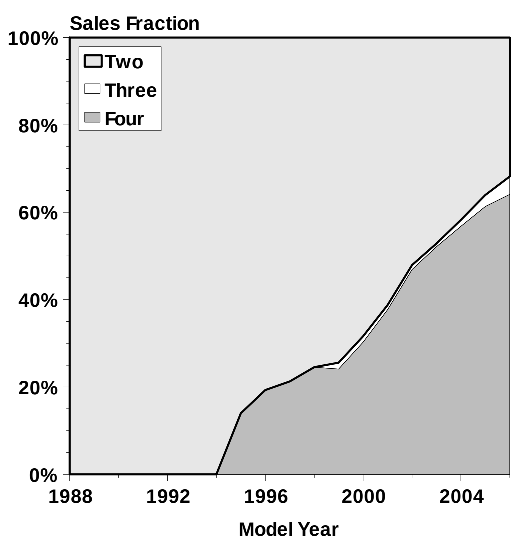


Figure 58

Number of Valves per Cylinder
(Three Year Moving Average)
Pickups

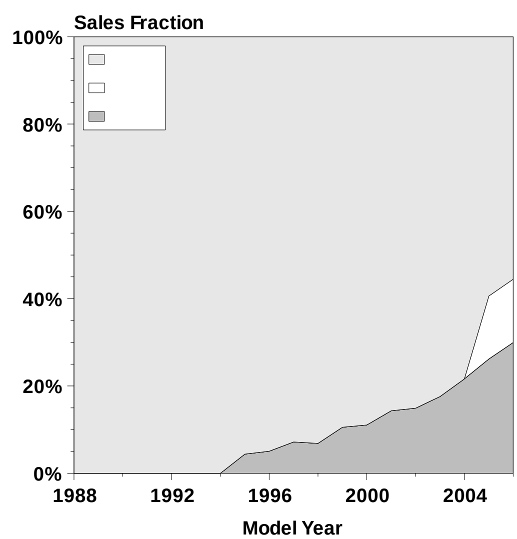


Figure 59

Figures 52 through 55 show that increases in HP per CID apply to all of the engines, except for a couple of case for engines with three valves. Engines with more valves per cylinder deliver higher values of HP per CID. 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 increases in HP and HP-per-CID is due to changes in engine technologies. Figures 56 through 59 show that usage of multi-valve engines is increasing for all vehicle types and as shown in Table 16 for MY2007, is now over 80 percent for cars, nearly 70 percent for SUVs, and about 45 percent for pickups and vans.

Figures 60 and 61 and Table 19 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, with a clear trend towards increased use of variable valve timing. In 1975, about 95 percent of all cars had carburetors as did almost all of the trucks, by 1988 use of carburetors had dropped below the 20 percent level for all vehicle types. For MY2007, nearly 70 percent of cars have multi-valve, port fuel injected engines with variable valve timing, as do about half of SUVs, vans, and pickups.

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

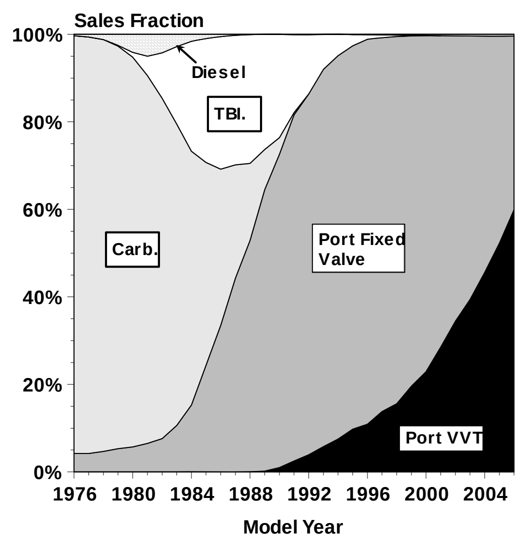


Figure 60

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

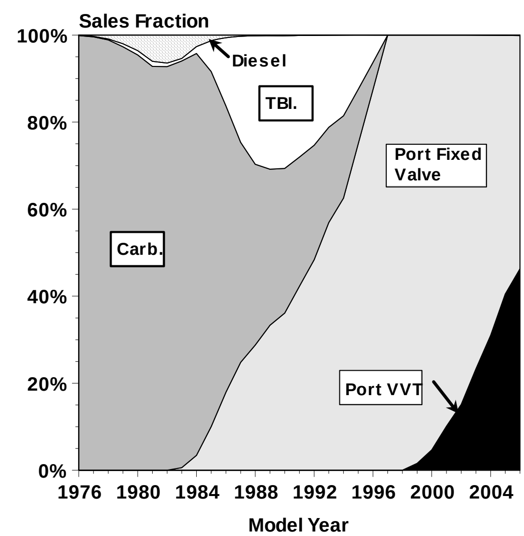


Figure 61

Table 19

Sales Fraction of MY1988 and MY2007 Light Vehicles by Engine Type and Valve Timing

Engine Type	Cars		Vans		SUVs		Pickups		All	
	1988	2007	1988	2007	1988	2007	1988	2007	1988	2007
Carb	16%	---	<1%	---	16%	---	16%	---	15%	---
TBI	30%	---	43%	---	37%	---	48%	---	34%	---
Port Fixed	54%	32%	57%	54%	47%	47%	36%	54	51%	41%
Port Variable	---	65%	---	46%	---	51%	---	46	---	57%
Diesel	<1%	<1%	<1%	---	<1%	<1%	<1%	---	<1%	<1%
Hybrids	---	3%	---	---	---	2%	---	<1%	---	2%

For over a decade and an half, automotive manufacturers have been using engines which use either cams or electric solenoids to provide variable intake and/ or exhaust valve timing and in some cases valve lift. Conventional engines use camshafts which are permanently synchronized with the engine's crankshaft so that they operate the valves at a specific fixed point in each combustion cycle regardless of the speed and load at which the engine is operated. The ability to control valve timing allows the design of an engine combustion chamber with a higher compression level than in engines equipped with fixed valve timing engines which in turn provides greater engine efficiency, more power and improved combustion efficiency. Variable valve timing (VVT) also allows the valves to be operated at different points in the combustion cycle, to provide performance that is precisely tailored to the engine's specific speed and load at any given instant with the valve timing set to allow the best overall performance across the engine's normal operating range. This results in improved engine efficiency under low-load conditions, such as at idle or highway cruising, and increased power at times of high demand. In addition, variable valve timing can result in reduced pumping losses, from the work required to pull air in and push exhaust out of the cylinder.

Because automobile manufacturers are not currently required to provide EPA with data on the type of valve timing their engines have, the data base used to generate EPA's fuel economy trend report was augmented to indicate whether a vehicle had fixed or variable valve timing. The data augmentation was based on data from trade publications and data published by automotive manufacturers. In addition, no differentiation between engines which used cams or solenoids to control the valve timing was made, nor was valve lift considered. For cars, the augmented data covers model years 1989 to 2007, while for trucks the augmentation covered model years 1999 to 2007.

Table 20

Comparison of MY1988 and MY2007 Cars
by Engine Fuel Metering, Number of Valves and Valve Timing

Fuel Metering	Number of Valves	Valve Timing	Horsepower		CID		HP/CID		Ton MPG		0 to 60 Time	
			1988	**2007**	**1988**	**2007**	**1988**	**2007**	**1988**	**2007**	**1988**	**2007**
Carb		Fixed	88	---	131	---	.75	---	37.2	---	14.3	---
TBI	2	Fixed	97	---	141	---	.71	---	36.9	---	13.7	---
Port	2	Fixed	136	261	193	285	.74	.92	36.6	40.4	11.9	8.6
Port	4	Fixed	137	189	131	162	1.05	1.18	37.9	40.2	11.1	9.8
Port	4	Variable	---	194	---	157	---	1.22	---	42.6	---	9.6
Percent Change over 1988 Port Two Valve, Fixed Valve Timing												
Carb		Fixed	-35%	---	-32%	---	1%	---	2%	---	20%	---
TBI	2	Fixed	-29%	---	-27%	---	-4%	---	1%	---	15%	---
Port	2	Fixed	0%	92%	0%	48%	0%	24%	0%	10%	0%	-28%
Port	4	Fixed	1%	38%	-32%	-16%	42%	59%	4%	10%	-7%	-18%
Port	4	Variable	---	43%	---	-19%	---	65%	---	16%	---	-19%

Table 20 compares horsepower, engine size (CID), specific power (HP/CID), Ton- mpg, and estimated 0-to-60 acceleration time for five selected MY1988 and 2007 engine types.

Because 1988 was the peak year for car fuel economy, and because the two valve, fixed valve timing, port injected engine accounted for about half of the car engines built that year, it was selected as a base line engine with its average characteristics compared to those for the MY2007 two- and four-valve, fixed valve timing and four- valve VVT engines. As shown in Figure 62, all three of these MY2007 engine types had substantially higher horsepower than the baseline MY1988 engine, but the MY2007 four valve engines fixed and VVT engines are considerably smaller and have substantially higher specific power. Not all of these improvements in engine design for these engine types that occurred between 1988 and 2007 were used to improve fuel economy as indicated by the nominal 20 percent decrease in 0-to-60 time each achieved. As mentioned earlier, in this report vehicle performance for 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.

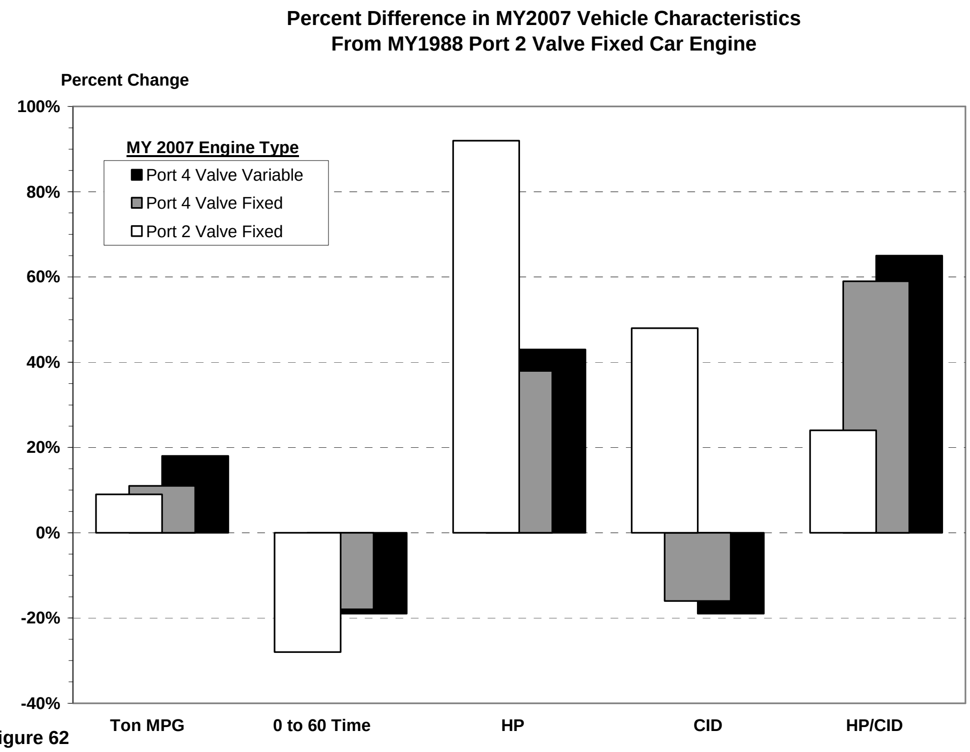


Figure 62

For the current model year fleet, specific power has been studied at an even more detailed level of stratification with both car and truck engines being classified according to: (1) the number of valves per cylinder, (2) the manufacturer's fuel recommendation, (3) the presence or absence of an intake boost device such as a turbocharger or supercharger and (4) whether or not the engine had fixed or variable valve timing. (See Tables 21 and 22.) Higher HP/CID is associated with: (a) more valves per cylinder, (b) higher octane fuel, (c) intake boost and (4) use of variable valve timing. The technical approaches result in specific power ranges for cars and trucks from about .9 to about 1.7. The relative sales fractions in Tables 21 and 22 are just for each technical option in the table and exclude hybrids.

Tables 21 and 22 show 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 20 percent of the current car fleet is comprised of vehicles which use engines for which high octane fuel is recommended. By comparison, about 12 percent of this year's light trucks require premium fuel.

Engine technology which delivers improved specific power thus 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.

Table 21

HP/CID and Sales Fraction by Fuel and Engine Technology

Model Year 2007 Cars

Number of Valves per Cylinder

Fuel/Boost/Valves	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/FIX	.88	.088	----	----	1.11	.175	1.35	----	.263
Regular/No Boost/VVT	1.02	.077	1.07	.010	1.15	.414	----	----	.501
Regular/Boost /FIX	----	----	----	----	----	----	----	----	.000
Regular/Boost /VVT	----	----	----	----	1.52	.001	----	----	.001
Premium/No Boost/FIX	1.16	.013	.89	.001	1.22	.013	1.35	----	.027
Premium/No Boost/VVT	----	----	----	----	1.31	.160	----	----	.160
Premium/Boost /FIX	1.08	.001	1.52	.001	1.62	.028	----	----	.030
Premium/Boost /VVT	----	----	1.52	----	1.67	.017	----	----	.017
Diesel/No Boost	----	----	----	----	----	----	----	----	.000
Diesel/Boost	----	----	----	----	1.16	.001	----	----	.001
Total		.179		.012		.808		----	1.000

Table 22

HP/CID and Sales Fraction by Fuel and Engine Technology

Model Year 2007 Trucks

Number of Valves per Cylinder

Fuel/Boost/Valves	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/FIX	0.90	0.371	1.04	0.009	1.10	0.099	----	----	0.480
Regular/No Boost/VVT	0.97	0.027	0.91	0.056	1.10	0.310	----	----	0.393
Regular/Boost /FIX	----	----	----	----	----	----	----	----	0.000
Regular/Boost /VVT	----	----	----	----	1.53	0.001	----	----	0.001
Premium/No Boost/FIX	1.02	0.006	0.99	0.001	1.18	0.012	----	----	0.019
Premium/No Boost/VVT	1.06	0.012	----	----	1.18	0.088	----	----	0.100
Premium/Boost /FIX	----	----	1.48	----	----	----	----	----	0.000
Premium/Boost /VVT	----	----	1.35	----	1.70	0.005	----	----	0.005
Diesel/No Boost	----	----	----	----	----	----	----	----	0.000
Diesel/Boost	1.03	----	----	----	1.18	0.002	----	----	0.002
Total		0.417		0.066		0.517		----	1.000

A recent engine development has been the reintroduction of cylinder deactivation, an automotive technology that was used by General Motors in some MY1981 V-8 engines that could be operated in 8- , 6- and 4-cylinder modes. This approach, which has also been called by a number of names including ‘variable displacement’, ‘displacement on demand’, ‘active fuel management’ and ‘multiple displacement’, involves allowing the valves of selected cylinders of the engine to remain closed and interrupting the fuel supply to these cylinders when engine power demands are below a predetermined threshold, as typically happens under less demanding driving conditions, such as steady state operation. Under light load conditions, the engine can thus provide better fuel mileage than would otherwise be achieved. Although frictional and thermodynamic energy losses still occur in the cylinders that are not being used, these losses are more than offset by the increased load and reduced specific fuel consumption of the remaining cylinders. Typically half of the usual number of cylinders are deactivated. Challenges to the engine designer for this type of engine include mode transitions, idle quality, and noise and vibration. For MY2007, as shown previously in Table 16, it is estimated that about three percent of cars and about 12 percent of trucks are equipped with cylinder deactivation.

Table 23

Comparison of MY2007 Cars with Engines with Cylinder Deactivation

Car Class	Model Name	Drive	Trans	Inertia Weight	Engine CID	Engine HP	Lab. 55/45	Cyl. Deact.	Pct. Change HP	Pct. Change MPG
Midsize	Grand Prix	Front	L4	4000	325	290	25.1	Yes	16%	-2%
Car	Grand Prix				231	250	25.5	No		
Large	Impala	Front	L4	4000	325	290	24.7	Yes	21%	-4%
Car	Impala				237	240	25.6	No		
	300 AWD	4wd	L5	4500	348	340	23.1	Yes	34%	1%
	300 AWD				215	253	22.8	No		
Midsize	Magnum AWD	4wd	L5	4500	348	340	23.1	Yes	34%	1%
Wagon	Magnum AWD				215	253	22.8	No		

Table 24

Comparison of MY2007 Trucks with Engines with Cylinder Deactivation

Truck Class	Model Name	Drive	Trans	Inertia Weight	Engine CID	Engine HP	Lab. 55/45	Cyl. Deact.	Pct. HP	Change MPG
Midsize Van	Odyssey	Front	L5	4500	212	244	25.0	Yes	0%	5%
	Odyssey				212	244	23.9	No		
Midsize SUV	Grand Cherokee	Rear	L5	5000	348	345	19.5	Yes	50%	-1%
	Grand Cherokee				287	230	19.7	No		
Large SUV	Envoy	4wd	L4	5000	325	280	20.0	Yes	2%	-3%
	Envoy				254	275	20.6	No		
	Durango	Rear	L5	5000	348	345	19.5	Yes	47%	7%
	Durango	Rear	L5	5000	287	235	18.3	No		
Large Pickup	Ram 1500	Rear	L5	5000	348	345	19.5	Yes	47%	7%
	Ram 1500				287	235	18.3	No		
	Ram 1500	4wd	L5	5500	348	345	18.8	Yes	47%	11%
	Ram 1500				287	235	17.0	No		

Table 23 compares examples of individual MY2007 car models with cylinder deactivation with their same-model counterparts with optional smaller engines that do not incorporate cylinder deactivation. For every case in the table, the version of the model equipped with cylinder deactivation has horsepower ratings that are significantly higher and about the same fuel economy. Some of the truck examples in Table 24 indicate that models equipped with cylinder deactivation can achieve both higher horsepower and fuel economy than their counterparts. The data in Tables 23 and 24 indicate cylinder deactivation can be used to increase fuel economy at constant horsepower, or to maintain equivalent fuel economy at higher horsepower levels, or, in some cases, to increase both horsepower and fuel economy.

Car Technology Penetration
Years After First Significant Use

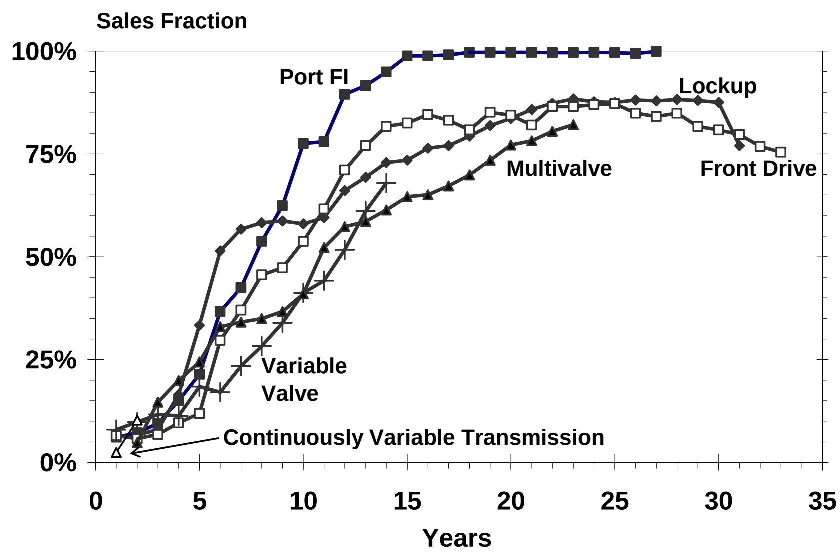


Figure 63

Figure 63 compares penetration rates for six passenger car technologies, namely port fuel injection (Port FI), front-wheel drive (FWD), multi-valve engines (i.e., engines with more than two valves per cylinder), lockup transmissions, engines with variable valve timing, and CVTs. The sales fraction for VVT car engines has increased in a similar fashion to the others shown in the figure. This indicates that, in the past, it has taken 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.

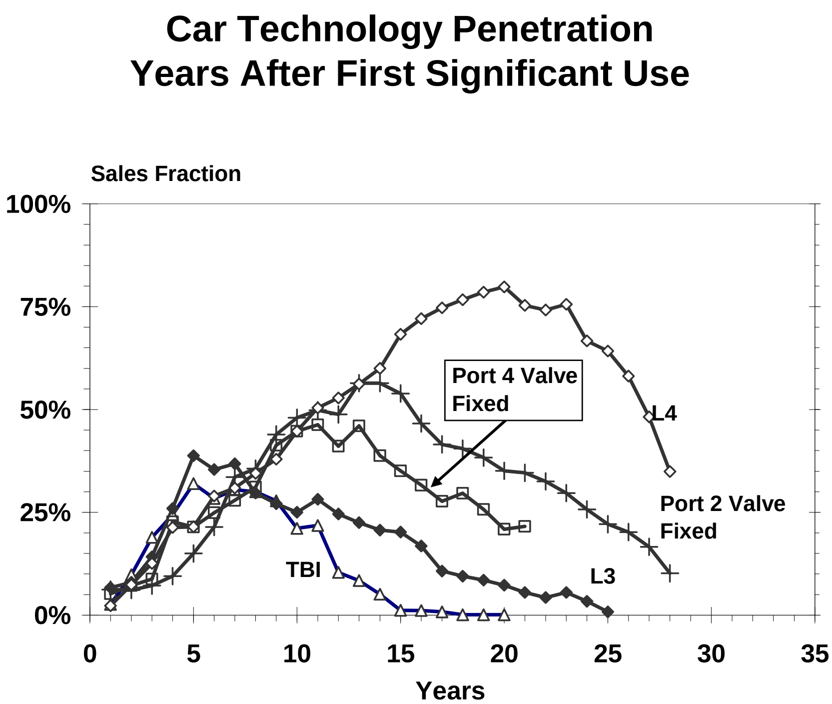


Figure 64

A similar comparison of five technologies whose sales fraction peaked out is shown in Figure 64. This figure shows that, in the past, it has taken a number of years for technologies such as throttle body fuel injection (TBI), lockup 3-speed (L3) and 4-speed (L4) transmissions to reach their maximum sales fraction, and, even then, use of these technologies has often continued for a decade or longer. For the limited number of historical cases studied, the time a given technology has taken to attain and then pass a market share of about 40 to 50 percent appears to be one indicator of whether it later attains a stabilized high level of market penetration. L4 transmissions and both two- and four-valve, port injected, fixed valve timing car engines (Port 2V- and 4V- Fixed) now can be classified with technologies such as TBI engines and L3 transmissions which have reached their peak sales fractions and, thus, are likely to disappear from the new vehicle fleet.

Table 25 compares inertia weight, the fuel economy ratings, the ratio of highway to city fuel economy, and ton-mpg of the MY2007 hybrid and diesel vehicles with those for the average conventionally powered MY2007 car and truck. All of the hybrid and diesel vehicles in the table have a lower highway/city ratio than the average conventional car or truck.

Table 25

Characteristics of MY 2007 Hybrid and Diesel Vehicles

Model Name	Inertia Weight	CID	Trans	Lab 55/45 MPG	<----- Adjusted City MPG	HWY MPG	-----> COMP MPG	HWY/ City Ratio	Ton-MPG
Hybrid Cars									
Prius	3000	91	CVT	65.8	47.7	45.1	46.2	.95	69.3
Altima	3500	152	CVT	46.7	35.1	33.0	33.9	.94	59.3
Accord	4000	183	L5	36.3	24.4	32.1	28.3	1.31	56.5
Gs 450H	4500	211	L6	30.8	21.9	25.3	23.7	1.15	53.4
Civic	3000	82	CVT	58.8	40.2	45.3	42.9	1.13	64.4
Camry	4000	144	CVT	45.9	33.4	34.1	33.8	1.02	67.6
Hybrid Trucks									
Vue	3500	145	L4	34.0	23.3	29.3	26.4	1.26	46.2
RX 400H 2WD	4500	202	CVT	35.0	27.5	24.5	25.7	.89	57.9
Mariner 4WD	4000	140	CVT	36.4	27.6	26.7	27.1	.97	54.1
Highlander 4WD	4500	202	CVT	34.3	26.5	24.6	25.4	.93	57.1
Highlander 2WD	4500	202	CVT	35.0	27.5	24.5	25.7	.89	57.9
Escape FWD	4000	140	CVT	40.6	31.3	28.5	29.7	.91	59.3
Escape 4WD	4000	140	CVT	36.4	27.6	26.7	27.1	.97	54.1
RX 400H 4Wd	4500	202	CVT	34.3	26.5	24.6	25.4	.93	57.1
K15 Silverado classic 4WD	5500	325	L4	20.9	14.9	18.0	16.5	1.21	45.5
K15 Sierra classic 4WD	5500	325	L4	20.9	14.9	18.0	16.5	1.21	45.5
C15 Silverado classic 2WD	5000	325	L4	22.3	15.9	19.2	17.6	1.20	44.0
C15 Sierra classic 2WD	5000	325	L4	22.3	15.9	19.2	17.6	1.20	44.0
Diesel Cars									
R320 CDI 4MATIC	5500	182	L7	28.2	19.0	25.9	22.4	1.36	61.5
E320 BLUETEC	4000	182	L7	34.7	22.8	32.2	27.3	1.41	54.7
Diesel Trucks									
Touareg	6000	300	L6	21.7	14.8	20.0	17.4	1.35	52.2
GL320 CDI 4MATIC	6000	182	L7	26.1	17.9	23.4	20.7	1.30	62.0
Grand Cherokee 4WD	5000	183	L5	25.1	17.5	22.1	19.8	1.27	49.6
Grand Cherokee 2WD	4500	183	L5	26.0	17.9	23.0	20.5	1.28	46.2
ML320 CDI 4MATIC	5000	182	L7	27.5	18.9	24.4	21.7	1.29	54.2
Average Car	3588	176	--	29.4	19.5	27.6	23.4	1.42	42.6
Average Truck	4722	245	--	22.1	15.1	20.4	17.7	1.35	42.0

In addition, there are several cases in the table for which the highway to city 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. For MY2007, the Toyota Prius achieves 79 Ton-mpg, almost twice that of the average car.

All but two of the vehicles in Table 25 (the Toyota Prius and GL320 CDI 4MATIC) have conventionally powered counterparts. Tables 26 and 27 compare the adjusted composite 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 for simplicity there is only one listing for "twin" vehicles, namely: the Escape/ Mariner, the GM C15-K15 Silverado/ Sierra pickups and the Highlander/ RX400 H. 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

Table 26

Comparison of MY2007 Hybrid Vehicles With Their Conventional Counterparts

	<----- Hybrid Version ------>					<---- Baseline Version --->					<Improvement>	
Model Name	**Inertia Weight**	**CID**	**Trans**	**ADJ COMP MPG**	**Gal Per Year***	**Inertia Weight**	**CID**	**Trans**	**ADJ COMP MPG**	**Gal Per Year***	**ADJ COMP MPG**	**Gal Per Year***
Accord	4000	183	L5	28.3	530	3500	183	L5	22.0	682	29%	152
Altima	3500	152	CVT	33.9	442	3500	152	CVT	26.9	558	26%	115
Civic	3000	82	CVT	42.9	350	3000	110	L5	29.6	507	45%	157
Camry	4000	144	CVT	33.8	444	3500	144	L5	25.4	591	33%	147
Vue	3500	145	L4	26.4	568	3500	134	L4	22.8	657	16%	90
Escape FWD	4000	140	CVT	29.7	505	3500	140	L4	21.9	685	36%	180
						3500	140	M5	23.8	630	25%	125
Escape 4WD	4000	140	CVT	27.1	554	3500	140	L4	20.5	732	32%	178
						3500	140	M5	22.4	670	21%	116
Highlander 2WD	4500	202	CVT	25.7	584	4000	202	L5	19.9	754	29%	170
Highlander 4WD	4500	202	CVT	25.4	591	4500	202	L5	19.2	781	32%	191
C15 Silverado Classic 2WD	5000	325	L4	17.6	852	5000	325	L4	16.8	893	5%	41
K15 Silverado Classic 4WD	5500	325	L4	16.5	909	5500	325	L4	16.4	915	1%	6

*Note:

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

torque, but slower 0-to-60 times. In addition, some hybrid vehicles use 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 25 thus typically includes a comparison for the CVT-equipped Escape Hybrid with 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 26 vary considerably from about five percent for the GM pickups to 45 percent for the CVT-equipped Civic hybrid. Similarly, fuel economy improvements for diesels range from 16 to 35 percent, and these vehicles also offer relatively high savings in fuel usage. Several years after the introduction for sale in the U.S. of the first hybrid vehicle, the MY2000 Honda Insight, hybrid vehicles now account for over two percent of the combined car/truck fleet. In addition, the sales fraction for diesels remains below a quarter of one percent, more than an order of magnitude smaller than their 5.9 percent sales fraction in 1981.

Table 27

Comparison of MY2007 Diesel Vehicles With Their Conventional Counterparts

	<----- Hybrid Version ----->					<----- Baseline Version ----->					<Improvement>	
Model Name	**Inertia Weight**	**CID**	**Trans**	**ADJ COMP MPG**	**Gal Per Year***	**Inertia Weight**	**CID**	**Trans**	**ADJ COMP MPG**	**Gal Per Year***	**ADJ COMP MPG**	**Gal Per Year***
E320 BLUETEC**	4000	182	L7	27.3	549	4000	213	L7	20.2	743	35%	193
R320 CDI 4MATIC**	5500	182	L7	22.4	670	5500	213	L7	17.0	882	32%	213
ML320 CDI 4MATIC**	5000	182	L7	21.7	691	5000	213	L7	17.4	862	25%	171
Touareg	6000	300	L6	17.4	862	5500	254	L6	14.8	1014	18%	151
Grand Cherokee 4WD	5000	183	L5	19.8	758	4500	226	L5	17.1	877	16%	120
Grand Cherokee 2WD	4500	215	L5	20.5	732	4500	226	L5	17.7	847	16%	116

*Note:

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

**Note:

Baseline version used for the E320 BLUETEC comparison is the E350. Baseline version used for the R320 CDI 4MATIC comparison is the R350 4MATIC. Baseline version used for the ML320 CDI 4MATIC comparison is the ML350 4MATIC.

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 become more transnational in nature, this type of vehicle classification has become 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, and Daewoo;

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

3) The DaimlerChrysler Group includes Chrysler and Mercedes Benz;

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, Porsche, Lamborghini, Buggati, and Bentley.

Taken together, the eight major marketing groups comprise over 95 percent of the MY2007 new vehicle market in the U.S. It is expected that these marketing groups will continue to evolve and perhaps expand, or possibly contract as further changes in the automotive industry occur. For example, GM sold nearly its entire interest in Suzuki in 2006, and so Suzuki has been deleted from the GM marketing group in this year's report. More recently, Ford sold its interest in Aston Martin, and Daimler sold most of its stake in Chrysler.

Table 28 compares laboratory fuel economy values for the marketing groups described above for model year 2007 with the overall fleet average. For each marketing group, the table also shows the effect of adding certain individual manufacturers in that group. For example, if just GM cars were considered, the GM group would have an average laboratory car fuel economy of 27.9 mpg. Adding Daewoo raises GM's car laboratory value to 28.1 mpg. Adding Saab and Isuzu does not change the value further. Toyota, Honda, and Hyundai-Kia have the highest laboratory fuel economy values, while GM, Ford, and DC have the lowest values. DC is the only marketing group with over 60 percent truck share, while VW is the only one with less than 40 percent truck share. Table 29 presents similar data to that in Table 28, except this table uses adjusted fuel economy values.

A more detailed comparison of model year 2007 laboratory fuel economy, by vehicle type and size, is presented in Table 30. Stratifying by marketing group, vehicle type and size for MY2007, Toyota has the highest laboratory fuel economy average in four of the ten classes in which there is widespread competition, Honda leads in three classes, and GM, HK, and VW each lead in one class. Table 31 is a companion table to Table 30, but like Table 29 uses adjusted mpg data.

Figures 65 through 72 compare for model years 1975 to 2007: 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 of these marketing groups, combined car and truck fuel economy is lower now than it was in 1988. 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 its fuel economy in 1988, 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 1988, can be seen. The results are shown in Figures 73 through 80.

All the marketing groups have lower absolute fuel economy now than they did in 1988. The declines are similar, except the VW Group has not declined as much, due at least in part to the fact their truck share (shown on Figure 72) has remained very low. More information stratified by marketing group can be found in the Appendixes L through O.

Table 28

Model Year 2007 Laboratory 55/45 Fuel Economy by Marketing Group

		<-- FUEL ECONOMY -->			Percent
Group	**Group Member Added**	**Cars**	**Trucks**	**Both**	**Truck**
GM	GM	27.9	21.3	23.8	55%
	Above plus Daewoo	28.1	21.3	24.0	53%
	Above plus Saab	28.1	21.3	24.0	53%
	Above plus Isuzu	28.1	21.3	24.0	53%
	Entire GM Group	28.1	21.3	24.0	53%
Ford	Ford	26.6	20.7	22.8	59%
	Above plus Mazda	27.3	20.8	23.4	54%
	Above plus Volvo	27.3	20.8	23.4	52%
	Above plus Land Rover	27.3	20.6	23.3	53%
	Above plus Jaguar	27.3	20.6	23.3	53%
	Above plus Ast. Mart.	27.2	20.6	23.3	53%
	Entire Ford Group	27.2	20.6	23.3	53%
DC	Chrysler	25.6	21.5	22.8	66%
	Above plus Mercedes	25.1	21.5	22.7	61%
	Entire DC Group	25.1	21.5	22.7	61%
Toyota	Toyota	34.8	24.1	29.0	46%
Honda	Honda	33.4	25.0	28.7	48%
Nissan	Nissan	31.2	21.2	25.8	44%
HK	Kia	33.3	23.9	27.7	52%
	Above plus Hyundai	32.3	24.5	28.6	41%
VW	VW	28.9	19.7	27.4	11%
	Above plus Porsche	28.6	19.7	27.0	13%
	Above plus Bentley	28.3	19.7	26.7	13%
Others		27.6	24.7	26.7	27%
All	Fleet Average	29.4	22.1	25.3	49%

Table 29

Model Year 2007 Adjusted Composite Fuel Economy by Marketing Group

Group	Group Member Added	<-- FUEL ECONOMY --> Cars	Trucks	Both	Percent Truck
GM	GM	22.4	17.2	19.2	55%
	Above plus Daewoo	22.6	17.2	19.4	53%
	Above plus Saab	22.6	17.2	19.4	53%
	Above plus Isuzu	22.6	17.2	19.4	53%
	Entire GM Group	22.6	17.2	19.4	51%
Ford	Ford	21.4	16.7	18.3	59%
	Above plus Mazda	21.9	16.7	18.8	54%
	Above plus Volvo	21.9	16.7	18.8	52%
	Above plus Land Rover	21.9	16.6	18.7	53%
	Above plus Jaguar	21.8	16.6	18.7	53%
	Above plus Ast. Mart.	21.8	16.6	18.7	53%
	Entire Ford Group	21.8	16.6	18.7	53%
DC	Chrysler	20.5	17.3	18.3	66%
	Above plus Mercedes	20.1	17.3	18.3	61%
	Entire DC Group	20.1	17.3	18.3	61%
Toyota	Toyota	27.2	19.1	22.8	46%
Honda	Honda	26.4	20.0	22.9	48%
Nissan	Nissan	24.6	17.0	20.6	44%
HK	Kia	26.2	19.1	22.0	52%
	Above plus Hyundai	25.6	19.5	22.7	41%
VW	VW	23.1	15.8	21.9	11%
	Above plus Porsche	22.9	15.9	21.6	13%
	Above plus Bentley	22.6	15.8	21.4	13%
Others		22.1	19.7	21.4	27%
All	Fleet Average	23.4	17.7	20.2	49%

Table 30

Model Year 2007 Laboratory 55/45 Fuel Economy by Marketing Group

VEHICLE TYPE/SIZE	GM	Ford	DC	Toyota	Honda	Nissan	HK	VW	Others	All
Cars										
Small	29.5	29.0	27.5	34.0	37.8	25.2	35.4	28.7	28.2	30.3
Midsize	27.2	28.0	27.6	35.1	30.1	32.3	34.8	26.1	26.2	30.8
Large	26.5	24.2	22.8	29.8		23.5	28.6	23.6	22.3	25.3
All	27.8	27.2	25.2	34.3	33.1	31.2	32.4	28.2	27.4	29.3
Wagons										
Small	31.5	28.6	27.6	36.4	40.0			29.8	29.0	33.2
Midsize	26.5	28.4	23.0				27.6	28.5	27.8	26.7
Large			22.3							22.3
All	31.5	28.4	24.6	36.4	40.0		27.6	29.0	28.3	30.4
All Cars										
Small	29.8	29.0	27.5	35.3	38.0	25.2	35.4	28.7	28.2	30.8
Midsize	27.2	28.0	26.6	35.1	30.1	32.3	34.5	26.7	26.8	30.5
Large	26.5	24.2	22.6	29.8		23.5	28.6	23.6	22.3	25.1
All	28.1	27.2	25.1	34.8	33.4	31.2	32.3	28.3	27.6	29.4
Vans										
Small										0.0
Midsize	24.5	24.6	24.6	25.9	24.7	24.4	23.8			24.7
Large	19.7									19.7
All	22.9	24.6	24.6	25.9	24.7	24.4	23.8			24.6
SUVs										
Small			20.7						28.6	22.6
Midsize	27.4	25.4	22.0	25.8	25.5	21.4	24.8		23.6	24.6
Large	21.2	19.9	19.3	18.7		21.8	23.1	19.7	23.4	20.8
All	21.6	21.5	21.2	25.2	25.5	21.7	24.7	19.7	24.7	22.6
Pickups										
Small										0.0
Midsize	23.4	22.3		24.6						23.7
Large	20.5	18.8	19.2	19.8	21.4	19.6			20.1	19.7
All	20.6	19.3	19.2	21.7	21.4	19.6			20.1	20.1
Fleet										
All	24.0	23.3	22.7	29.0	28.7	25.8	28.6	26.7	26.7	25.3

Table 31

Model Year 2007 Adjusted Composite Fuel Economy by Marketing Group

VEHICLE TYPE/SIZE	GM	Ford	DC	Toyota	Honda	Nissan	HK	VW	Others	All
Cars										
Small	23.6	23.1	21.8	26.6	29.5	20.2	27.7	22.9	22.5	24.0
Midsize	22.0	22.4	22.1	27.5	24.0	25.4	27.3	21.0	21.1	24.5
Large	21.5	19.6	18.5	23.8		18.9	23.0	19.0	18.1	20.5
All	22.4	21.8	20.3	26.9	26.2	24.6	25.6	22.6	22.0	23.4
Wagons										
Small	24.8	22.9	21.8	28.2	30.7			23.7	23.0	25.9
Midsize	21.5	22.6	18.7				22.0	22.8	22.1	21.4
Large			18.1							18.1
All	24.8	22.6	19.7	28.2	30.7		22.0	23.2	22.4	24.0
All Cars										
Small	23.8	23.1	21.8	27.4	29.6	20.2	27.7	23.0	22.6	24.4
Midsize	22.0	22.4	21.4	27.5	24.0	25.4	27.1	21.5	21.5	24.3
Large	21.5	19.6	18.4	23.8		18.9	23.0	19.0	18.1	20.3
All	22.6	21.8	20.1	27.2	26.4	24.6	25.6	22.6	22.1	23.4
Vans										
Small										0.0
Midsize	19.8	19.7	19.8	20.6	20.0	19.7	19.2			19.9
Large	15.8									15.8
All	18.4	19.7	19.8	20.6	20.0	19.7	19.2			19.8
SUVs										
Small			16.5						22.5	17.9
Midsize	21.9	20.0	17.7	20.3	20.3	17.2	19.7		18.8	19.5
Large	17.2	16.2	15.5	14.9		17.5	18.7	15.9	18.8	16.8
All	17.5	17.4	17.0	19.8	20.3	17.4	19.7	15.9	19.7	18.1
Pickups										
Small										0.0
Midsize	18.9	17.8		19.5						18.8
Large	16.4	15.2	15.5	15.9	17.2	15.8			16.2	15.8
All	16.6	15.5	15.5	17.3	17.2	15.8			16.2	16.2
Fleet										
All	19.4	18.7	18.3	22.8	22.9	20.6	22.7	21.4	21.4	20.2

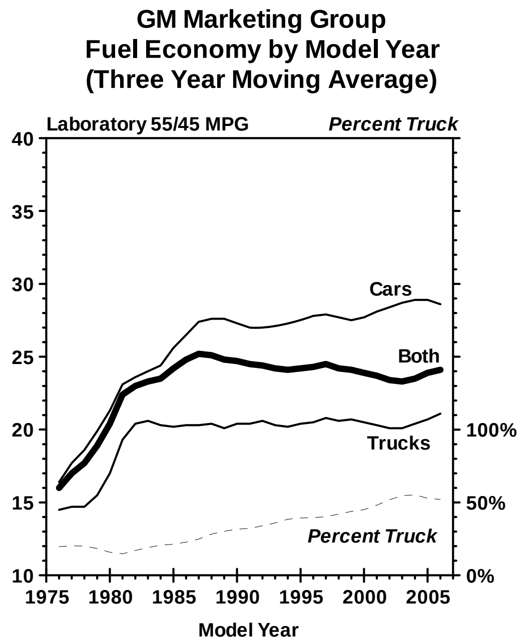


Figure 65

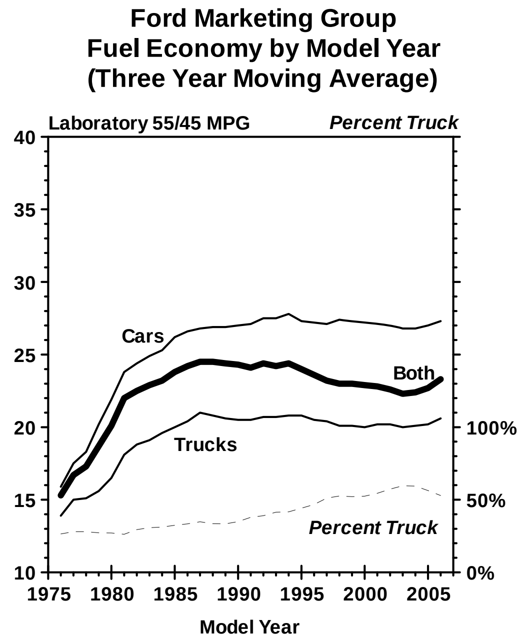
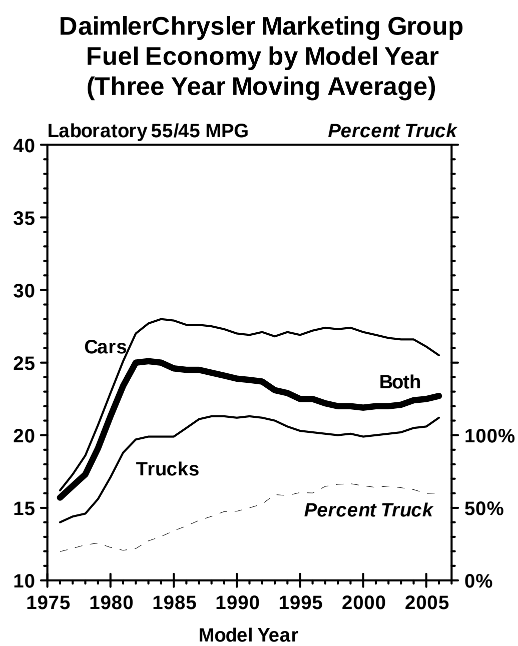


Figure 66



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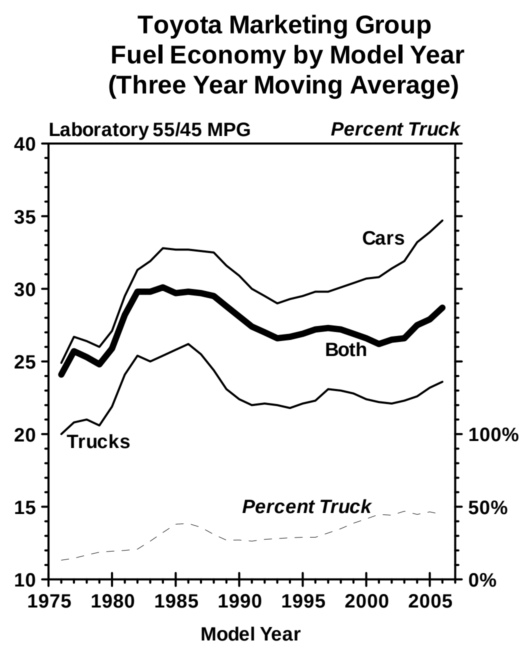

Figure 68

Honda Marketing Group
Fuel Economy by Model Year
(Three Year Moving Average)

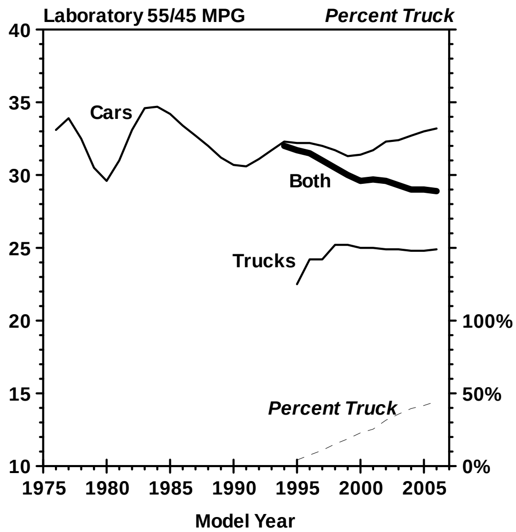

Figure 69

Nissan Marketing Group
Fuel Economy by Model Year
(Three Year Moving Average)

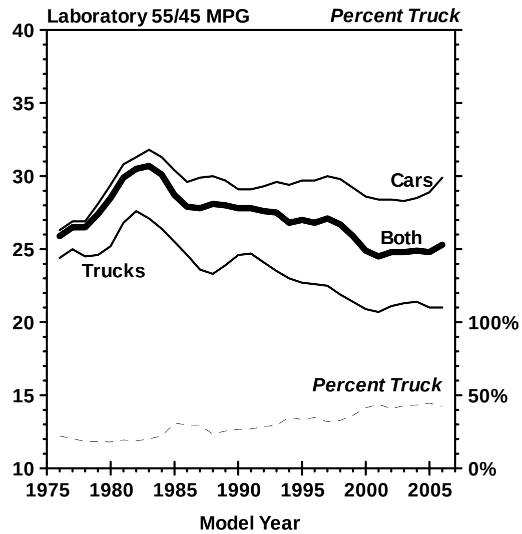

Figure 70

Hyundai-Kia Marketing Group
Fuel Economy by Model Year
(Three Year Moving Average)

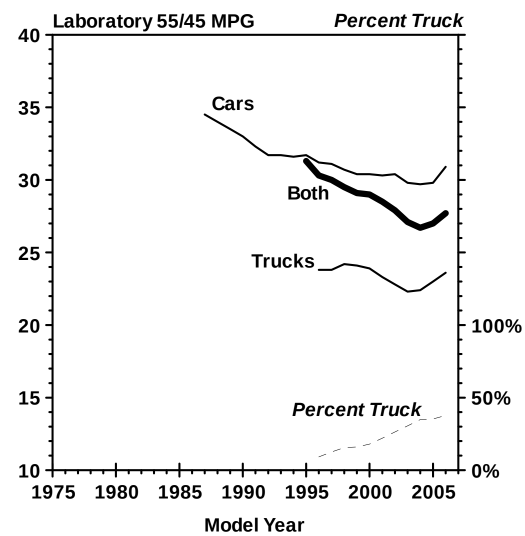

Figure 71

VW Marketing Group
Fuel Economy by Model Year
(Three Year Moving Average)

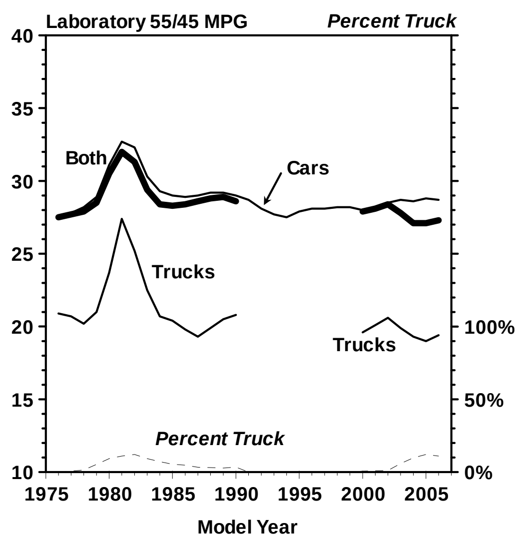

Figure 72

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

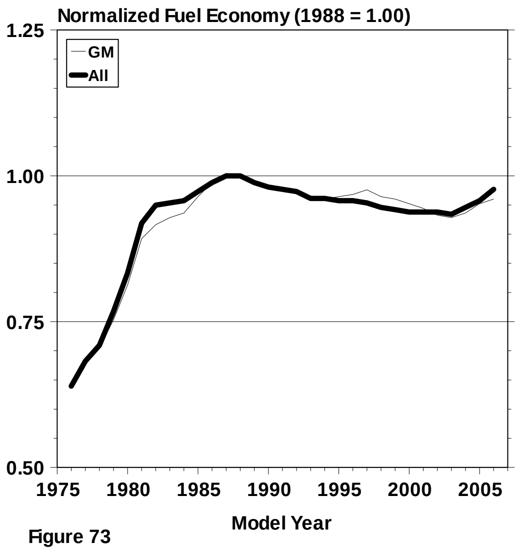

Figure 73

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

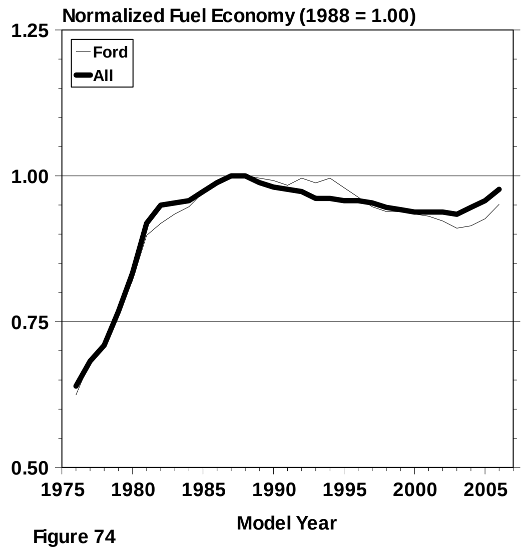

Figure 74

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

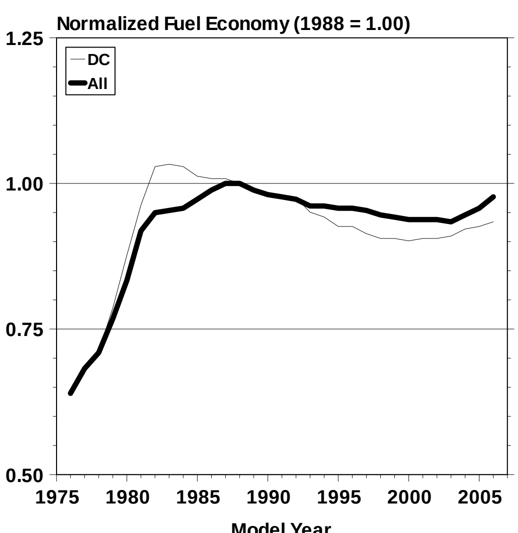

Figure 75

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

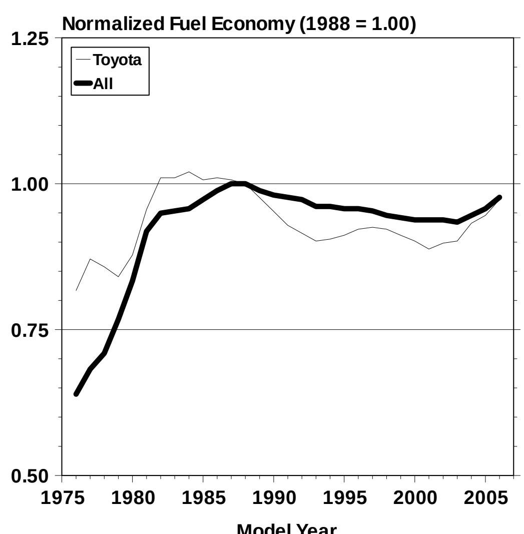

Figure 76

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

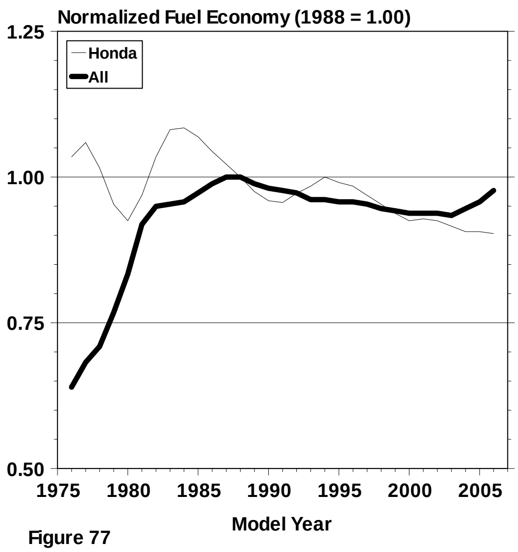

Figure 77

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

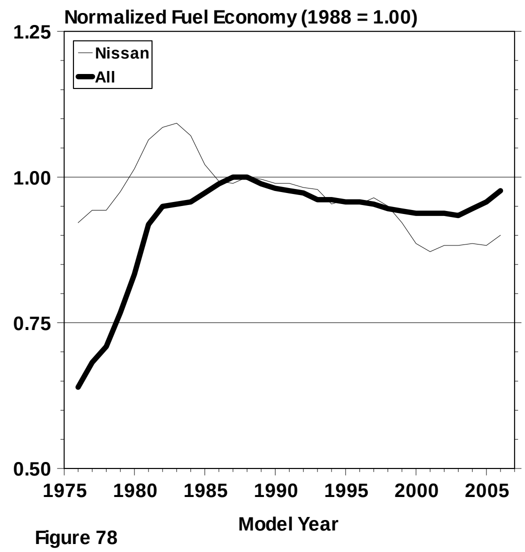

Figure 78

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

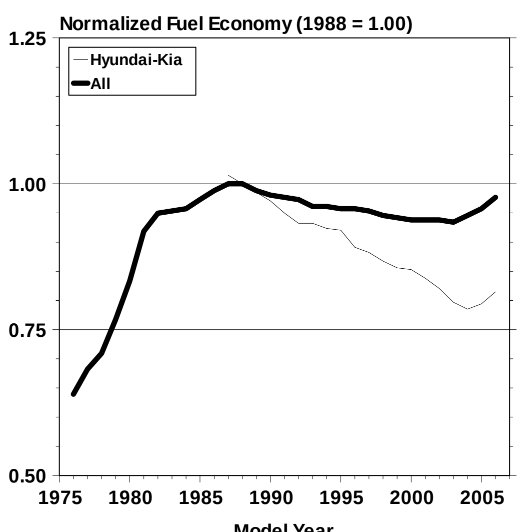

Figure 79

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

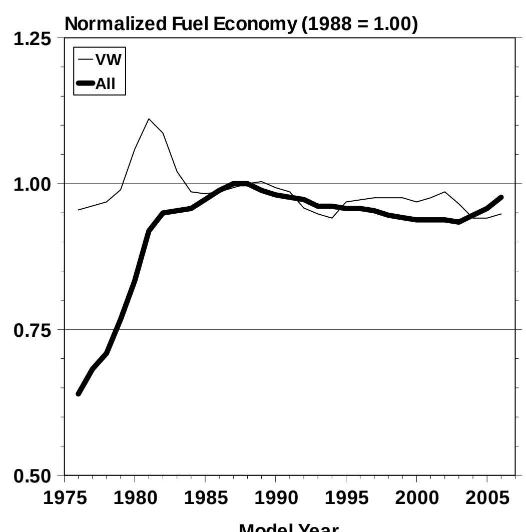

Figure 80

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

This section is limited to a discussion of hypothetical fleets of vehicles comprised of existing fuel-efficient vehicles and the fuel economy and other characteristics of those fleets. While it 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 currently being used 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, as mentioned above, does not treat market risk. 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 3 and 4, 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 three "best in class" (BIC) analysis techniques. This type of 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. 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 analysis is to use as role models the four nameplates with the highest fuel economy in each size class. (See Tables Q-1 and Q-2 in Appendix Q.) 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 different nameplates. 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 Q-3 and Q-4 in Appendix Q 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 Q-5 and Q-6 in Appendix Q 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 32 to 34 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 2007. 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.

Under all of the best-in-class 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 front wheel drive, VVT, CVTs, and hybrid powertrains than the entire fleet as a whole. For trucks, the BIC data set vehicles make greater use of these same technologies plus multi-valve engines.

For both cars and trucks in MY2007, depending on the scenario chosen, cars could have achieved from 16 to 31 percent better fuel economy than they did. Similarly, for trucks the fuel economy improvement ranges from 11 to 23 percent better fuel economy, and the combined car and truck fleet could have been 12 to 32 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.

Table 32

Best in Class Results 2007 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	29.4	38.5	36.5	34.1
	Adjusted City	19.5	25.9	24.4	22.8
	Adjusted Highway	27.6	33.5	32.4	30.8
	Adjusted Composite	23.4	29.7	28.4	26.7
Vehicle Size	Weight (lb.)	3588	3217	3210	3588
	Volume (Cu. Ft)	111	111	111	114
Engine	CID	176	129	131	155
	HP	200	141	146	187
	HP/CID	1.16	1.10	1.12	1.20
	HP/WT	.055	.043	.045	.051
	Percent Multivalve	82%	86%	87%	97%
	Percent Variable Valve	68%	89%	83%	86%
	Percent Diesel	0.1%	<0.1%	<0.1%	0.4%
Performance	0-60 Time (Sec.)	9.5	10.3	10.4	9.7
	Top Speed	138	121	123	133
	Ton-MPG	43.2	50.0	47.0	48.8
	Cu. Ft. Mpg	2732	3479	3273	3134
	Cu. Ft. Ton-MPG	4829	5547	5215	5549
Drive	Front	75%	96%	95%	89%
	Rear	8%	2%	4%	8%
	4WD	17%	2%	2%	3%
Transmission	Manual	12%	11%	15%	12%
	Lockup	77%	59%	59%	50%
	CVT	10%	29%	24%	38%
Hybrid Vehicle		3.0%	28.5%	17.0%	12.6%

Table 33

Best in Class Results 2007 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	22.1	27.2	26.0	24.6
	Adjusted City	15.1	19.0	17.8	16.7
	Adjusted Highway	20.4	23.5	23.4	22.7
	Adjusted Composite	17.7	21.3	20.6	19.7
Vehicle Size	Weight (lb.)	4723	4164	4087	4723
Engine	CID	245	198	195	221
	HP	247	195	203	241
	HP/CID	1.02	0.99	1.05	1.11
	HP/WT	.052	.047	.050	.051
	Percent Multivalve	58%	61%	72%	69%
	Percent Variable Valve	50%	66%	71%	68%
	Percent Diesel	0.2%	1.2%	0.5%	1.6%
Performance	0-60 Time (Sec.)	9.7	9.7	9.9	9.8
	Top Speed	140	130	133	138
	Ton-MPG	42.0	45.4	42.5	46.3
Drive	Front	25%	49%	54%	39%
	Rear	27%	28%	19%	19%
	4WD	49%	24%	28%	42%
Transmission	Manual	4%	5%	9%	3%
	Lockup	93%	54%	72%	91%
	CVT	4%	41%	19%	7%
Hybrid Vehicle		1.4%	30.4%	8.1%	3.8%

Table 34

Best in Class Results 2007 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	25.3	33.4	31.3	28.3
	Adjusted City	17.1	22.8	21.2	19.1
	Adjusted Highway	23.6	29.0	28.0	25.9
	Adjusted Composite	20.2	26.0	24.6	22.5
Vehicle Size	Weight (lb.)	4144	3565	3571	4144
Engine	CID	210	154	157	190
	HP	223	161	169	215
	HP/CID	1.10	1.06	1.09	1.15
	HP/WT	.053	.045	.047	.051
	Percent Multivalve	70%	77%	81%	82%
	Percent Variable Valve	59%	80%	78%	77%
	Percent Diesel	0.1%	0.5%	0.2%	1.0%
Performance	0-60 Time (Sec.)	9.6	10.1	10.2	9.8
	Top Speed	139	124	127	135
	Ton-MPG	42.6	48.3	45.1	47.5
Drive	Front	51%	79%	78%	62%
	Rear	22%	12%	10%	14%
	4WD	28%	10%	12%	24%
Transmission	Manual	8%	9%	13%	7%
	Lockup	85%	58%	65%	72%
	CVT	7%	33%	22%	22%
Hybrid Vehicle		2.2%	29.2%	13.3%	7.9%

Another general approach for determining potential fuel economy improvement is to study the effects on fuel economy caused by the changes that have occurred in the distributions of vehicle weight and size. This technique involves preserving the average characteristics of vehicles within each size or weight strata in today's fleet, but re-mixing the sales distributions to match those of a baseline year and then calculating the fleet wide averages for those characteristics using the re-mixed sales data. The sales distribution of the resultant fleet by *vehicle type and size,* thus is forced to be the same as that for the base year. As with the best in car size class technique, there can be some fluctuation in average interior volume for cars because of the distribution of interior volume within a car class. Similarly, if the sales proportions in each inertia weight class are held the same as the base year's, the sales distribution of the resultant fleet by *weight* remains the same as that for the base year change, and the recalculated average weight is the same as the base year's. In should be noted that both hybrid and diesel vehicles were excluded from the analysis so that only vehicles with conventional powertrains were considered

Table 35 compares laboratory fuel economy, weight, interior volume, engine CID and HP, estimated 0-to-60 time and fuel economy for conventionally powered MY2007 cars as calculated from the actual 2007 sales distribution and then recalculated using the size and weight distributions from MY1981 and MY1988. The base years of 1981 and 1988 were chosen because 1981 was the year with the lowest average weight and horsepower levels, and 1988 was the year with the highest LAB fuel economy. This table includes the actual 1981 and 1988 fleet

Table 35

Characteristics of MY 2007 Cars

Calculated From:	**Inertia Weight**	**Interior Volume**	**Engine CID**	**Engine HP**	**0 to 60 Time**	**Lab 55/45 MPG**
2007 Actual Distribution	3598	111	178	203	9.4	29.0
1981 Weight Distribution	3043	99	137	168	9.7	32.9
1988 Weight Distribution	3047	103	131	154	10.3	33.9
1981 Size Distribution	3517	108	171	199	9.4	29.4
1988 Size Distribution	3516	108	169	196	9.5	29.3
Reference: 1981 Actual	3043	106	178	99	14.1	24.9
Reference: 1988 Actual	3047	107	160	116	12.8	28.6
Percent Change:						
2007 Actual Distribution	0%	0%	0%	0%	0%	0%
1981 Weight Distribution	-15%	-11%	-23%	-17%	3%	13%
1988 Weight Distribution	-15%	-7%	-26%	-24%	10%	17%
1981 Size Distribution	-2%	-3%	-4%	-2%	0%	1%
1988 Size Distribution	-2%	-3%	-5%	-3%	1%	1%
Reference: 1981 Actual	-15%	-5%	0%	-51%	50%	-14%
Reference: 1988 Actual	-15%	-4%	-10%	-43%	36%	-1%

averages as a point of reference. In both of the weight distribution cases, the fuel economy of the re-mixed 2007 fleet would have been higher than actually is: 13% if the 1981 weight distribution is used, 17% if the 1988 weight distribution is used. For both re-mixed weight cases, interior volume is smaller by 11 and 7 percent, respectively, and horsepower substantially lower. Using the MY1981 and MY1988 size mix distributions results in a much smaller change of only a one percent increase in car fuel economy. In addition both of these remixed car class scenarios results in an average weight and horsepower for the hypothetical remixed fleets that is very close to the actual 2007 data.

Table 36 shows similar data for trucks, and as with the car class cases using either the 1981 or the 1988 sales distribution by weight class, results in higher recalculated fuel economy than using the corresponding size class sales distribution. Figures 81 to 84 compare actual fuel economy for all model years from 1975 to 2007 with what it would have been had the distributions of weight or size been the same as 1981 or 1988. For both cars and trucks, using either the 1981 or 1988 weight class distribution, results in significantly high fuel economy improvements than the similar size class cases.

Table 36

Characteristics of MY 2007 Trucks

Calculated From:	**Inertia Weight**	**Engine CID**	**HP**	**0 to 60 Time**	**Lab 55/45 MPG**
2007 Actual Distribution	4728	246	248	9.7	22.0
1981 Weight Distribution	3841	180	198	9.9	29.8
1988 Weight Distribution	3838	180	190	10.3	29.1
1981 Size Distribution	4442	246	242	9.8	22.2
1988 Size Distribution	4301	226	223	10.0	23.0
Reference: 1981 Actual	3841	252	121	14.4	19.7
Reference: 1988 Actual	3838	227	141	12.9	21.2
Percent Change:					
2007 Actual Distribution	0%	0%	0%	0%	0%
1981 Weight Distribution	-19%	-27%	-20%	2%	35%
1988 Weight Distribution	-19%	-27%	-23%	6%	32%
1981 Size Distribution	-6%	0%	-2%	1%	1%
1988 Size Distribution	-9%	-8%	-10%	3%	5%
Reference: 1981 Actual	-19%	2%	-51%	48%	-10%
Reference: 1988 Actual	-19%	-8%	-43%	33%	-4%

Effect of Weight and Size On Car Fuel Economy

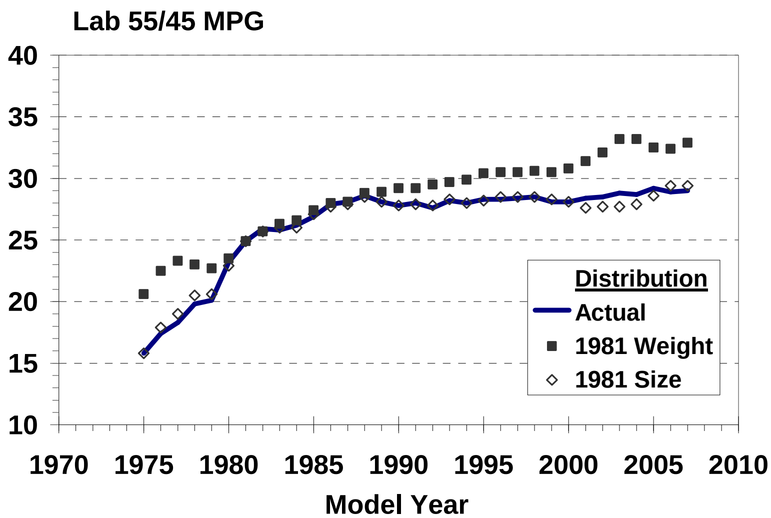

Figure 81

Effect of Weight and Size On Truck Fuel Economy

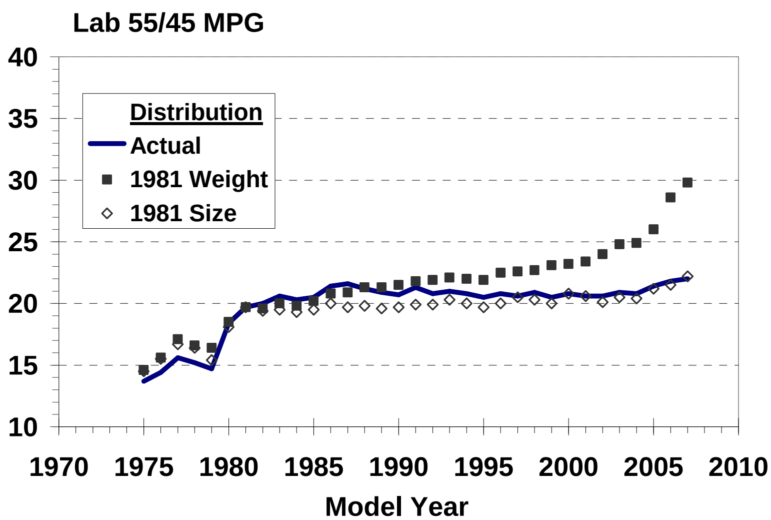

Figure 82

Effect of Weight and Size On Car Fuel Economy

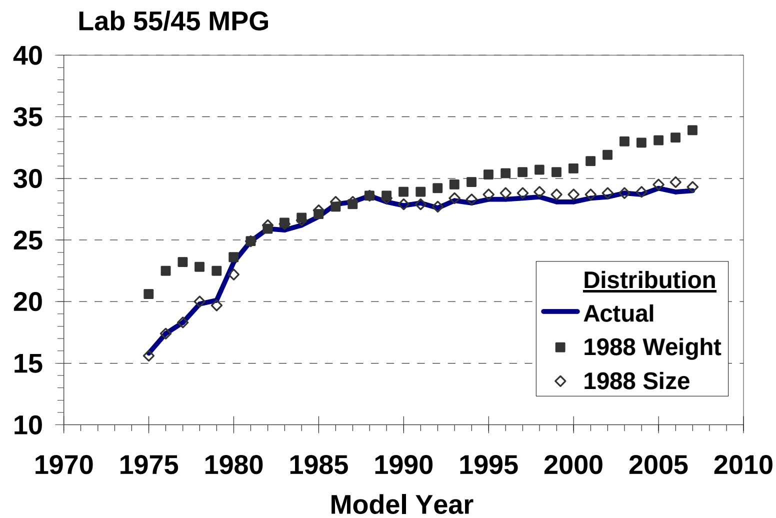

Figure 83

Effect of Weight and Size On Truck Fuel Economy

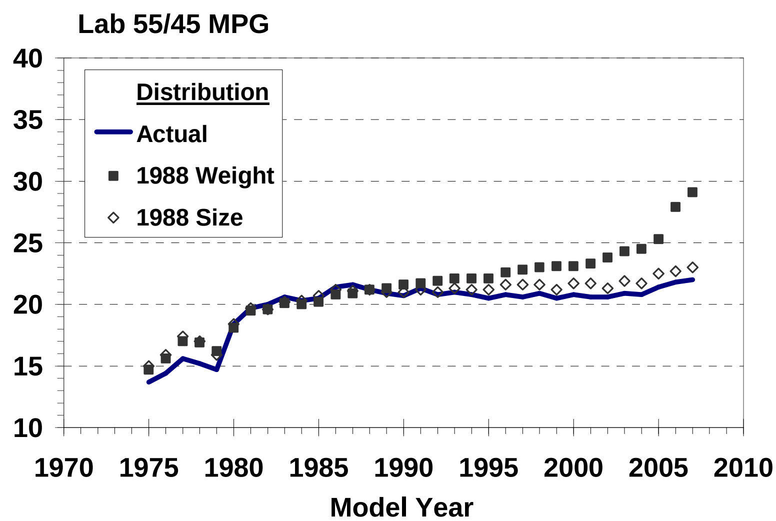

Figure 84

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