Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2010

United States
Environmental Protection
Agency

Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2010

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 carbon dioxide (CO_2) emissions, fuel economy and technology usage related to model year (MY) 1975 through 2010 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, minivans, vans, and pickup trucks with gross vehicle weight ratings up to 8500 pounds). The data in this report supersede the data in previous reports in this series.

Earlier this year, EPA, in conjunction with the National Highway Traffic Safety Administration (NHTSA), published the first-ever light-duty vehicle greenhouse gas emissions standards, under the Clean Air Act, for MY2012-2016 (75 Federal Register 25324, May 7, 2010). These standards are part of a joint, harmonized National Program that also includes corporate average fuel economy (CAFE) standards for the same years established by NHTSA. By MY2016, the average industry-wide compliance levels are projected to be 250 grams per mile (g/mi) CO_2 and 34.1 miles per gallon (mpg) CAFE. The 250 g/mi CO_2 compliance level is equivalent to 35.5 mpg if all CO_2 emissions reductions are achieved through fuel economy improvements. On May 21, 2010, the President announced that EPA and NHTSA would be extending the National Program for MY2017 and beyond, and on October 13, 2010 the agencies published a Notice of Intent to propose new greenhouse gas emissions and CAFE standards by the fall of 2011 (75 Federal Register 62739). Accordingly, this is the second year that Section IV of this report includes tailpipe CO_2 emissions data in addition to the fuel economy data that have been the cornerstone of this report since 1975. Tailpipe CO_2 emissions data represent 90 to 95 percent of total light-duty vehicle greenhouse gas emissions.

Final MY2009 data are based on formal end-of-year CAFE reports submitted by automakers to EPA and will not change. MY2009 was a year of considerable turmoil in the automotive market. Due primarily to the economic recession, light-duty vehicle production totalled 9.2 million units, the lowest of any year since this database began in 1975. This represented a 34% reduction in total vehicle production compared to MY2008, and a 40% drop since MY2007. The Car Allowance Rebate System (or "Cash for Clunkers") likely impacted consumer demand. Fuel prices remained high relative to historic levels, though lower than in the previous three years. The turmoil introduced by these factors is demonstrated by the fact that the final MY2009 values for CO_2 emissions and fuel economy in this report are 25 g/mi lower and 1.3 mpg higher, respectively, than the projected MY2009 values that were provided in last year's report.

The preliminary MY2010 data in this report are based on confidential pre-model year production volume projections provided to EPA by automakers during the MY2009 market turmoil. Accordingly, there is uncertainty in the MY2010 data (for example, total projected vehicle production is significantly higher than actual sales as reported by trade sources). This report will often focus on the final MY2009 data, rather than on the preliminary MY2010 data.

The great majority of the CO_2 emissions and fuel economy values in this report are adjusted (ADJ) EPA "real-world" estimates provided to consumers and based on EPA's 5-cycle test methodology. Appendix A provides a detailed explanation of the method used to calculate these adjusted fuel economy and CO_2 values, which last changed with the 2007 version of this report. On August 30, 2010, EPA and NHTSA proposed to revise the fuel economy labels to include, among other things, tailpipe CO_2 emissions levels, but this proposal does not affect the methodology for calculating the adjusted CO_2 emissions and fuel economy levels provided in this report (75 Federal Register 58078, September 23, 2010). In a few cases, the report also provides unadjusted EPA laboratory (LAB) values, which are based on a 2-cycle test methodology and used for automaker compliance with CO_2 emissions and CAFE standards. All combinations of adjusted or laboratory, and CO_2 emissions or fuel economy values, may be reported as city, highway, or, most commonly, as composite (combined city/highway, or COMP).

Since 1975, overall new light-duty vehicle CO_2 emissions have moved through four phases:

1. A rapid decrease from 1975 through 1981;
2. A slower decrease until reaching a valley in 1987;
3. A gradual increase until 2004; and
4. A decrease for the six years beginning in 2005, with the largest decrease in 2009.

The fleetwide average adjusted (or real world) MY2009 light-duty vehicle CO_2 emissions value is 397 g/mi, which is a 27 g/mi reduction relative to MY2008 and an all-time low since the database began in 1975. The projected fleetwide average MY2010 level is 395 g/mi. This projected MY2010 value is essentially the same as the final MY2009 value, and it is impossible to know, at this time, whether the actual MY2010 value will be higher or lower than the MY2009 value.

Since fuel economy has an inverse relationship to tailpipe CO_2 emissions, overall new light-duty vehicle fuel economy has also moved through four phases, with the trends in fuel economy mirroring those of CO_2 emissions:

1. A rapid increase from 1975 through 1981;
2. A slower increase until reaching its peak in 1987;
3. A gradual decline until 2004; and
4. An increase for the six years beginning in 2005, with the largest increase in 2009.

The fleetwide average adjusted MY2009 light-duty vehicle fuel economy is 22.4 mpg, an increase of 1.4 mpg since MY2008, and the highest since the database began in 1975. The projected fleetwide average MY2010 value is 22.5 mpg. Again, it is impossible to predict whether actual MY2010 fuel economy will be higher or lower than the preliminary MY2010 value.

Because the underlying methodology for generating unadjusted laboratory CO_2 emissions and fuel economy values has not changed since this series began in the mid-1970s, these values provide an excellent basis for comparing long-term CO_2 emissions and fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world driving that are reflected in the adjusted values. These unadjusted laboratory values form the basis for automaker compliance with CO_2 emissions and CAFE standards. Laboratory composite values represent a harmonic average of 55 percent city and 45 percent highway operation, or "55/45." For 2005 and later model years, unadjusted laboratory composite CO_2 emissions values are, on average, about 20 percent lower than adjusted composite CO_2 values, and unadjusted laboratory composite fuel economy values are, on average, about 25 percent greater than adjusted composite fuel economy values. The final MY2009 unadjusted laboratory composite values of 316 g/mi and 28.2 mpg represent a record low for CO_2 emissions and an all-time high for fuel economy since the database began in 1975.

NHTSA has the overall responsibility for the CAFE program. For 2010, the CAFE standards are 27.5 mpg for cars and 23.5 mpg for light trucks (for light trucks, individual manufacturers can choose between the fixed, unreformed 23.5 mpg standard and a reformed vehicle footprint-based standard which yields different compliance targets for each manufacturer). In March 2009, NHTSA promulgated new footprint-based CAFE standards for MY2011. These standards projected average MY2011 industry-wide compliance levels of 30.2 mpg for cars (including a 27.8 mpg alternative minimum standard for domestic cars for all manufacturers) and 24.1 mpg for light trucks. Because of real world adjustments, alternative fuel vehicle credits, and test procedure adjustments, fleetwide NHTSA CAFE values are a minimum of 25 percent higher than EPA adjusted fuel economy values.

Characteristics of Light Duty Vehicles for Six Model Years

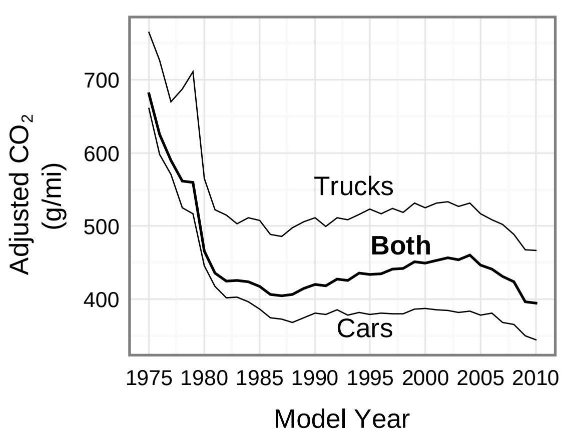
	1975	**1987**	**1998**	**2008**	**2009**	**2010**
Adjusted CO_2 Emissions (g/mi)	681	405	442	424	397	395
Adjusted Fuel Economy (MPG)	13.1	22.0	20.1	21.0	22.4	22.5
Weight (lb)	4060	3221	3744	4085	3917	4009
Horsepower	137	118	171	219	208	220
0 to 60 Time (sec.)	14.1	13.1	10.9	9.7	9.7	9.5
Percent Truck Production	19%	28%	45%	47%	40%	41%
Percent Front-Wheel Drive	5%	58%	56%	54%	63%	59%
Percent Four-Wheel Drive	3%	10%	20%	27%	24%	24%
Percent Four-Cylinder Engine	20%	55%	36%	38%	51%	48%
Percent Eight-Cylinder Engine	62%	15%	18%	17%	12%	16%
Percent Multi-Valve Engine	-	11%	41%	76%	84%	86%
Percent Variable Valve Timing	-	-	-	58%	72%	86%
Percent Cylinder Deactivation	-	-	-	7%	7%	7%
Percent Gasoline Direct Injection	-	-	-	2.3%	4.2%	8.5%
Percent Turbocharger	-	-	1.4%	3.0%	3.3%	3.2%
Percent Manual Transmission	23%	29%	13%	5%	5%	7%
Percent Continuously Variable Transmission	-	-	0%	8%	10%	10%
Percent Hybrid	-	-	-	2.5%	2.3%	4.3%
Percent Diesel	0.2%	0.3%	0.1%	0.1%	0.5%	0.4%

Highlight #1: MY2009 had the lowest CO_2 emission rate and highest fuel economy, partly due to the economic conditions that led to the lowest vehicle production, since the database began in 1975.

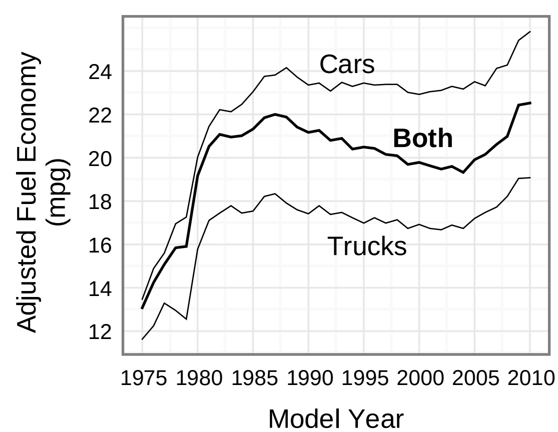
> *MY2009 adjusted composite CO_2 emissions were 397 g/mi, a record low for the post-1975 database. The 27 g/mi (6 percent) decrease compared to MY2008 was the largest yearly CO_2 decrease since 1981. MY2009 adjusted composite fuel economy was 22.4 mpg, an all-time high since the database began in 1975, and the 1.4 mpg (7 percent) increase over MY2008 was the biggest fuel economy increase since 1980. Vehicle production totalled 9.2 million units, the lowest for any year in the database. Projected MY2010 values of 395 g/mi CO_2 emissions and 22.5 mpg fuel economy, reflecting slight improvements over MY2009, are uncertain given the market turmoil when these projections were provided to EPA.*

The previous records for lowest CO_2 emissions and highest fuel economy were in MY1987, and the recent improvements in CO_2 emissions and fuel economy reverse an opposite trend from MY1987 through MY2004. Compared to the previous best year of MY1987, MY2009 CO_2 emissions were 8 g/mi (2 percent) lower, and fuel economy was 0.4 mpg (2 percent) higher. From MY2004 to MY2009, CO_2 emissions decreased by 64 g/mi (14 percent), and fuel economy increased by 3.1 mpg (16 percent).

Adjusted CO_2 Emissions by Model Year



Adjusted Fuel Economy by Model Year



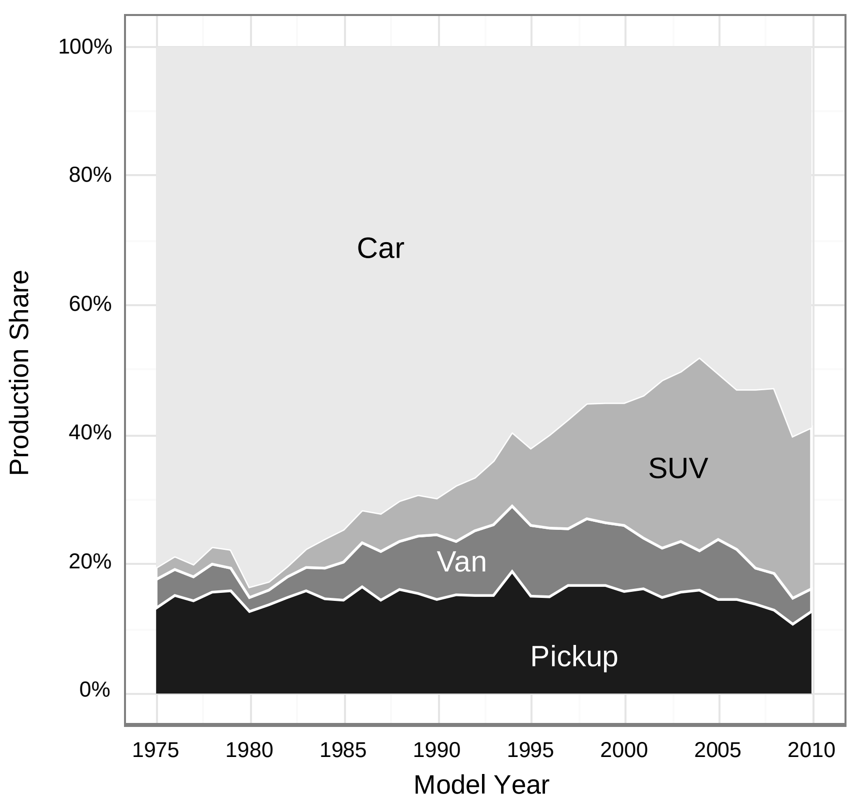
MY2009 unadjusted laboratory composite values, which reflect vehicle design considerations only and do not account for the many factors which affect real world CO_2 emissions and fuel economy performance, were also at an all-time low for CO_2 emissions (316 g/mi) and a record high for fuel economy (28.2 mpg) since the database began in 1975. These values are 27 g/mi (8 percent) lower and 2.3 mpg (9 percent) higher than the previous best values in MY1987.

Highlight #2: MY2009 truck market share dropped by 8 percent to its lowest level since 1995.

> *Light trucks, which include SUVs, minivans/vans, and pickup trucks, accounted for 40 percent of all light-duty vehicle sales in MY2009, an 8 percent decrease since MY2008 and a 12 percent decrease since the peak in MY2004. Truck market share is now at the lowest level since MY1995. The MY2010 light truck market share is projected to be 41 percent, based on pre-model year production projections by automakers.*

Historically, growth in the light truck market was primarily driven by the explosive increase in the market share of SUVs (EPA does not have a separate category for crossover vehicles and classifies many crossover vehicles as SUVs). The SUV market share increased from 6 percent of the overall new light-duty vehicle market in MY1990 to a peak of about 30 percent in MY2004, dropping to 25 percent in MY2009. By comparison, market shares for both vans and pickup trucks have declined since 1990, with van market share falling by over half from 10 percent to 4 percent. The increased overall market share of light trucks, which in recent years have averaged 120 – 140 g/mi higher CO_2 emissions and 6 – 7 mpg lower fuel economy than cars, accounted for much of the increase in CO_2 emissions and decline in fuel economy of the overall new light-duty vehicle fleet from MY1987 through MY2004.

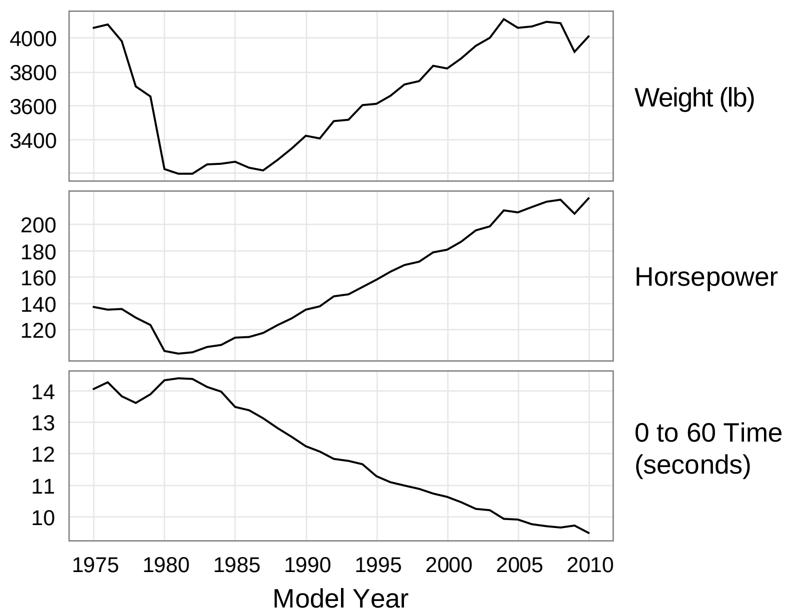
Production Share by Vehicle Type



Highlight #3: MY2009 had the largest annual decrease in vehicle weight and power since 1980.

MY2009 vehicle weight averaged 3917 pounds, the lowest average weight since MY2001. This reflects a decrease of 168 pounds (4 percent) from MY2008, and the largest annual decrease since MY1980. The average truck weight dropped by about 100 pounds, the average car weight dropped by about 60 pounds, and the remaining difference was due to lower truck market share. In MY2009, the average vehicle power was 208 horsepower, the lowest value since MY2003. Average horsepower dropped by 11 horsepower (5 percent), the largest annual decrease since MY1980, with most of the decrease explained by cars having lower horsepower levels and trucks having a lower market share. The four-cylinder engine market share grew from 38 percent in MY2008 to 51 percent in MY2009 (and comprised nearly 70 percent of the car market). Estimated MY2009 0-to-60 acceleration time remained constant at 9.7 seconds.

Weight, Horsepower and 0-to-60 Performance



Vehicle weight and performance are two of the most important engineering parameters that help determine a vehicle's CO_2 emissions and 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 increase a vehicle's CO_2 emissions and decrease fuel economy. Automotive engineers are constantly developing more advanced and efficient vehicle technologies. From MY1987 through MY2004, on a fleetwide basis, this technology innovation was utilized exclusively to support market-driven attributes other than CO_2 emissions and fuel economy, such as vehicle weight, performance, and utility. Beginning in MY2005, technology has been used to increase both fuel economy (which has reduced CO_2 emissions) and performance, while keeping vehicle weight relatively constant.

MY2010 projections are for an increase in both vehicle weight and performance, but these projections are uncertain.

Highlight #4: Nearly every manufacturer increased fuel economy in MY2009, resulting in lower CO_2 emission rates.

All but one of the 14 highest-selling manufacturers increased fuel economy (which also reduced CO_2 g/mi emission rates) from MY2008 to MY2009, the last two years for which we have definitive data, and 7 manufacturers increased fuel economy by 1 mpg or more.

Adjusted CO_2 emissions and fuel economy values are shown for the 14 highest-selling manufacturers, which accounted for 99 percent of the market in MY2009. Manufacturers are defined in accordance with current NHTSA CAFE guidelines, and these definitions are applied retroactively for the entire database back to 1975 for purposes of maintaining integrity of trends over time. In MY2009, the last year for which EPA has final production data, Toyota had the lowest fleetwide adjusted composite CO_2 emissions (and highest fuel economy) performance, followed by Hyundai and Honda. Chrysler, the one manufacturer that did not improve in MY2009, had the highest CO_2 emissions (and lowest fuel economy), followed by Daimler and Ford. Toyota had the biggest improvement in adjusted CO_2 (and fuel economy) performance from MY2008 to MY2009, with a 40 g/mi reduction in fleetwide CO_2 emissions (and 2.6 mpg fuel economy improvement), followed by Nissan (29 g/mi reduction in CO_2 emissions) and Ford (22 g/mi reduction in CO_2 emissions).

Preliminary MY2010 values suggest that most manufacturers will improve further in MY2010, though these projections are uncertain and EPA will not have final data until next year's report.

MY2008–2010 Manufacturer Fuel Economy and CO_2 Emissions (Adjusted Composite Values)

Manufacturer	MY2008 MPG	MY2008 CO_2 (g/mi)	MY2009 MPG	MY2009 CO_2 (g/mi)	MY2010 MPG	MY2010 CO_2 (g/mi)
Toyota	22.8	389	25.4	349	24.5	363
Hyundai	24.4	364	25.1	355	25.9	343
Honda	23.9	372	24.6	361	25.6	346
Kia	22.9	388	24.2	367	25.1	354
VW	22.3	398	23.8	379	24.6	367
Nissan	21.9	406	23.6	377	23.8	373
Mitsubishi	22.3	399	23.5	379	24.2	367
Mazda	23.1	385	23.2	383	22.7	391
Subaru	22.3	399	22.6	393	23.3	382
BMW	21.2	419	21.9	407	22.3	399
GM	19.6	452	20.6	432	20.8	427
Ford	19.3	459	20.3	437	20.5	434
Daimler	19.3	464	19.5	457	19.4	459
Chrysler	19.3	460	19.2	464	19.2	463
All	21.0	424	22.4	397	22.5	395

EPA data is based on model year production, as is CAFE data. This means that year-to-year comparisons can be affected by longer or shorter model year designations by the manufacturers. Section VII has greater detail on the fuel economy and CO_2 emissions for these 14 manufacturers, as well as for these manufacturers' individual makes (i.e., brands).

Important Notes with Respect to the Data Presented in This Report

Most of the CO_2 emissions and fuel economy values in this report are *adjusted* composite (combined city/highway) CO_2 emissions or fuel economy values, consistent with 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*. These adjusted values are based on 5-cycle testing where additional test procedures provide a more accurate representation of real world vehicle usage.

In some tables and figures, *laboratory* composite (combined city/highway) CO_2 or fuel economy values are also shown. These laboratory composite values are based on the 2-cycle results from the EPA Federal Test Procedure and Highway Fuel Economy Test, which are two of the five cycles used for the adjusted CO_2 and fuel economy values. Because the underlying methodology for generating and reporting laboratory values has not changed since this series began in the mid-1970s, these laboratory values provide an excellent basis for comparing long-term CO_2 emissions and fuel economy trends from the perspective of vehicle design, apart from the factors that affect real-world CO_2 and fuel economy that are reflected in the adjusted values. For 2005 and later model years, laboratory composite fuel economy values are, on average, about 25 percent greater than adjusted composite fuel economy values, and laboratory composite CO_2 emissions values are, on average, about 20 percent lower than adjusted composite CO_2 values.

Formal CAFE compliance data as reported by NHTSA do not correlate precisely with either the adjusted or laboratory fuel economy values in this report. While EPA's laboratory composite fuel economy data form 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 percent higher than EPA adjusted fuel economy values for model years 2005 through 2010.

This report supersedes all previous reports in this series. In general, users of this report should rely exclusively on data in this latest report, which covers the years 1975 through 2010, and not make comparisons to data in previous reports in this series. There are two main reasons for this.

One, EPA revised the methodology for estimating real-world fuel economy values in December 2006. This is the fourth report in this series to reflect this revised 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 reports in this series prior to the 2007 report. Accordingly, adjusted fuel economy values for 1986 and later model years should not be compared with the corresponding values from pre-2007 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 six percent lower than under the methodology previously used by EPA. See Appendix A for more in-depth discussion of the current methodology and how it affects both the adjusted fuel economy values for individual models and the historical fuel economy trends database. This same methodology is used to calculate adjusted CO_2 emissions values as well.

Two, when EPA changes a manufacturer or make definition to reflect a change in the industry's current financial arrangements, EPA makes the same adjustment in the historical database as well. This maintains a consistent manufacturer/make definition over time, which allows the identification of long-term trends. On the other hand, it means that the database does not necessarily reflect actual past financial arrangements. For example, the 2010 database, which includes data for the entire time series 1975 through

2010, accounts for all Chrysler vehicles in the 1975-2010 timeframe under the Chrysler manufacturer designation, and no longer reflects the fact that Chrysler was combined with Daimler for several years.

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 there are occasional cases 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.

Vehicle population data in this report represent production delivered for sale in the U.S., rather than actual sales data. Automakers submit production data in formal end-of-year CAFE compliance reports to EPA, which is the basis for this report. Accordingly, the production data in this report may differ from sales data reported by press sources. In addition, the data presented in this report are tabulated on a model year basis. In years past, manufacturers typically used a consistent approach toward model year designations, i.e., from fall of one year to the fall of the following year. More recently, however, many manufacturers have used a more flexible approach and it is not uncommon to see a new or redesigned model be introduced in the spring or summer, rather than the fall. This means that a model year for an individual vehicle can be "stretched out." Accordingly, year-to-year comparisons can be affected by these model year anomalies, though, these even out over a multi-year period. In addition, some 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 2008, 2009, and 2010 is MY2009. Figures are based on annual data unless otherwise noted.

All of the data in this report are from vehicles certified to operate on gasoline or diesel fuel, from laboratory testing with test fuels as defined in EPA test protocols. There are no data from the very small number of vehicles that are certified to operate only on alternative fuels. The data from ethanol flexible fuel vehicles, which can operate on both an 85 percent ethanol/15 percent gasoline blend or gasoline or any mixture in between, are from gasoline operation.

While CO_2 emissions values can be arithmetically averaged, all average fuel economy values were calculated using harmonic rather than arithmetic averaging, in order to maintain mathematical integrity. See Appendix A.

The EPA database for this report was frozen in June 2010.

Through MY2009, the CO_2 emissions, fuel economy, vehicle characteristics, and vehicle production volume 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 through 2009 can be considered final.

For MY2010, EPA has exclusively used confidential pre-model year production volume projections. Accordingly, MY2010 projections are uncertain, particularly given the recent changes in the automotive marketplace driven by the economic recession, fuel prices, and other factors. Historically, the differences between the initial estimates based on vehicle production projections and later, final values have ranged between 0.4 mpg lower to 0.6 mpg higher. But, the market turmoil in MY2009 proved to be a major exception in this regard, as the final MY2009 value reported herein is 1.3 mpg higher than the preliminary value for MY2009 in last year's report based on projected production volumes.

For More Information

*Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 through 20*10 (EPA420-R-10-023) is available on the Office of Transportation and Air Quality's (OTAQ) Web site at:

www.epa.gov/otaq/fetrends.htm

Printed copies are available from the OTAQ library at:

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

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

www.fueleconomy.gov

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

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

www.epa.gov/greenvehicles

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

http://www.nhtsa.dot.gov/fuel-economy

II. Introduction

Light-duty automotive technology, carbon dioxide (CO_2) emissions, and fuel economy trends are examined here, using the latest and most complete EPA data available. Pre-2009 reports in this series [1-35] [1] presented fuel economy and technology trends only, and did not include CO_2 emissions data. Beginning in 2009, reports [36] have included key CO_2 emissions summary tables as well. 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 production and fuel economy data have become available. In addition, changes have been made periodically in the way EPA calculates adjusted fuel economy values. Thus, it is not appropriate to compare adjusted fuel economy values from this report with others in this series. Finally, manufacturer definitions also change over time to reflect changes in the financial arrangements within the automobile industry.

The EPA CO_2 emissions and fuel economy database used in this report was frozen in June 2010. New data beyond that used in last year's report was added for model years 2009 and 2010. Through MY2009, the CO_2 emissions, fuel economy, vehicle characteristics, and production volume data used for this report came from the formal end-of-year submissions from automakers obtained from EPA's database that is used for CAFE compliance purposes, and can be considered to be final. For MY2010, EPA has exclusively used confidential pre-model year production projections submitted to EPA by automakers. Vehicle population data in this report represent production delivered for sale in the U.S., rather than actual sales data. Accordingly, the vehicle production data in this report may differ from sales data reported by press sources. In addition, the data presented in this report were tabulated on a model year, not calendar year, basis. In years past, manufacturers typically used a consistent approach toward model year designations, i.e., from fall of one year to the fall of the following year. More recently, however, many manufacturers have used a more flexible approach and it is not uncommon to see a new or redesigned model be introduced in the spring or summer, rather than the fall. This means that a model year for an individual vehicle can be "stretched out." Accordingly, year-to-year comparisons can be affected by these model year anomalies, though these even out over a multi-year period.

All fuel economy values in this report are production-weighted harmonic averages (necessary to maintain mathematical integrity) and all CO_2 emissions values are production-weighted arithmetic averages. In earlier reports in this series through 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 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*, the *Fuel Economy Labels* that are on new vehicles, and in EPA's *Green Vehicle Guide.* Starting with the MY2001 report, this series has provided fuel economy trends in adjusted mpg values in addition to the laboratory mpg values. Now, most of the tables exclusively show the adjusted CO_2 and fuel economy values. To facilitate comparison with data in older reports in this series, a few data tables include laboratory 55/45 fuel economy values as well as the adjusted city, highway, and composite fuel economy values. In the tables, these two mpg values are called "Laboratory MPG" and "Adjusted MPG," and abbreviated "LAB" MPG and "ADJ" MPG. These same metrics are used for CO_2 emissions values as well.

Where only one CO_2 or mpg value is presented in this report and it is not explicitly identified otherwise, it is the "adjusted composite" value. This value represents a combined city/highway CO_2 or fuel economy value, and is based on equations (see Appendix A) that allow a computation of adjusted city and highway values based on laboratory city and highway test values.

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[1] Numbers in brackets denote references listed in the references section of this report.

It is important to note that EPA revised the methodology by which EPA estimates adjusted fuel economy values in December 2006. This is the fourth report in this series to reflect this new methodology, and every adjusted fuel economy value in this report for 1986 and later model years is lower than given in pre-2007 reports. Accordingly, adjusted fuel economy values for 1986 and later model years should not be compared with corresponding values from older 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 six percent lower than under the methodology previously used by EPA. This same methodology is used to generate adjusted CO_2 emissions values as well. See Appendix A for more in-depth discussion of this new methodology and how it affects both the adjusted CO_2 and fuel economy values for individual models and the historical trends database.

Data are tabulated on a model year basis, but some figures 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 2008, 2009, and 2010 is model year 2009 (See Table A-2, Appendix A). The fuel economy values reported by the Department of Transportation (DOT) for compliance with the Corporate Average Fuel Economy (CAFE) program are higher than the data in this report for four reasons:

1. The DOT data do not include the EPA real world fuel economy adjustments for city and highway mpg;

2. The DOT data include CAFE credits for those manufacturers that produce dedicated alternative fuel vehicles and flexible fuel vehicles (credits generated through the production of flexible fuel vehicles are currently capped at 1.2 mpg per fleet);

3. The DOT data include credits for test procedure adjustments for cars; and

4. There are a few differences in the way 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 for MY1975-2010. Table A-7 shows a more detailed comparison for MY2008 and MY2009, by manufacturer, of values for EPA laboratory fuel economy, alternative fuel vehicle credits, test procedure adjustment credits for cars, and NHTSA CAFE performance.

In the various appendices to this report, when there is no entry under “Model Year,” that means there was no production volume for the parameter in question. Also, there may be some historical technology data elements, such as carbureted fuel systems or rear wheel drive, that have been deleted from some tables because of space limitations. In these cases, technology options may not always add up to 100% for previous years in the database.

While this report contains data through MY2010, it is important to emphasize that the data through MY2009 is based on formal end-of-year CAFE data submitted by automakers to EPA and therefore is final data that will not change. On the other hand, the MY2010 data is based on confidential pre-model year production volume projections provided by manufacturers to EPA in the spring/summer of 2009 and are more uncertain than in most years due to the economic recession, volatile oil prices, and other factors. The uncertainty introduced by these factors is demonstrated by the fact that the actual MY2009 values for CO_2 emissions and fuel economy are 25 g/mi lower and 1.3 mpg higher, respectively, than the projected MY2009 values that were provided in last year’s report. Given the greater uncertainty in the MY2010 data than in other years (for example, the total projected vehicle sales for MY2010 provided to EPA by automakers are significantly higher than actual MY2010 sales as reported by trade sources), this report will often focus as much or more on the MY2009 data than the MY2010 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.

The light truck data used in this series of reports include only vehicles classified as light trucks with gross vehicle weight ratings (GVWR) up to 8500 pounds (lb). The most recent estimates we have made for the impact of 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%) of the MY2001 vehicles above 8500 lb GVWR was 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 production 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% 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.

"Ton-MPG" is defined as a vehicle's mpg multiplied by its weight in tons. 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 at constant mpg can also be considered an improvement. "CO_2/ton" is the equivalent CO_2 metric and is reported in Section IV.

"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. "CO_2/cubic feet" values are given in Section IV.

"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 fuel economy, weight and volume. "CO_2/ton-cubic feet"" is the equivalent CO_2 metric and is shown in Section IV.

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

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

where the coefficients F and f are empirical parameters determined in the literature by obtaining a least-squares fit for available test data. The values for the F and f coefficients are .892 and .805, respectively, for vehicles with automatic transmissions and .967 and .775, respectively, for those with manual transmissions [37]. Other authors [38, 39, and 40] 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 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.

For cars, vehicle classification as it relates to vehicle type and size class generally follows the fuel economy label, *Fuel Economy Guide*, and fuel economy standards protocols. For example, car and wagon classes are based on the interior volume (passenger plus cargo) thresholds described in the *Fuel Economy Guide* (since interior volume is undefined for the two-seater class, this report assigns an interior volume value of 50 cubic feet for all two-seaters). Exceptions to these protocols are listed in Appendix A, Table A-3. In many of the passenger car tables, large sedans and wagons are aggregated as "Large," midsize sedans and wagons are aggregated as "Midsize," and all other cars are aggregated as “Small.” In some of the car tables, an alternative classification system is used, namely: Large Cars, Large Wagons, Midsize Cars, Midsize Wagons, Small Cars, and Small Wagons with the EPA Two-Seater, Mini-Compact, Subcompact, and Compact car classes combined into the "Small Car" class. In some 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 production 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 insignificant.

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.

Published data from external sources is also used for three other vehicle characteristics for which data is not currently being submitted to EPA by the automotive manufacturers, or to supplement data that is submitted to EPA: (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; (2) engines with cylinder deactivation, which involves allowing the valves of selected cylinders of the engine to remain closed under certain driving conditions; and (3) vehicle footprint, which is the product of wheelbase times average track width and upon which future CAFE (MY2011 and later) and CO_2 emissions standards are based.

III. Fuel Economy Trends

Figure 1 and Table 1 depict time trends in car, light truck, and car-plus-light truck fuel economy, as well as truck production share, with the individual data points representing the data for each year, and trend lines representing three-year moving averages. 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 1981;
2. A slow increase until reaching its peak in 1987;
3. A gradual decline until 2004; and
4. An increase beginning in 2005, with the largest increase in 2009.

Figure 1

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

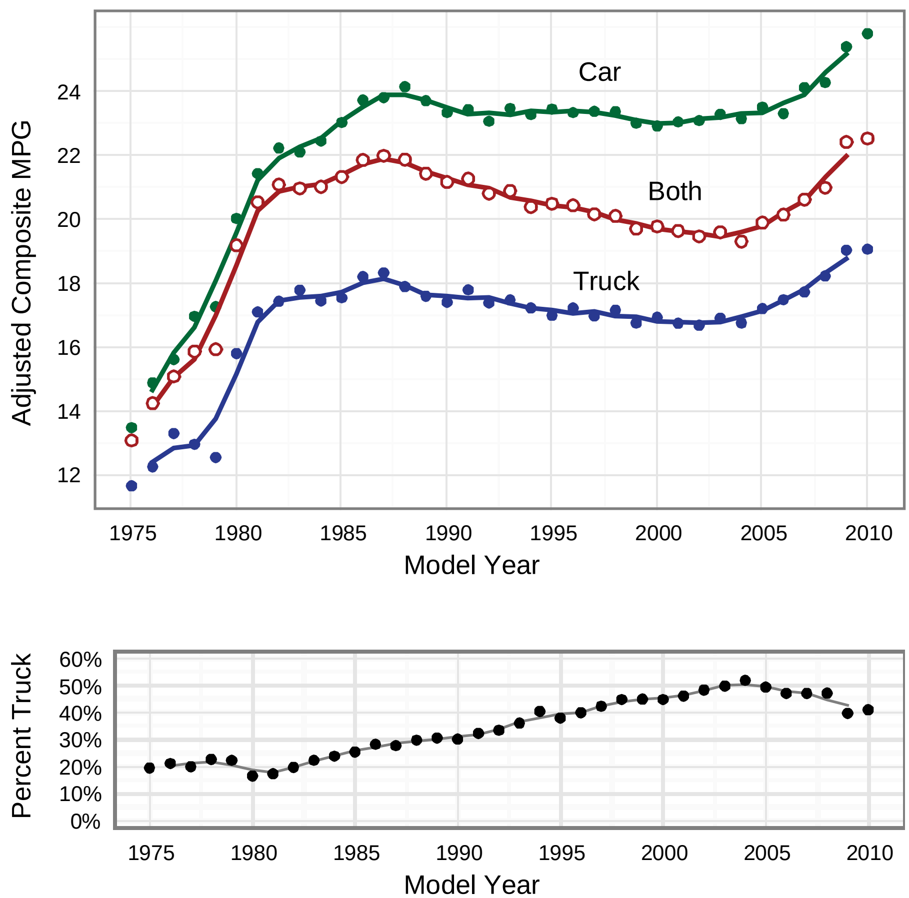


Table 1

Vehicle Size and Design Characteristics of 1975 to 2010 Light Duty Vehicles

Cars

Model Year	Production (000)	Production Percent	Lab City MPG	Lab Hwy MPG	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Cu Ft-MPG	Cu Ft-Ton-MPG
1975	8237	80.6%	13.7	19.5	15.8	12.3	15.2	13.5	27.6	-	-
1976	9722	78.8%	15.2	21.3	17.5	13.7	16.6	14.9	30.2	-	-
1977	11300	80.0%	16.0	22.3	18.3	14.4	17.4	15.6	31.0	1780	3423
1978	11175	77.3%	17.2	24.5	19.9	15.5	19.1	16.9	30.6	1908	3345
1979	10794	77.8%	17.7	24.6	20.3	15.9	19.2	17.2	30.2	1922	3301
1980	9443	83.5%	20.3	29.0	23.5	18.3	22.6	20.0	31.2	2136	3273
1981	8733	82.7%	21.7	31.1	25.1	19.6	24.2	21.4	33.1	2338	3547
1982	7819	80.3%	22.3	32.7	26.0	20.1	25.5	22.2	34.2	2419	3645
1983	8002	77.7%	22.1	32.7	25.9	19.9	25.5	22.1	34.7	2476	3776
1984	10675	76.1%	22.4	33.3	26.3	20.2	26.0	22.4	35.1	2482	3776
1985	10791	74.6%	23.0	34.3	27.0	20.7	26.8	23.0	35.8	2553	3884
1986	11015	71.7%	23.7	35.5	27.9	21.2	27.6	23.7	36.2	2598	3899
1987	10731	72.2%	23.9	35.9	28.1	21.2	27.7	23.8	36.2	2584	3872
1988	10736	70.2%	24.2	36.6	28.6	21.4	28.2	24.1	36.9	2631	3963
1989	10018	69.3%	23.8	36.3	28.1	20.9	27.9	23.7	36.8	2591	3977
1990	8810	69.8%	23.4	36.0	27.8	20.5	27.5	23.3	37.1	2528	3984
1991	8524	67.8%	23.6	36.3	28.0	20.5	27.6	23.4	37.0	2540	3970
1992	8108	66.6%	23.1	36.3	27.6	20.0	27.5	23.1	37.4	2534	4071
1993	8456	64.0%	23.6	36.9	28.2	20.3	27.9	23.5	37.7	2580	4098
1994	8415	59.6%	23.4	36.9	28.0	20.0	27.7	23.3	37.9	2554	4108
1995	9396	62.0%	23.6	37.6	28.3	20.0	28.1	23.4	38.3	2584	4171
1996	7890	60.0%	23.5	37.6	28.3	19.8	28.0	23.3	38.3	2572	4186
1997	8335	57.6%	23.7	37.7	28.4	19.8	28.0	23.4	38.3	2565	4168
1998	7972	55.1%	23.7	37.9	28.5	19.7	28.0	23.4	38.7	2565	4210
1999	8379	55.1%	23.4	37.4	28.2	19.4	27.5	23.0	38.7	2531	4237
2000	9128	55.1%	23.5	37.3	28.2	19.3	27.3	22.9	38.6	2534	4246
2001	8408	53.9%	23.7	37.6	28.4	19.4	27.3	23.0	39.1	2551	4280
2002	8304	51.5%	24.0	37.6	28.6	19.4	27.2	23.1	39.3	2572	4331
2003	7922	50.2%	24.2	38.1	29.0	19.5	27.5	23.3	40.0	2591	4394
2004	7538	48.0%	24.1	38.2	28.9	19.3	27.4	23.1	40.3	2601	4464
2005	8027	50.5%	24.7	38.7	29.5	19.6	27.6	23.5	41.0	2677	4590
2006	7993	52.9%	24.4	38.5	29.2	19.4	27.5	23.3	41.6	2655	4649
2007	8085	52.9%	25.4	39.7	30.3	20.1	28.3	24.1	42.8	2733	4734
2008	7329	52.7%	25.6	40.0	30.5	20.3	28.5	24.3	43.3	2749	4784
2009	5562	60.2%	27.0	41.7	32.1	21.3	29.7	25.4	44.5	2863	4900
2010	-	58.9%	27.6	42.3	32.7	21.7	30.1	25.8	46.1	2947	5100

Table 1 (Continued)

Vehicle Size and Design Characteristics of 1975 to 2010 Light Duty Vehicles

Trucks

Model Year	Production (000)	Production Percent	Lab City MPG	Lab Hwy MPG	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG
1975	1987	19.4%	12.1	16.2	13.7	10.9	12.7	11.6	24.2
1976	2612	21.2%	12.8	16.9	14.4	11.5	13.2	12.2	26.0
1977	2823	20.0%	14.0	18.1	15.6	12.6	14.1	13.3	28.0
1978	3273	22.7%	13.8	17.5	15.2	12.4	13.7	12.9	27.5
1979	3088	22.2%	13.4	16.8	14.7	12.1	13.1	12.5	27.3
1980	1863	16.5%	16.5	21.9	18.6	14.8	17.1	15.8	30.9
1981	1821	17.3%	17.8	23.9	20.1	16.0	18.6	17.1	33.0
1982	1914	19.7%	18.1	24.4	20.5	16.3	19.0	17.4	33.7
1983	2300	22.3%	18.3	25.2	20.9	16.5	19.6	17.8	34.0
1984	3345	23.9%	17.9	24.8	20.5	16.1	19.3	17.4	33.5
1985	3669	25.4%	18.0	24.9	20.6	16.2	19.4	17.5	33.7
1986	4350	28.3%	18.8	25.9	21.4	16.8	20.2	18.2	34.3
1987	4134	27.8%	18.8	26.5	21.6	16.8	20.5	18.3	34.2
1988	4559	29.8%	18.3	26.2	21.2	16.2	20.2	17.9	34.5
1989	4435	30.7%	18.1	25.8	20.9	15.9	19.8	17.6	34.7
1990	3805	30.2%	17.8	25.9	20.7	15.6	19.8	17.4	35.1
1991	4049	32.2%	18.3	26.6	21.3	15.9	20.3	17.8	35.3
1992	4064	33.4%	17.8	26.2	20.8	15.5	19.9	17.4	35.4
1993	4754	36.0%	17.9	26.5	21.0	15.5	20.1	17.5	35.7
1994	5710	40.4%	17.8	26.1	20.8	15.3	19.7	17.2	35.7
1995	5749	38.0%	17.5	25.9	20.5	15.0	19.5	17.0	35.7
1996	5254	40.0%	17.7	26.5	20.8	15.1	19.9	17.2	36.6
1997	6124	42.4%	17.6	26.1	20.6	14.8	19.5	17.0	36.9
1998	6485	44.9%	17.7	26.6	20.9	14.9	19.8	17.1	36.8
1999	6839	44.9%	17.4	26.0	20.5	14.6	19.2	16.7	37.0
2000	7447	44.9%	17.7	26.2	20.8	14.7	19.4	16.9	37.1
2001	7202	46.1%	17.6	26.0	20.6	14.6	19.1	16.7	37.4
2002	7815	48.5%	17.6	26.0	20.6	14.4	19.1	16.7	38.0
2003	7853	49.8%	17.8	26.5	20.9	14.6	19.3	16.9	38.7
2004	8173	52.0%	17.7	26.5	20.8	14.3	19.2	16.7	39.4
2005	7866	49.5%	18.2	27.4	21.4	14.6	19.8	17.2	40.2
2006	7111	47.1%	18.5	27.8	21.8	14.9	20.1	17.5	40.9
2007	7192	47.1%	18.7	28.3	22.1	15.1	20.4	17.7	42.1
2008	6571	47.3%	19.2	29.1	22.7	15.5	21.0	18.2	43.0
2009	3673	39.8%	20.1	30.5	23.8	16.2	21.9	19.0	43.8
2010	-	41.1%	20.2	30.6	23.8	16.2	22.0	19.1	45.3

Table 1 (Continued)

Vehicle Size and Design Characteristics of 1975 to 2010 Light Duty Vehicles

Cars and Trucks

Model Year	Production (000)	Lab City MPG	Lab Hwy MPG	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG
1975	10224	13.4	18.7	15.3	12.0	14.6	13.1	26.9
1976	12334	14.6	20.2	16.7	13.2	15.7	14.2	29.3
1977	14123	15.6	21.3	17.7	14.0	16.6	15.1	30.4
1978	14448	16.3	22.5	18.6	14.7	17.5	15.8	29.9
1979	13882	16.5	22.3	18.7	14.9	17.4	15.9	29.5
1980	11306	19.6	27.5	22.5	17.6	21.5	19.2	31.2
1981	10554	20.9	29.5	24.1	18.8	23.0	20.5	33.1
1982	9732	21.3	30.7	24.7	19.2	23.9	21.1	34.1
1983	10302	21.2	30.6	24.6	19.0	23.9	21.0	34.5
1984	14020	21.2	30.8	24.6	19.1	24.0	21.0	34.7
1985	14460	21.5	31.3	25.0	19.3	24.4	21.3	35.3
1986	15365	22.1	32.2	25.7	19.8	25.0	21.8	35.7
1987	14865	22.2	32.6	25.9	19.8	25.3	22.0	35.7
1988	15295	22.1	32.7	25.9	19.6	25.2	21.9	36.2
1989	14453	21.7	32.3	25.4	19.1	24.8	21.4	36.2
1990	12615	21.4	32.2	25.2	18.7	24.6	21.2	36.5
1991	12573	21.6	32.5	25.4	18.8	24.7	21.2	36.5
1992	12172	21.0	32.1	24.9	18.2	24.4	20.8	36.8
1993	13211	21.2	32.4	25.1	18.2	24.4	20.9	37.0
1994	14125	20.8	31.6	24.6	17.8	23.8	20.4	37.0
1995	15145	20.8	32.1	24.7	17.7	24.1	20.5	37.3
1996	13144	20.8	32.2	24.8	17.6	24.0	20.4	37.6
1997	14459	20.6	31.8	24.5	17.4	23.6	20.1	37.7
1998	14458	20.6	31.9	24.5	17.2	23.6	20.1	37.9
1999	15218	20.3	31.2	24.1	16.9	23.0	19.7	38.0
2000	16574	20.5	31.4	24.3	16.9	23.0	19.8	37.9
2001	15610	20.5	31.1	24.2	16.8	22.8	19.6	38.3
2002	16119	20.4	30.9	24.1	16.6	22.5	19.4	38.7
2003	15775	20.6	31.3	24.3	16.7	22.7	19.6	39.4
2004	15711	20.2	31.0	24.0	16.3	22.4	19.3	39.9
2005	15893	21.0	32.1	24.8	16.8	23.1	19.9	40.6
2006	15105	21.2	32.6	25.2	17.0	23.4	20.1	41.2
2007	15277	21.8	33.4	25.8	17.4	24.0	20.6	42.5
2008	13900	22.1	34.0	26.3	17.7	24.4	21.0	43.2
2009	9235	23.8	36.4	28.2	18.9	26.0	22.4	44.2
2010	-	23.9	36.5	28.3	19.0	26.1	22.5	45.8

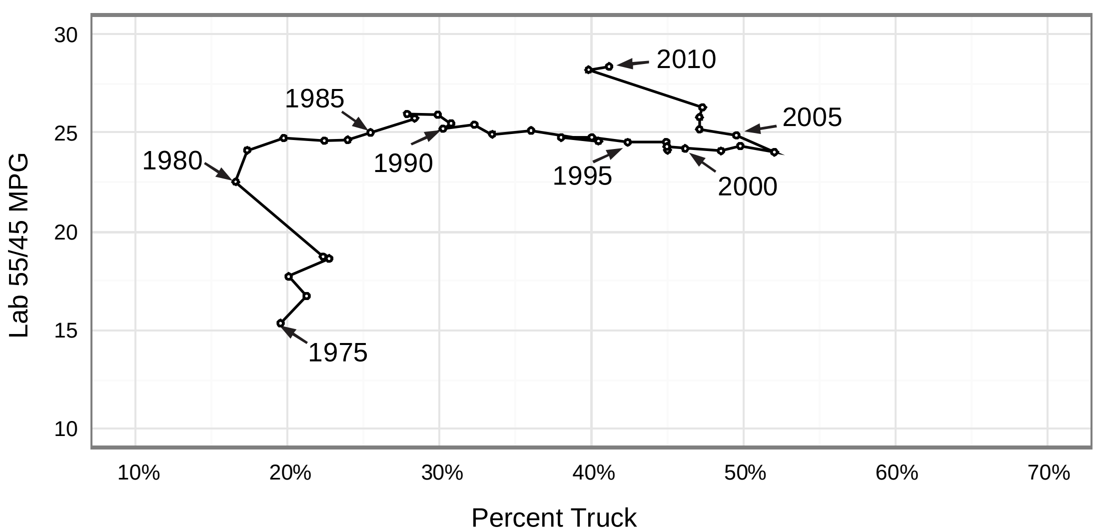
As shown in Table 1, the final fleetwide MY2009 adjusted composite fuel economy is 22.4 mpg, an all-time high. This MY2009 value is 1.4 mpg higher than in MY2008, and the greatest annual increase since 1980. The previous fuel economy high was in MY1987, and the MY2009 value is 0.4 mpg higher than in MY1987. The MY2009 adjusted fuel economy value is 3.1 mpg higher than in MY2004, a 16% increase. The projected MY2010 fleetwide fuel economy value is 22.5 mpg, but there is uncertainty about MY2010 projections given that they are based on automaker submissions to EPA in the spring and summer of 2009 when there was considerable market turmoil. Projected industry-wide MY2010 production is not shown in Table 1, as it is expected that actual MY2010 production will be considerably lower than automaker projections. Average fleetwide fuel economy has now increased for five consecutive years and is projected to increase for a sixth year. These increases reverse the longer term trend of declining adjusted composite fuel economy from 1987 through 2004. As shown in Table 1, based on laboratory 55/45 fuel economy values which reflect vehicle design considerations only, the MY2009 unadjusted fuel economy value of 28.2 mpg is an all-time record, and is 2.3 mpg higher than the previous peak of 25.9 mpg in 1987 and 1988.

Figure 1 shows that the light truck share of the market, based on the three-year moving average trend, peaked at 52% in 2004 and has decreased to near 40% in 2009 and 2010. Figure 2 compares laboratory 55/45 fuel economy for the combined car and truck fleet and the production fraction for trucks.

The MY2009 adjusted fuel economy for cars is estimated to average 25.4 mpg, which is an all-time high. For MY2009, the adjusted fuel economy for light trucks is estimated to average 19.0 mpg, also a record high. Fuel economy standards were unchanged for MY1996 through MY2004. In 2003, DOT raised the truck CAFE standards for MY2005 – 2007, and DOT subsequently raised the truck CAFE standards for MY2008 – 2016 through three separate final rules. The recent fuel economy improvement for trucks is likely due, in part, to these higher standards. The CAFE standard for cars has not changed since 1990, but will change for MY2011 – 2016 as a result of two recent final rules. The final rule for MY2012-2016 for both cars and trucks is at 75 Federal Register 25324, May 7, 2010.

Figure 2

Truck Production Share vs. Fleet MPG by Model Year

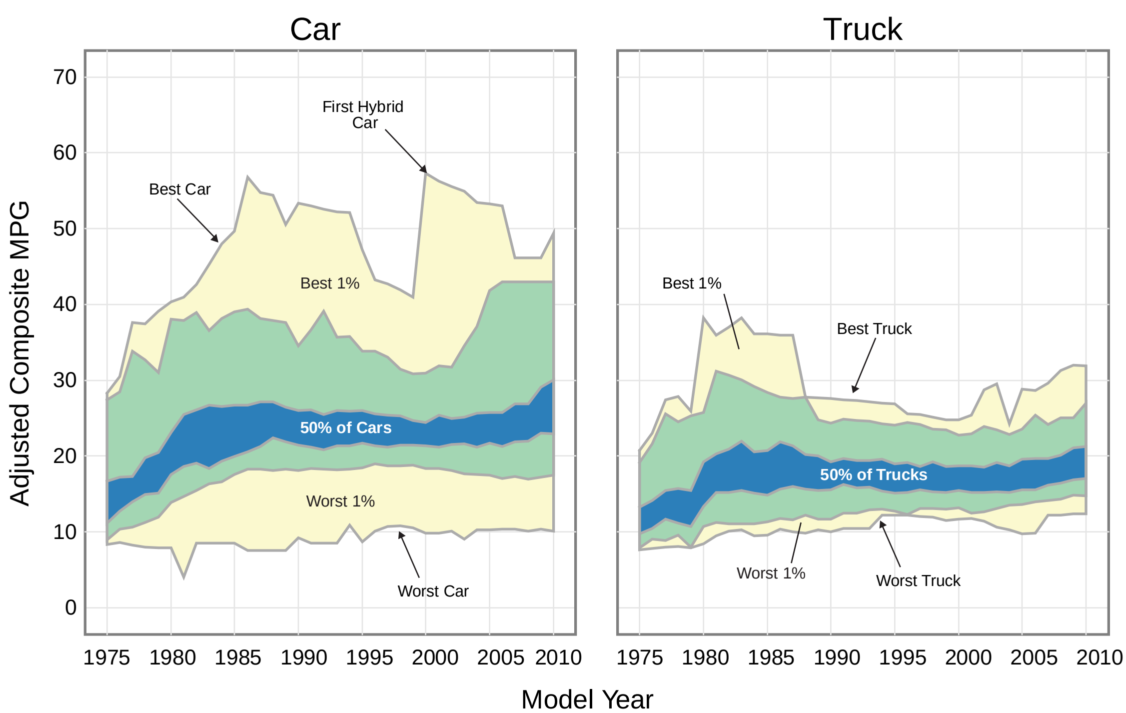


The distribution of fuel economy by model year is of interest. In Figure 3, highlights of the distribution of car and truck mpg are shown. Since 1975, half of the cars have consistently been within a few mpg of each other. The fuel economy difference between the least efficient and most efficient car increased from about 20 mpg in 1975 to nearly 50 mpg in 1986. The increased production share of hybrid cars accounts for the increase in the fuel economy of the best one percent of cars with the cut point for this stratum now about 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 nearly doubled since 1975.

The overall fuel economy distribution trend for trucks 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 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 now about 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

Production Weighted Fuel Economy Distribution



As shown in Table 2, MY2009 vehicle weight averaged 3917 pounds, the lowest average weight since 2001. This reflects a decrease of 168 pounds (4%) from MY2008, and is the largest annual decrease since MY1980. The average truck weight dropped by about 100 pounds, the average car weight decreased by about 60 pounds, and the remaining difference was due to lower truck production share. In MY2009, the average vehicle power was 208 horsepower, the lowest value since MY2003. Average vehicle power dropped by 11 horsepower (5%), the largest annual decrease since MY1980, with most of the decrease explained by cars having lower horsepower levels and trucks having lower production share.

Table 2 also includes vehicle footprint in square feet since MY2008. Footprint is one metric for vehicle size, and is the product of wheelbase and average track width. Essentially, footprint is the area defined by the four points where the tires touch the ground. Footprint is of interest as MY2008 – 2010 light truck CAFE standards allow manufacturers the option to choose footprint-based standards, MY2011 passenger car and light truck CAFE standards are based exclusively on footprint-mpg curves, and MY2012 – 2016 CAFE and CO_2 emissions standards are footprint-based as well. EPA does not receive comprehensive footprint data from manufacturers, so the MY2008 – MY 2010 footprint data in Table 2 is tabulated from external sources such as individual manufacturer websites, Edmonds.com, and Motortrend.com.

For MY2009, industry-wide footprint values were 45.2 square feet for cars, 52.7 square feet for trucks, and 48.2 square feet for cars and trucks combined. Car and truck footprints were both slightly smaller in MY2009 than in MY2008 (less than 1%); however, the overall industry footprint was down nearly 2% due to the decline in truck share. Industry projections for MY2010 cars are unchanged from MY2009. The average footprint for trucks in MY2010 is projected to increase 2.5%, resulting in a fleetwide average near that of MY2008.

The long-term trend since 1981 for both weight and power has been steady increases. Even with the decreases in MY2009 for both weight and power, MY2009 weight is over 700 pounds greater, and MY2009 power has more than doubled, as compared to MY1981. As shown in Figure 4, since 1975, Ton-MPG for both cars and trucks increased substantially (over 67% for cars and 87% for trucks). Typically, Ton-MPG for both vehicle types has increased at a rate of about one or two percent a year.

Table 2

Vehicle Size and Characteristics of 1975 to 2010 Light Duty Vehicles

Cars

Model Year	Production Percent	Adj Comp MPG	Vol (cu ft)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time	Top Speed	Small	Midsize	Large
1975	80.6%	13.5	-	4058	-	136	0.0331	14.2	111	55.4%	23.3%	21.3%
1976	78.8%	14.9	-	4059	-	134	0.0324	14.4	110	55.4%	25.2%	19.4%
1977	80.0%	15.6	110	3944	-	133	0.0335	14.0	111	51.9%	24.5%	23.5%
1978	77.3%	16.9	109	3588	-	124	0.0342	13.7	111	44.7%	34.4%	21.0%
1979	77.8%	17.2	109	3485	-	119	0.0338	13.8	110	43.7%	34.2%	22.1%
1980	83.5%	20.0	104	3101	-	100	0.0322	14.3	107	54.4%	34.4%	11.3%
1981	82.7%	21.4	106	3076	-	99	0.0320	14.4	106	51.5%	36.4%	12.2%
1982	80.3%	22.2	106	3054	-	99	0.0320	14.4	106	56.5%	31.0%	12.5%
1983	77.7%	22.1	109	3112	-	104	0.0330	14.0	108	53.1%	31.8%	15.1%
1984	76.1%	22.4	108	3099	-	106	0.0339	13.8	109	57.4%	29.4%	13.2%
1985	74.6%	23.0	108	3093	-	111	0.0355	13.3	111	55.7%	28.9%	15.4%
1986	71.7%	23.7	107	3041	-	111	0.0360	13.2	111	59.5%	27.9%	12.6%
1987	72.2%	23.8	107	3031	-	112	0.0365	13.0	112	63.5%	24.3%	12.2%
1988	70.2%	24.1	107	3047	-	116	0.0375	12.8	113	64.8%	22.3%	12.8%
1989	69.3%	23.7	108	3099	-	121	0.0387	12.5	115	58.3%	28.2%	13.5%
1990	69.8%	23.3	107	3176	-	129	0.0401	12.1	117	58.6%	28.7%	12.8%
1991	67.8%	23.4	107	3154	-	132	0.0413	11.8	118	61.5%	26.2%	12.3%
1992	66.6%	23.1	108	3240	-	141	0.0428	11.5	120	56.5%	27.8%	15.6%
1993	64.0%	23.5	108	3207	-	138	0.0425	11.6	120	57.2%	29.5%	13.3%
1994	59.6%	23.3	108	3250	-	143	0.0432	11.4	121	58.5%	26.1%	15.4%
1995	62.0%	23.4	109	3263	-	152	0.0460	10.9	125	57.3%	28.6%	14.0%
1996	60.0%	23.3	109	3282	-	154	0.0464	10.8	125	54.3%	32.0%	13.6%
1997	57.6%	23.4	109	3274	-	156	0.0469	10.7	126	55.1%	30.6%	14.3%
1998	55.1%	23.4	109	3306	-	159	0.0475	10.6	127	49.4%	39.1%	11.4%
1999	55.1%	23.0	109	3365	-	164	0.0481	10.5	128	47.7%	39.7%	12.6%
2000	55.1%	22.9	110	3369	-	168	0.0492	10.4	129	47.5%	34.3%	18.2%
2001	53.9%	23.0	109	3380	-	168	0.0492	10.3	129	50.9%	32.3%	16.8%
2002	51.5%	23.1	110	3391	-	173	0.0504	10.2	131	48.6%	36.3%	15.1%
2003	50.2%	23.3	110	3417	-	176	0.0510	10.0	132	50.6%	33.5%	15.9%
2004	48.0%	23.1	110	3462	-	182	0.0521	9.8	133	47.4%	35.5%	17.0%
2005	50.5%	23.5	111	3463	-	182	0.0518	9.8	133	44.2%	38.9%	16.8%
2006	52.9%	23.3	112	3534	-	194	0.0540	9.6	136	46.2%	32.9%	20.9%
2007	52.9%	24.1	110	3507	-	189	0.0531	9.6	135	44.6%	40.0%	15.4%
2008	52.7%	24.3	110	3527	45.4	193	0.0536	9.6	136	44.7%	35.8%	19.5%
2009	60.2%	25.4	110	3463	45.2	184	0.0520	9.8	133	48.2%	34.6%	17.2%
2010	58.9%	25.8	110	3499	45.2	192	0.0537	9.5	136	47.8%	38.5%	13.8%

Table 2 (continued)

Vehicle Size and Characteristics of 1975 to 2010 Light Duty Vehicles

Trucks

Model Year	Production Percent	Adj Comp MPG	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time	Top Speed	Van	SUV	Pickup
1975	19.4%	11.6	4072	-	142	0.0349	13.6	114	23.0%	9.4%	67.6%
1976	21.2%	12.2	4155	-	141	0.0340	13.8	113	19.2%	9.3%	71.4%
1977	20.0%	13.3	4135	-	147	0.0356	13.3	115	18.2%	10.0%	71.8%
1978	22.7%	12.9	4151	-	146	0.0351	13.4	114	19.1%	11.6%	69.3%
1979	22.2%	12.5	4252	-	138	0.0325	14.3	111	15.6%	13.0%	71.5%
1980	16.5%	15.8	3869	-	121	0.0313	14.5	108	13.0%	9.9%	77.1%
1981	17.3%	17.1	3806	-	119	0.0311	14.6	108	13.5%	7.5%	79.1%
1982	19.7%	17.4	3806	-	120	0.0317	14.5	109	16.2%	8.5%	75.3%
1983	22.3%	17.8	3763	-	118	0.0313	14.5	108	16.6%	12.6%	70.8%
1984	23.9%	17.4	3782	-	118	0.0310	14.7	108	20.2%	18.7%	61.1%
1985	25.4%	17.5	3795	-	124	0.0326	14.1	110	23.3%	20.0%	56.6%
1986	28.3%	18.2	3738	-	123	0.0330	14.0	110	24.0%	17.8%	58.2%
1987	27.8%	18.3	3713	-	131	0.0351	13.3	113	26.9%	21.1%	51.9%
1988	29.8%	17.9	3841	-	141	0.0366	12.9	115	24.8%	21.2%	53.9%
1989	30.7%	17.6	3921	-	146	0.0372	12.8	116	28.8%	20.9%	50.3%
1990	30.2%	17.4	4005	-	151	0.0377	12.6	117	33.2%	18.6%	48.2%
1991	32.2%	17.8	3948	-	150	0.0379	12.6	117	25.5%	27.0%	47.4%
1992	33.4%	17.4	4056	-	155	0.0382	12.5	118	30.0%	24.7%	45.3%
1993	36.0%	17.5	4073	-	162	0.0398	12.1	120	30.3%	27.6%	42.1%
1994	40.4%	17.2	4125	-	166	0.0403	12.0	121	24.8%	28.4%	46.7%
1995	38.0%	17.0	4184	-	168	0.0401	12.0	121	28.9%	31.6%	39.5%
1996	40.0%	17.2	4225	-	179	0.0423	11.5	124	26.8%	36.0%	37.2%
1997	42.4%	17.0	4344	-	187	0.0429	11.4	126	20.7%	40.0%	39.3%
1998	44.9%	17.1	4283	-	187	0.0435	11.2	126	23.0%	39.8%	37.2%
1999	44.9%	16.7	4412	-	197	0.0446	11.0	128	21.4%	41.4%	37.2%
2000	44.9%	16.9	4375	-	197	0.0448	11.0	128	22.7%	42.2%	35.1%
2001	46.1%	16.7	4463	-	209	0.0466	10.6	131	17.1%	47.9%	35.0%
2002	48.5%	16.7	4546	-	219	0.0482	10.4	134	15.9%	53.6%	30.5%
2003	49.8%	16.9	4586	-	221	0.0481	10.4	134	15.7%	52.8%	31.5%
2004	52.0%	16.7	4710	-	236	0.0501	10.0	137	11.7%	57.7%	30.7%
2005	49.5%	17.2	4668	-	237	0.0505	10.0	137	18.8%	51.9%	29.2%
2006	47.1%	17.5	4665	-	235	0.0502	10.0	137	16.4%	52.8%	30.8%
2007	47.1%	17.7	4752	-	248	0.0520	9.8	140	11.8%	58.8%	29.4%
2008	47.3%	18.2	4707	53.0	247	0.0521	9.7	140	12.0%	60.7%	27.3%
2009	39.8%	19.0	4605	52.7	245	0.0528	9.6	140	10.0%	63.0%	26.9%
2010	41.1%	19.1	4738	54.0	259	0.0544	9.4	143	8.5%	60.7%	30.8%

Table 2 (continued)

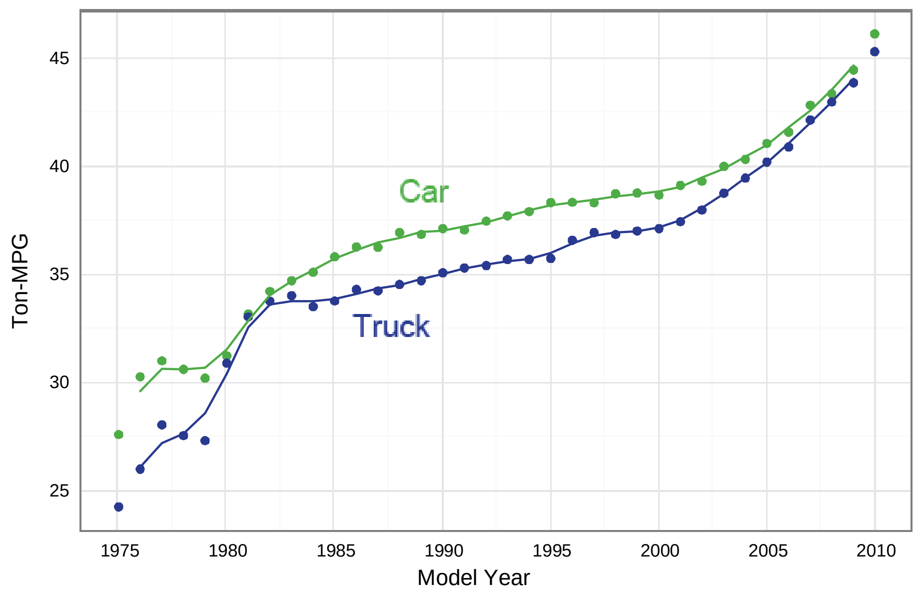
Vehicle Size and Characteristics of 1975 to 2010 Light Duty Vehicles

Cars and Trucks

Model Year	Adj Comp MPG	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time	Top Speed
1975	13.1	4060	-	137	0.0335	14.1	112
1976	14.2	4079	-	135	0.0328	14.3	111
1977	15.1	3982	-	136	0.0339	13.8	112
1978	15.8	3715	-	129	0.0344	13.6	112
1979	15.9	3655	-	124	0.0335	13.9	110
1980	19.2	3228	-	104	0.0320	14.3	107
1981	20.5	3202	-	102	0.0318	14.4	107
1982	21.1	3202	-	103	0.0320	14.4	107
1983	21.0	3257	-	107	0.0327	14.1	108
1984	21.0	3262	-	109	0.0332	14.0	109
1985	21.3	3271	-	114	0.0347	13.5	110
1986	21.8	3238	-	114	0.0351	13.4	111
1987	22.0	3221	-	118	0.0361	13.1	112
1988	21.9	3283	-	123	0.0372	12.8	114
1989	21.4	3351	-	129	0.0382	12.5	115
1990	21.2	3426	-	135	0.0394	12.2	117
1991	21.2	3410	-	138	0.0402	12.1	118
1992	20.8	3512	-	145	0.0413	11.8	120
1993	20.9	3519	-	147	0.0416	11.8	120
1994	20.4	3603	-	152	0.0420	11.7	121
1995	20.5	3613	-	158	0.0438	11.3	123
1996	20.4	3659	-	164	0.0447	11.1	125
1997	20.1	3727	-	169	0.0452	11.0	126
1998	20.1	3744	-	171	0.0457	10.9	126
1999	19.7	3835	-	179	0.0465	10.7	128
2000	19.8	3821	-	181	0.0472	10.6	129
2001	19.6	3879	-	187	0.0480	10.5	130
2002	19.4	3951	-	195	0.0493	10.3	132
2003	19.6	3999	-	199	0.0496	10.2	133
2004	19.3	4111	-	211	0.0511	9.9	135
2005	19.9	4059	-	209	0.0512	9.9	135
2006	20.1	4067	-	213	0.0522	9.8	137
2007	20.6	4093	-	217	0.0525	9.7	137
2008	21.0	4085	49.0	219	0.0529	9.7	138
2009	22.4	3917	48.2	208	0.0523	9.7	136
2010	22.5	4009	48.8	220	0.0540	9.5	139

Figure 4

Ton-MPG by Model Year
(with Three-Year Moving Average)



Another dramatic long-term trend has been the substantial increase in performance of cars and light trucks as measured by their estimated 0-to-60 mph acceleration time. These trends are shown graphically in Figure 5, which plots fuel economy versus performance for model years since 1975. 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 production share trend in understanding trends in overall fleet mpg.

Figure 6 is similar to Figure 5, but shows the trends in weight and laboratory fuel economy and 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 recently.

Figure 5

Laboratory MPG vs. 0-to-60 Time by Model Year

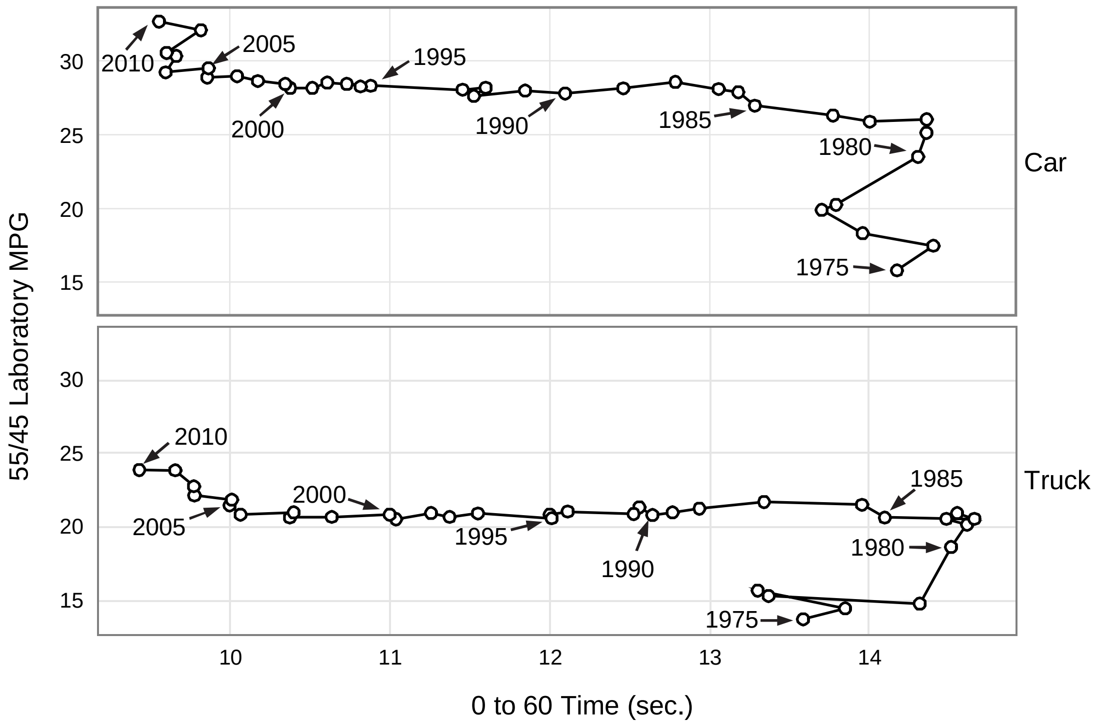
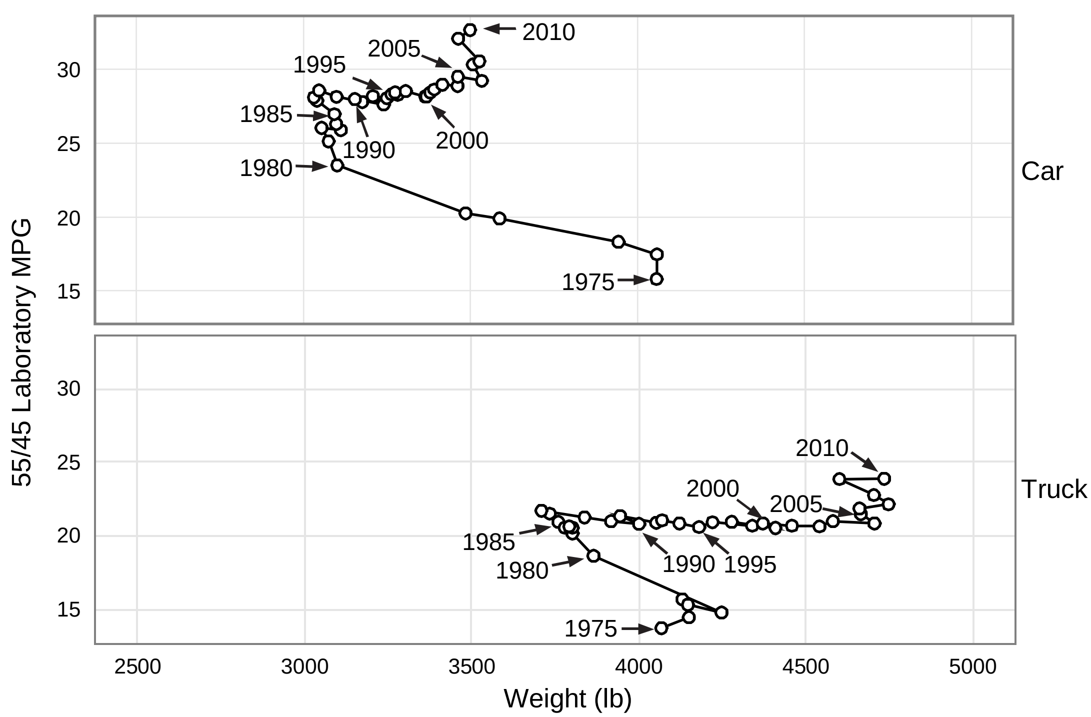


Figure 6

Laboratory MPG vs. Vehicle Weight by Model Year



IV. Carbon Dioxide Emissions Trends

This section focuses on light-duty vehicle tailpipe carbon dioxide (CO_2) emissions data that are measured over the EPA city and highway test procedures.

CO_2 is the most important greenhouse gas, responsible for a majority of all global, anthropogenic greenhouse gas emissions. Light-duty vehicles directly emit approximately 17% of total U.S. CO_2 emissions.[2] In April 2007, the U.S. Supreme Court determined that CO_2 is a pollutant under the Clean Air Act[3], and in December 2009, EPA published two findings that CO_2 and other greenhouse gases from new motor vehicles and new motor vehicle engines contribute to air pollution, and that the air pollution may reasonably be anticipated to endanger public health and welfare.[4] In May 2010, EPA and NHTSA published the first-ever light-duty vehicle greenhouse gas emissions standards, under the Clean Air Act, for MY2012-2016.[5] These standards are part of a new, harmonized National Program that also includes new CAFE standards for MY2012-2016, established and administered by DOT's National Highway Traffic Safety Administration (NHTSA). One of the goals of the National Policy is to establish a harmonized set of greenhouse gas emissions and CAFE standards that automakers can meet with a single national fleet. On May 21, 2010, the President announced that EPA and NHTSA would be extending the National Program for MY2017 and beyond.[6] On October 13, 2010, EPA and NHTSA published a Notice of Intent to propose new greenhouse gas emissions and CAFE standards, for 2017 and beyond, by the fall of 2011.[7]

Pre-2009 reports in this series have presented fuel economy data only and have not included CO_2 emissions data. Beginning with the 2009 report, EPA has added CO_2 emissions data. Rather than adding CO_2 emissions data to all or most of the large number of tables and figures in this report, we are providing a few key summary tables and figures dedicated to CO_2 emissions in this section as well as a methodology with which a reader can convert fuel economy values from other sections of this report to equivalent CO_2 emissions levels. EPA also intends to expand its annual Compliance Report to include CO_2 information.[8] Section III and Sections V through VIII of this report, as well as all of the appendices, continue to focus exclusively on fuel economy data.

The light-duty vehicle tailpipe CO_2 emissions data provided in this report represent the sum of three pollutants that EPA and automakers directly measure in the formal emissions certification and fuel economy compliance test programs:

- CO_2 emissions;
- Carbon monoxide emissions, converted to an equivalent CO_2 level on a mass basis by multiplying by a factor of 1.57, which is based on the ratio of molecular weights; and
- Hydrocarbon emissions, converted to an equivalent CO_2 level on a mass basis by multiplying by a factor of approximately 3.17, which is dependent on the measured carbon weight fraction of vehicle test fuel.

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[2] U.S. EPA, 2009, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007, EPA 430-R-09-004.
[3] 549 U.S. 497 (2007).
[4] 74 Federal Register 66496 (December 15, 2009).
[5] 75 Federal Register 25324 (May 7, 2010)
[6] Remarks by the President at Signing of Presidential Memorandum on Fuel Efficiency Standards, The White House, Office of the Press Secretary, May 21, 2010.
[7] 75 Federal Register 62739 (October 13, 2010).
[8] 2007 Progress Report: Vehicle and Engine Compliance Activities (EPA-420-R-08-11).

While including the carbon monoxide and hydrocarbon emissions adds, on average, less than one percent to the tailpipe CO_2-equivalent emissions for late model year light-duty vehicles, they are included in the CO_2 emissions values for three reasons:

- Atmospheric processes convert carbon monoxide and hydrocarbons to CO_2 relatively quickly compared to the much longer atmospheric lifetime of CO_2;

- Carbon monoxide and hydrocarbon emissions are included, along with CO_2, in the "carbon balance" equations that EPA uses to calculate fuel economy values, so they must also be included in the CO_2 values to maintain the mathematical integrity of the equations given below to convert between CO_2 emissions and fuel economy values; and

- Including carbon monoxide and hydrocarbon emissions is consistent with EPA's light-duty vehicle CO_2 emissions standard-setting approach.

EPA routinely measures CO_2, carbon monoxide, and hydrocarbon emissions as part of its compliance programs. In fact, the individual fuel economy test values that comprise the EPA fuel economy trends database are calculated from a set of "carbon balance" equations based on direct measurement of CO_2, carbon monoxide, and total hydrocarbon emissions. Since carbon is neither created nor destroyed in the combustion process, quantifying the various carbon-containing compounds in the vehicle exhaust as well as the carbon weight fraction of the gasoline test fuel allows the precise calculation of the amount of fuel that was combusted in the vehicle engine. Ironically, while the fuel economy values are calculated from CO_2, carbon monoxide, and hydrocarbon emissions data, the historic EPA fuel economy trends database files do not include the direct emissions data. In order to add CO_2 emissions data to the historical database, EPA has back-calculated the CO_2 emissions (and associated carbon monoxide and hydrocarbon emissions, converted to CO_2 on a mass basis) levels from fuel economy values by reversing the carbon balance equations.

As with the fuel economy data in this report, the light-duty vehicle CO_2 emissions values are expressed in two ways: unadjusted/laboratory values (which will be used for CO_2 emissions regulatory compliance beginning in MY2012) and adjusted/real world values (which are used for consumer information and environmental analysis). The CO_2 emissions values do not represent total light-duty vehicle greenhouse gas emissions, as there are other sources of greenhouse gas emissions beyond the tailpipe CO_2 emissions values. It is also important to note that the tailpipe CO_2 emissions data in this report do not reflect greenhouse gas emissions associated with vehicle assembly, component manufacturing, or vehicle disposal, nor upstream fuel-related production or distribution.

The unadjusted/laboratory CO_2 emissions values are the direct emissions data measured over the EPA city and highway tests. The vehicle air conditioner is turned off during these tests. The EPA city and highway tests will be used for compliance with future EPA light-duty vehicle CO_2 emissions standards (CO_2 standards allow the use of air conditioning and other credits so that the unadjusted CO_2 emissions data in this report may not align perfectly with the EPA CO_2 standards). For late model year vehicles, the unadjusted CO_2 emissions values represent about 90% of total unadjusted light-duty vehicle greenhouse gas emissions. The remaining 10% of total light-duty vehicle greenhouse gas emissions is comprised of air conditioner efficiency-related CO_2 emissions (about 4%), air conditioner hydrofluorocarbon refrigerant emissions leaks (approximately 5%), tailpipe nitrous oxide emissions (about 2%), and tailpipe methane emissions (methane is one hydrocarbon compound with a longer atmospheric lifetime and higher global warming potency, but its mass emissions are so low from gasoline vehicles that its potency-adjusted CO_2-equivalent emissions are about 0.2% of total light-duty vehicle greenhouse gas emissions).[9]

[9] 75 Federal Register 25421-25425 (May 7, 2010).

The adjusted CO_2 emissions values are calculated by adjusting the direct CO_2 unadjusted/laboratory emissions test data upward to account for the many variables that can affect real world vehicle CO_2 emissions. For a detailed discussion of the methodology that EPA uses to convert unadjusted vehicle fuel economy values to adjusted fuel economy values, see Appendix A. This same methodology is used to calculate adjusted CO_2 emissions values as well. On average, based on the current fleet mix, adjusted CO_2 emissions levels are about 25% higher than unadjusted CO_2 values. Because the adjusted CO_2 values take the impact of air conditioner operation on vehicle tailpipe CO_2 emissions into account, these values represent about 95% of total adjusted real world light-duty vehicle greenhouse gas emissions, with the remainder composed of air conditioner hydrofluorocarbon refrigerant emissions leaks, tailpipe nitrous oxide emissions, and the higher global warming potency associated with tailpipe methane emissions.

Table 3 gives key light-duty vehicle CO_2 emissions data for the entire data series from 1975 through 2010 for cars only, trucks only, and cars and trucks combined. Table 3 is very similar to Table 1, except that the fuel economy data in Table 1 is replaced with CO_2 emissions data in Table 3. Projected industry-wide MY2010 production volumes, which represent the sum of manufacturer-specific production projections provided by automakers to EPA in the spring and summer of 2009, are not shown in Table 3 as it is expected that actual MY2010 production will be considerably lower than projected values due to the recent economic downturn.

Table 3

Carbon Dioxide Emissions Characteristics of 1975 to 2010 Light Duty Vehicles

Cars

Model Year	Production (000)	Production Percent	Lab City CO_2 (g/mi)	Lab Hwy CO_2 (g/mi)	Lab 55/45 CO_2 (g/mi)	Adj City CO_2 (g/mi)	Adj Hwy CO_2 (g/mi)	Adj Comp CO_2 (g/mi)	CO_2/ Ton	CO_2/ Cu Ft	CO_2/ Ton/ Cu Ft
1975	8237	80.6%	649	457	563	722	586	660	327	-	-
1976	9722	78.8%	584	418	509	649	536	598	297	-	-
1977	11300	80.0%	556	399	485	618	512	570	290	5.2	2.7
1978	11175	77.3%	516	363	447	573	466	525	294	4.9	2.8
1979	10794	77.8%	503	362	440	559	464	517	298	4.8	2.9
1980	9443	83.5%	439	308	380	488	395	446	289	4.4	2.9
1981	8733	82.7%	412	288	356	458	369	418	273	4.0	2.7
1982	7819	80.3%	401	273	343	445	350	402	264	3.9	2.6
1983	8002	77.7%	402	273	344	447	350	403	259	3.8	2.5
1984	10675	76.1%	397	267	339	441	343	397	256	3.8	2.5
1985	10791	74.6%	388	259	330	431	333	387	250	3.7	2.4
1986	11015	71.7%	375	250	319	419	322	375	247	3.6	2.4
1987	10731	72.2%	373	248	317	419	320	373	247	3.6	2.4
1988	10736	70.2%	367	243	311	415	315	368	242	3.5	2.3
1989	10018	69.3%	374	245	316	425	319	375	243	3.5	2.3
1990	8810	69.8%	380	247	320	434	323	381	241	3.6	2.3
1991	8524	67.8%	377	245	318	434	322	380	241	3.6	2.3
1992	8108	66.6%	385	245	322	445	324	385	239	3.6	2.3
1993	8456	64.0%	376	241	315	439	319	379	237	3.5	2.2
1994	8415	59.6%	379	241	317	444	321	382	236	3.6	2.2
1995	9396	62.0%	377	236	314	445	316	379	233	3.5	2.2
1996	7890	60.0%	378	237	314	448	318	381	233	3.5	2.2
1997	8335	57.6%	376	235	313	449	318	380	233	3.5	2.2
1998	7972	55.1%	375	235	312	450	318	380	231	3.5	2.2
1999	8379	55.1%	380	237	316	459	323	386	230	3.6	2.2
2000	9128	55.1%	379	238	316	461	326	388	231	3.6	2.2
2001	8408	53.9%	374	237	312	459	325	386	229	3.6	2.1
2002	8304	51.5%	371	237	310	458	326	385	228	3.6	2.1
2003	7922	50.2%	367	233	307	456	323	382	224	3.6	2.1
2004	7538	48.0%	369	233	308	462	324	384	222	3.6	2.1
2005	8027	50.5%	360	230	301	454	322	378	219	3.5	2.0
2006	7993	52.9%	364	231	304	459	324	382	216	3.5	2.0
2007	8085	52.9%	349	224	293	442	314	369	211	3.4	2.0
2008	7329	52.7%	347	222	291	439	311	366	208	3.4	1.9
2009	5562	60.2%	329	213	277	418	300	350	202	3.2	1.9
2010	-	58.9%	323	210	272	410	295	345	197	3.2	1.8

Table 3 (continued)

Carbon Dioxide Emissions Characteristics of 1975 to 2010 Light Duty Vehicles

Trucks

Model Year	Production (000)	Production Percent	Lab City CO_2 (g/mi)	Lab Hwy CO_2 (g/mi)	Lab 55/45 CO_2 (g/mi)	Adj City CO_2 (g/mi)	Adj Hwy CO_2 (g/mi)	Adj Comp CO_2 (g/mi)	CO_2/ Ton
1975	1987	19.4%	733	548	650	815	702	764	374
1976	2612	21.2%	693	525	617	770	673	726	349
1977	2823	20.0%	633	490	569	703	628	669	323
1978	3273	22.7%	646	507	583	717	650	687	330
1979	3088	22.2%	663	530	604	736	679	711	333
1980	1863	16.5%	541	407	481	602	521	565	294
1981	1821	17.3%	502	374	445	558	479	523	275
1982	1914	19.7%	496	368	438	551	472	515	272
1983	2300	22.3%	488	355	428	542	455	503	268
1984	3345	23.9%	497	360	435	552	461	511	270
1985	3669	25.4%	494	357	432	548	458	508	267
1986	4350	28.3%	474	343	415	529	441	489	262
1987	4134	27.8%	472	336	411	530	434	486	262
1988	4559	29.8%	485	340	420	547	441	497	260
1989	4435	30.7%	491	344	425	557	448	506	258
1990	3805	30.2%	498	344	429	568	449	511	256
1991	4049	32.2%	486	335	418	558	439	500	254
1992	4064	33.4%	498	340	427	574	447	512	253
1993	4754	36.0%	496	335	424	575	443	509	251
1994	5710	40.4%	500	341	428	582	452	516	251
1995	5749	38.0%	507	343	433	594	456	523	251
1996	5254	40.0%	501	335	426	590	448	516	245
1997	6124	42.4%	506	340	431	598	456	524	243
1998	6485	44.9%	501	334	426	596	449	519	243
1999	6839	44.9%	510	342	434	610	462	531	242
2000	7447	44.9%	501	339	428	603	459	525	241
2001	7202	46.1%	504	342	431	610	466	532	240
2002	7815	48.5%	506	341	432	616	466	533	236
2003	7853	49.8%	499	335	425	610	460	526	231
2004	8173	52.0%	503	336	428	620	462	531	227
2005	7866	49.5%	490	325	415	607	449	517	223
2006	7111	47.1%	481	320	408	596	443	509	219
2007	7192	47.1%	475	314	403	590	436	502	213
2008	6571	47.3%	462	305	391	574	423	488	209
2009	3673	39.8%	441	292	374	550	405	467	204
2010	-	41.1%	441	291	373	550	404	467	198

Table 3 (continued)

Carbon Dioxide Emissions Characteristics of 1975 to 2010 Light Duty Vehicles

Cars and Trucks

Model Year	Production (000)	Production Percent	Lab City CO_2 (g/mi)	Lab Hwy CO_2 (g/mi)	Lab 55/45 CO_2 (g/mi)	Adj City CO_2 (g/mi)	Adj Hwy CO_2 (g/mi)	Adj Comp CO_2 (g/mi)	CO_2/ Ton
1975	10224	100.0%	666	474	580	740	608	681	336
1976	12334	100.0%	607	440	532	674	565	625	308
1977	14123	100.0%	571	418	502	635	535	590	296
1978	14448	100.0%	545	396	478	606	508	562	302
1979	13882	100.0%	539	399	476	599	512	560	306
1980	11306	100.0%	456	324	397	507	416	466	290
1981	10554	100.0%	428	303	371	475	388	436	274
1982	9732	100.0%	419	292	362	466	374	425	266
1983	10302	100.0%	421	291	363	468	373	426	261
1984	14020	100.0%	421	290	362	467	371	424	259
1985	14460	100.0%	414	284	356	461	364	417	255
1986	15365	100.0%	403	276	346	450	356	407	251
1987	14865	100.0%	400	272	343	450	352	405	251
1988	15295	100.0%	402	272	343	454	353	407	248
1989	14453	100.0%	410	275	349	466	359	415	248
1990	12615	100.0%	415	276	353	475	361	420	245
1991	12573	100.0%	412	274	350	474	360	418	245
1992	12172	100.0%	423	277	357	488	365	428	244
1993	13211	100.0%	419	275	354	488	364	426	242
1994	14125	100.0%	428	281	362	500	374	436	242
1995	15145	100.0%	426	277	359	501	369	434	240
1996	13144	100.0%	427	276	359	505	370	435	238
1997	14459	100.0%	431	280	363	512	376	441	237
1998	14458	100.0%	431	279	363	516	377	442	236
1999	15218	100.0%	438	285	369	527	386	451	236
2000	16574	100.0%	434	283	366	525	386	450	236
2001	15610	100.0%	434	285	367	529	390	453	234
2002	16119	100.0%	436	287	369	534	394	457	232
2003	15775	100.0%	432	284	366	533	391	454	228
2004	15711	100.0%	439	286	370	544	396	461	225
2005	15893	100.0%	424	277	358	529	385	447	221
2006	15105	100.0%	419	273	353	523	380	442	218
2007	15277	100.0%	409	266	345	511	371	431	212
2008	13900	100.0%	401	261	338	503	364	424	208
2009	9235	100.0%	374	245	316	470	342	397	203
2010	-	100.0%	371	243	314	467	340	395	198

Figure 7 plots the adjusted CO_2 emissions values over time, for cars only, trucks only, and both cars and trucks combined.

Figure 7

Adjusted CO_2 Emissions by Model Year (grams/mile)

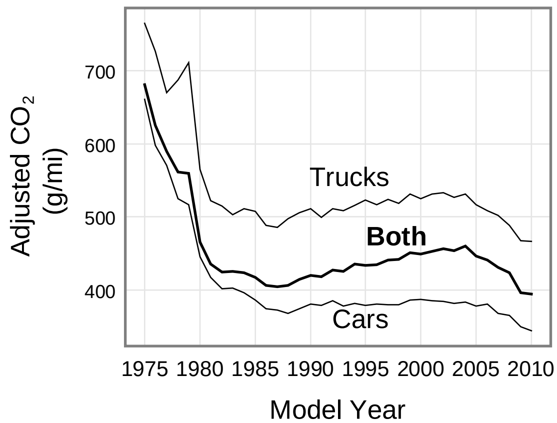


Table 3 and Figure 7 show that, over the last 35 years, adjusted (real world) CO_2 emissions rates have gone through four distinct phases. Most dramatically, adjusted composite (city/highway) CO_2 emissions rates for the combined car/truck fleet fell sharply from 681 grams per mile (g/mi) in MY1975 to 436 g/mi in MY1981, for a 36% reduction over 6 years. Adjusted CO_2 emissions continued to decline, though much more slowly, reaching 405 g/mi in MY1987, which represents a 41% reduction from MY1975. The trend then reversed, as adjusted CO_2 levels rose slowly over the next 17 years, reaching 461 g/mi in MY2004, a 14% increase relative to the MY1987 low. Adjusted CO_2 emissions have decreased for each of the last six years. The MY2009 value, based on final CAFE reports, is 397 g/mi, which is an all-time low, and represents a 14% reduction relative to MY2004. The 6% decrease from MY2008 to MY2009 is the largest single year-to-year decrease since 1981. The preliminary MY2010 value, based on automaker production projections made prior to the beginning of the model year, is 395 g/mi, which if accurate, would be another all-time low.

Laboratory CO_2 emissions values are also given in Table 3. Because laboratory values do not reflect the changes that EPA made to its methodology for adjusting fuel economy and CO_2 emissions levels for real world estimates for consumers, they are the best metric for evaluating CO_2 emissions trends solely on vehicle design considerations. Based on the 55/45 (city/highway) laboratory CO_2 values in Table 3, the 316 g/mi value in MY2009 and the preliminary MY2010 value of 314 g/mi also represent all-time lows.

Table 4 shows key light-duty vehicle characteristics, along with the adjusted composite CO_2 emissions values, for the 1975 through 2010 timeframe for cars only, trucks only, and cars and trucks combined. Table 4 is very similar to Table 2, except that the fuel economy data in Table 2 is replaced with CO_2 emissions data in Table 4.

Table 4

Vehicle Size and Design Characteristics of 1975 to 2010 Light Duty Vehicles

Cars

Model Year	Production Percent	Adj Comp CO_2 (g/mi)	Vol (cu ft)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time	Top Speed	Small	Midsize	Large
1975	80.6%	660	-	4058	-	136	0.0331	14.2	111	55.4%	23.3%	21.3%
1976	78.8%	598	-	4059	-	134	0.0324	14.4	110	55.4%	25.2%	19.4%
1977	80.0%	570	110	3944	-	133	0.0335	14.0	111	51.9%	24.5%	23.5%
1978	77.3%	525	109	3588	-	124	0.0342	13.7	111	44.7%	34.4%	21.0%
1979	77.8%	517	109	3485	-	119	0.0338	13.8	110	43.7%	34.2%	22.1%
1980	83.5%	446	104	3101	-	100	0.0322	14.3	107	54.4%	34.4%	11.3%
1981	82.7%	418	106	3076	-	99	0.0320	14.4	106	51.5%	36.4%	12.2%
1982	80.3%	402	106	3054	-	99	0.0320	14.4	106	56.5%	31.0%	12.5%
1983	77.7%	403	109	3112	-	104	0.0330	14.0	108	53.1%	31.8%	15.1%
1984	76.1%	397	108	3099	-	106	0.0339	13.8	109	57.4%	29.4%	13.2%
1985	74.6%	387	108	3093	-	111	0.0355	13.3	111	55.7%	28.9%	15.4%
1986	71.7%	375	107	3041	-	111	0.0360	13.2	111	59.5%	27.9%	12.6%
1987	72.2%	373	107	3031	-	112	0.0365	13.0	112	63.5%	24.3%	12.2%
1988	70.2%	368	107	3047	-	116	0.0375	12.8	113	64.8%	22.3%	12.8%
1989	69.3%	375	108	3099	-	121	0.0387	12.5	115	58.3%	28.2%	13.5%
1990	69.8%	381	107	3176	-	129	0.0401	12.1	117	58.6%	28.7%	12.8%
1991	67.8%	380	107	3154	-	132	0.0413	11.8	118	61.5%	26.2%	12.3%
1992	66.6%	385	108	3240	-	141	0.0428	11.5	120	56.5%	27.8%	15.6%
1993	64.0%	379	108	3207	-	138	0.0425	11.6	120	57.2%	29.5%	13.3%
1994	59.6%	382	108	3250	-	143	0.0432	11.4	121	58.5%	26.1%	15.4%
1995	62.0%	379	109	3263	-	152	0.0460	10.9	125	57.3%	28.6%	14.0%
1996	60.0%	381	109	3282	-	154	0.0464	10.8	125	54.3%	32.0%	13.6%
1997	57.6%	380	109	3274	-	156	0.0469	10.7	126	55.1%	30.6%	14.3%
1998	55.1%	380	109	3306	-	159	0.0475	10.6	127	49.4%	39.1%	11.4%
1999	55.1%	386	109	3365	-	164	0.0481	10.5	128	47.7%	39.7%	12.6%
2000	55.1%	388	110	3369	-	168	0.0492	10.4	129	47.5%	34.3%	18.2%
2001	53.9%	386	109	3380	-	168	0.0492	10.3	129	50.9%	32.3%	16.8%
2002	51.5%	385	110	3391	-	173	0.0504	10.2	131	48.6%	36.3%	15.1%
2003	50.2%	382	110	3417	-	176	0.0510	10.0	132	50.6%	33.5%	15.9%
2004	48.0%	384	110	3462	-	182	0.0521	9.8	133	47.4%	35.5%	17.0%
2005	50.5%	378	111	3463	-	182	0.0518	9.8	133	44.2%	38.9%	16.8%
2006	52.9%	382	112	3534	-	194	0.0540	9.6	136	46.2%	32.9%	20.9%
2007	52.9%	369	110	3507	-	189	0.0531	9.6	135	44.6%	40.0%	15.4%
2008	52.7%	366	110	3527	45.4	193	0.0536	9.6	136	44.7%	35.8%	19.5%
2009	60.2%	350	110	3463	45.2	184	0.0520	9.8	133	48.2%	34.6%	17.2%
2010	58.9%	345	110	3499	45.2	192	0.0537	9.5	136	47.8%	38.5%	13.8%

Table 4 (continued)

Vehicle Size and Design Characteristics of 1975 to 2010 Light Duty Vehicles

Trucks

Model Year	Production Percent	Adj Comp CO_2 (g/mi)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time	Top Speed	Small	Midsize	Large	Van	SUV	Pickup
1975	19.4%	764	4072	-	142	0.0349	13.6	114	10.9%	24.2%	64.9%	23.0%	9.4%	67.6%
1976	21.2%	726	4155	-	141	0.0340	13.8	113	9.0%	20.3%	70.7%	19.2%	9.3%	71.4%
1977	20.0%	669	4135	-	147	0.0356	13.3	115	11.0%	20.4%	68.5%	18.2%	10.0%	71.8%
1978	22.7%	687	4151	-	146	0.0351	13.4	114	10.9%	22.7%	66.3%	19.1%	11.6%	69.3%
1979	22.2%	711	4252	-	138	0.0325	14.3	111	15.2%	19.5%	65.3%	15.6%	13.0%	71.5%
1980	16.5%	565	3869	-	121	0.0313	14.5	108	28.4%	17.6%	54.0%	13.0%	9.9%	77.1%
1981	17.3%	523	3806	-	119	0.0311	14.6	108	23.2%	19.1%	57.7%	13.5%	7.5%	79.1%
1982	19.7%	515	3806	-	120	0.0317	14.5	109	21.1%	31.0%	47.9%	16.2%	8.5%	75.3%
1983	22.3%	503	3763	-	118	0.0313	14.5	108	16.6%	45.9%	37.6%	16.6%	12.6%	70.8%
1984	23.9%	511	3782	-	118	0.0310	14.7	108	19.5%	46.4%	34.1%	20.2%	18.7%	61.1%
1985	25.4%	508	3795	-	124	0.0326	14.1	110	19.2%	48.5%	32.3%	23.3%	20.0%	56.6%
1986	28.3%	489	3738	-	123	0.0330	14.0	110	23.5%	48.5%	28.0%	24.0%	17.8%	58.2%
1987	27.8%	486	3713	-	131	0.0351	13.3	113	19.9%	59.6%	20.6%	26.9%	21.1%	51.9%
1988	29.8%	497	3841	-	141	0.0366	12.9	115	15.0%	57.2%	27.8%	24.8%	21.2%	53.9%
1989	30.7%	506	3921	-	146	0.0372	12.8	116	13.9%	58.9%	27.2%	28.8%	20.9%	50.3%
1990	30.2%	511	4005	-	151	0.0377	12.6	117	13.4%	57.1%	29.6%	33.2%	18.6%	48.2%
1991	32.2%	500	3948	-	150	0.0379	12.6	117	11.4%	67.2%	21.4%	25.5%	27.0%	47.4%
1992	33.4%	512	4056	-	155	0.0382	12.5	118	10.4%	64.0%	25.6%	30.0%	24.7%	45.3%
1993	36.0%	509	4073	-	162	0.0398	12.1	120	8.8%	65.3%	25.9%	30.3%	27.6%	42.1%
1994	40.4%	516	4125	-	166	0.0403	12.0	121	9.8%	63.1%	27.2%	24.8%	28.4%	46.7%
1995	38.0%	523	4184	-	168	0.0401	12.0	121	8.6%	63.5%	27.9%	28.9%	31.6%	39.5%
1996	40.0%	516	4225	-	179	0.0423	11.5	124	6.5%	67.1%	26.4%	26.8%	36.0%	37.2%
1997	42.4%	524	4344	-	187	0.0429	11.4	126	10.1%	52.5%	37.3%	20.7%	40.0%	39.3%
1998	44.9%	519	4283	-	187	0.0435	11.2	126	8.9%	58.7%	32.4%	23.0%	39.8%	37.2%
1999	44.9%	531	4412	-	197	0.0446	11.0	128	7.7%	55.8%	36.5%	21.4%	41.4%	37.2%
2000	44.9%	525	4375	-	197	0.0448	11.0	128	6.7%	55.7%	37.5%	22.7%	42.2%	35.1%
2001	46.1%	532	4463	-	209	0.0466	10.6	131	6.6%	47.6%	45.9%	17.1%	47.9%	35.0%
2002	48.5%	533	4546	-	219	0.0482	10.4	134	7.1%	43.5%	49.4%	15.9%	53.6%	30.5%
2003	49.8%	526	4586	-	221	0.0481	10.4	134	5.8%	48.0%	46.1%	15.7%	52.8%	31.5%
2004	52.0%	531	4710	-	236	0.0501	10.0	137	5.1%	46.2%	48.7%	11.7%	57.7%	30.7%
2005	49.5%	517	4668	-	237	0.0505	10.0	137	2.8%	47.3%	49.9%	18.8%	51.9%	29.2%
2006	47.1%	509	4665	-	235	0.0502	10.0	137	2.0%	49.0%	49.0%	16.4%	52.8%	30.8%
2007	47.1%	502	4752	-	248	0.0520	9.8	140	2.0%	44.9%	53.1%	11.8%	58.8%	29.4%
2008	47.3%	488	4707	53.0	247	0.0521	9.7	140	2.5%	49.6%	47.9%	12.0%	60.7%	27.3%
2009	39.8%	467	4605	52.7	245	0.0528	9.6	140	2.1%	52.6%	45.3%	10.0%	63.0%	26.9%
2010	41.1%	467	4738	54.0	259	0.0544	9.4	143	1.4%	45.7%	52.9%	8.5%	60.7%	30.8%

Table 4 (continued)

Vehicle Size and Design Characteristics of 1975 to 2010 Light Duty Vehicles

Cars and Trucks

Model Year	Adj Comp CO_2 (g/mi)	Weight (lb)	Footprint (sq ft)	HP	HP/ Weight	0-to-60 Time	Top Speed
1975	681	4060	-	137	0.0335	14.1	112
1976	625	4079	-	135	0.0328	14.3	111
1977	590	3982	-	136	0.0339	13.8	112
1978	562	3715	-	129	0.0344	13.6	112
1979	560	3655	-	124	0.0335	13.9	110
1980	466	3228	-	104	0.0320	14.3	107
1981	436	3202	-	102	0.0318	14.4	107
1982	425	3202	-	103	0.0320	14.4	107
1983	426	3257	-	107	0.0327	14.1	108
1984	424	3262	-	109	0.0332	14.0	109
1985	417	3271	-	114	0.0347	13.5	110
1986	407	3238	-	114	0.0351	13.4	111
1987	405	3221	-	118	0.0361	13.1	112
1988	407	3283	-	123	0.0372	12.8	114
1989	415	3351	-	129	0.0382	12.5	115
1990	420	3426	-	135	0.0394	12.2	117
1991	418	3410	-	138	0.0402	12.1	118
1992	428	3512	-	145	0.0413	11.8	120
1993	426	3519	-	147	0.0416	11.8	120
1994	436	3603	-	152	0.0420	11.7	121
1995	434	3613	-	158	0.0438	11.3	123
1996	435	3659	-	164	0.0447	11.1	125
1997	441	3727	-	169	0.0452	11.0	126
1998	442	3744	-	171	0.0457	10.9	126
1999	451	3835	-	179	0.0465	10.7	128
2000	450	3821	-	181	0.0472	10.6	129
2001	453	3879	-	187	0.0480	10.5	130
2002	457	3951	-	195	0.0493	10.3	132
2003	454	3999	-	199	0.0496	10.2	133
2004	461	4111	-	211	0.0511	9.9	135
2005	447	4059	-	209	0.0512	9.9	135
2006	442	4067	-	213	0.0522	9.8	137
2007	431	4093	-	217	0.0525	9.7	137
2008	424	4085	49.0	219	0.0529	9.7	138
2009	397	3917	48.2	208	0.0523	9.7	136
2010	395	4009	48.8	220	0.0540	9.5	139

Table 4 shows that average, combined car/truck, weight and horsepower levels declined significantly from MY1975 through MY1981, with weight decreasing by over 850 pounds (21%) and power decreasing by 35 horsepower (26%). Average vehicle weight grew slowly in the 1980s, and more rapidly thereafter, and by MY2004 average weight had reached an all-time high of 4111 pounds. It was relatively constant through 2008, but fell by 168 pounds in MY2009 and is now almost 200 pounds less than the all-time high in MY2004. Average vehicle horsepower grew steadily since MY1981, until decreasing by 11 horsepower in MY2009. The projected MY2010 level of 220 horsepower represents a 61% increase over MY1975, and a 116% increase relative to MY1981, which was the all-time low for this data series. Table 4 also shows that average MY2009 footprint values were 45.2 square feet for cars, 52.7 square feet for trucks, and 48.2 square feet for cars and trucks combined.

This report adopts a new approach for grouping vehicles by “Manufacturer” and “Make” compared to previous reports in this series. The manufacturer definition is that used by the National Highway Traffic Safety Administration (NHTSA) for purposes of implementation of and manufacturer compliance with the CAFE program. Make is typically included in the model name and is generally recognized by consumers as the “brand” of the vehicle. The Pontiac and Saturn makes no longer exist, but are included since Table 5 also includes model years 2008 and 2009. For more details on this vehicle grouping approach, and the thresholds that were used to identify the 14 manufacturers and 32 makes shown in Table 5, see the more detailed discussion in Section VII. It is important to note that when a manufacturer or make grouping is changed to reflect a change in the industry's financial structure, EPA makes the same adjustment in the historical database back to 1975. This maintains a consistent manufacturer (or make) definition over time, which allows a better identification of long-term trends. On the other hand, this also means that the current database does not necessarily reflect actual financial or structural arrangements in the past. For example, the 2010 database no longer accounts for the fact that Chrysler was combined with Daimler for several years, and Table 5 shows data for a Chrysler Ram make for 2008 and 2009, even though Ram did not formally become a separate make until MY2010.

Table 5 gives adjusted CO_2 emissions values for cars, trucks, and cars and trucks combined for MY2008-2010, for the 14 highest-selling manufacturers and 32 largest makes associated with those manufacturers. Manufacturers are listed in order of increasing MY2009 car plus truck CO_2 emissions rate. Due to the higher-than-usual uncertainty associated with the MY2010 projections (because they were submitted by automakers to EPA during the market turmoil of 2009), three years of data are shown in these tables. By including data from both MY2008 and MY2009, with formal end-of-year data for both years, it is possible to identify meaningful changes from year-to-year (though MY2009 was admittedly a very unusual year in terms of economic recession and industry sales). Because of the uncertainty associated with the MY2010 projections, changes from MY2009 to MY2010 are less meaningful. EPA anticipates that the 2010 results for all manufacturers will change after the final MY2010 data has been submitted to EPA, and the final MY2010 data will be included in next year’s report.

Table 5

Adjusted Carbon Dioxide Emissions by Manufacturer and Make for MY2008-2010 (g/mi)

Manufacturer	Make	2008 Cars	2008 Trucks	2008 Cars and Trucks	2009 Cars	2009 Trucks	2009 Cars and Trucks	2010 Cars	2010 Trucks	2010 Cars and Trucks
Toyota	Toyota	292	469	386	305	424	341	296	471	358
Toyota	Lexus	396	456	422	390	466	425	376	415	394
Toyota	Scion	350	-	350	350	-	350	344	-	344
Toyota	**All**	**317**	**467**	**389**	**314**	**430**	**349**	**307**	**461**	**363**
Hyundai	**All**	**334**	**435**	**364**	**333**	**431**	**355**	**336**	**381**	**343**
Honda	Honda	321	430	365	319	420	354	309	411	338
Honda	Acura	401	504	443	381	496	424	394	472	420
Honda	**All**	**328**	**437**	**372**	**325**	**428**	**361**	**317**	**418**	**346**
Kia	**All**	**339**	**458**	**388**	**326**	**447**	**367**	**319**	**438**	**354**
Nissan	Nissan	335	500	396	332	444	371	330	451	364
Nissan	Infiniti	441	519	465	418	492	437	414	475	435
Nissan	**All**	**351**	**502**	**406**	**341**	**447**	**377**	**340**	**455**	**373**
VW	VW	373	541	381	357	435	365	340	447	351
VW	Audi	399	549	423	391	488	410	370	467	390
VW	**All**	**385**	**545**	**398**	**367**	**456**	**379**	**352**	**458**	**367**
Mitsubishi	**All**	**378**	**460**	**399**	**373**	**415**	**379**	**359**	**399**	**367**
Mazda	**All**	**353**	**440**	**385**	**360**	**422**	**383**	**361**	**438**	**391**
Subaru	**All**	**391**	**425**	**399**	**389**	**397**	**393**	**373**	**398**	**382**
BMW	BMW	422	482	434	417	491	432	425	486	437
BMW	Mini	307	-	307	293	-	293	302	-	302
BMW	**All**	**406**	**482**	**419**	**390**	**491**	**407**	**384**	**486**	**399**
GM	Chevrolet	371	517	448	359	514	430	361	477	421
GM	Pontiac	388	437	393	376	438	379	-	-	-
GM	GMC	-	522	522	-	517	517	-	468	468
GM	Buick	429	471	444	366	464	390	417	454	425
GM	Cadillac	456	560	488	465	562	487	442	475	455
GM	Saturn	381	437	415	350	425	393	-	-	-
GM	**All**	**387**	**510**	**452**	**371**	**507**	**432**	**375**	**472**	**427**
Ford	Ford	385	503	461	352	478	438	361	483	436
Ford	Lincoln	432	498	465	437	465	443	422	481	433
Ford	Mercury	426	454	437	435	406	422	379	436	401
Ford	Volvo	424	532	457	414	530	432	411	471	438
Ford	**All**	**398**	**501**	**459**	**379**	**475**	**437**	**375**	**481**	**434**
Daimler	Mercedes Benz	461	544	482	454	542	476	442	525	467
Daimler	Smart	239	-	239	239	-	239	239	-	239
Daimler	**All**	**439**	**544**	**464**	**432**	**542**	**457**	**432**	**525**	**459**
Chrysler	Dodge	393	489	434	403	467	429	414	468	440
Chrysler	Chrysler	411	452	426	404	452	436	399	450	426
Chrysler	Jeep	-	491	491	-	494	494	-	474	474
Chrysler	Ram	-	548	548	-	563	563	-	558	558
Chrysler	**All**	**401**	**495**	**460**	**403**	**490**	**464**	**409**	**489**	**463**
Other	All	398	529	462	411	527	453	400	548	476
Fleet		**366**	**488**	**424**	**350**	**467**	**397**	**345**	**467**	**395**

For MY2008, Hyundai's overall, adjusted CO_2 emissions performance of 364 g/mi was the lowest of any manufacturer, followed by Honda at 372 g/mi and Mazda at 385 g/mi. Daimler had the highest adjusted CO_2 emissions performance in MY2008, at 464 g/mi, followed closely by Chrysler and Ford.

All but one of the 14 manufacturers reduced CO_2 emissions in MY2009, and the industry level of 397 g/mi represents an all-time low. In terms of manufacturers, Toyota had the lowest MY2009 adjusted CO_2 emissions performance of 349 g/mi, followed by Hyundai at 355 g/mi and Honda at 361 g/mi. Chrysler had the highest MY2009 adjusted CO_2 emissions performance for any manufacturer, 464 g/mi, and was followed by Daimler at 457 g/mi and Ford at 437 g/mi. In terms of improvement from MY2008 to MY2009, Toyota had the largest reduction of 40 g/mi, followed by Nissan at 29 g/mi and Ford with 22 g/mi.

In terms of makes in MY2009, the Smart had the lowest CO_2 emissions of 239 g/mi. Of course, the Smart Fortwo is the smallest and lightest car in the U.S. market and has relatively small production volumes. The make with the second-lowest CO_2 emissions performance in MY2009 is the Mini, which also produces relatively low volumes of small vehicles, at 293 g/mi. Of the makes with higher production, Toyota (that is, Toyota manufacturer vehicles sold under the Toyota brand) had the lowest overall CO_2 emissions at 341 g/mi, followed by Honda at 354 g/mi and Hyundai at 355 g/mi.

Preliminary projections suggest that 11 of the 14 manufacturers will improve CO_2 emissions performance further in MY2010, though EPA will not have actual data for MY2010 until next year. Hyundai, Honda, and Kia are projected to be the overall CO_2 emissions leaders for MY2010, with the same three manufacturers projected to make the biggest gains in MY2010.

While Tables 3, 4, and 5 provide key summary CO_2 emissions data, EPA recognizes that many users will want the CO_2 emissions values equivalent to the fuel economy values in many other tables in this report. Converting fuel economy values from tables in this report to approximate equivalent CO_2 emissions values is fairly straightforward.

If it is known that a fuel economy value in this report is based on a single gasoline vehicle, or a 100% gasoline vehicle fleet, one can calculate the precise corresponding CO_2 value by simply dividing 8887 (which is a typical value for the grams of CO_2 per gallon of gasoline test fuel, assuming all the carbon is converted to CO_2) by the fuel economy value in miles per gallon. For example, 8887 divided by a gasoline vehicle fuel economy of 30 mpg would yield an equivalent CO_2 emissions value of 296 grams per mile.

Since gasoline vehicle production has accounted for 99+% of all light-duty vehicle production for all model years since 1975 except for the six years from 1979 through 1984, this simple approach yields very accurate results for most model years.

Diesel fuel has 14.5% higher carbon content per gallon than gasoline. To calculate a CO_2 equivalent value for a diesel vehicle, one should divide 10,180 by the diesel vehicle fuel economy value. Accordingly, a 30 mpg diesel vehicle would have a CO_2 equivalent value of 339 grams per mile.

Table 6 should be used by those who want to make the most accurate conversions of industry-wide fuel economy values to CO_2 emissions values. Table 6 gives model year-specific industry-wide values for grams of CO_2 per gallon based on actual light-duty gasoline and diesel vehicle production in that year. Using these model year-specific values and dividing by the fuel economy value in miles per gallon will allow accurate conversions of industry-wide fuel economy values to industry-wide CO_2 emissions values.

Readers will have to make judgment calls about how to best convert fuel economy values that do not represent industry-wide values (e.g., just small cars or vehicles with 5-speed automatic transmissions). If the user knows the gasoline/diesel production volume fractions of the individual database component, it is best to generate a weighted value of grams of CO_2 per gallon based on the 8887 (gasoline) and 10,180 (diesel) factors discussed above. Otherwise, the reader can choose between the model year-specific weighting in Table 6 (which implicitly assumes that the diesel fraction in the database component of interest is similar to that for the overall fleet in that year) or the gasoline value of 8887 (implicitly assuming no diesels in that database component). In nearly all cases, any error associated with either of these approaches will be relatively small.

Table 6

Factors for Converting Industry-wide Fuel Economy Values from this Report to Carbon Dioxide Emissions Values

Model Year	Gasoline Production Share	Diesel Production Share	Weighted CO_2 per Gallon (grams)
1975	99.8%	0.2%	8890
1976	99.8%	0.2%	8890
1977	99.6%	0.4%	8892
1978	99.1%	0.9%	8899
1979	98.0%	2.0%	8913
1980	95.7%	4.3%	8943
1981	94.1%	5.9%	8963
1982	94.4%	5.6%	8959
1983	97.3%	2.7%	8922
1984	98.2%	1.8%	8910
1985	99.1%	0.9%	8899
1986	99.6%	0.4%	8892
1987	99.7%	0.3%	8891
1988	99.9%	0.1%	8888
1989	99.9%	0.1%	8888
1990	99.9%	0.1%	8888
1991	99.9%	0.1%	8888
1992	99.9%	0.1%	8888
1993	100.0%	-	8887
1994	100.0%	0.0%	8887
1995	100.0%	0.0%	8887
1996	99.9%	0.1%	8888
1997	99.9%	0.1%	8888
1998	99.9%	0.1%	8888
1999	99.9%	0.1%	8888
2000	99.9%	0.1%	8888
2001	99.9%	0.1%	8888
2002	99.8%	0.2%	8890
2003	99.8%	0.2%	8890
2004	99.9%	0.1%	8888
2005	99.7%	0.3%	8891
2006	99.6%	0.4%	8892
2007	99.9%	0.1%	8888
2008	99.9%	0.1%	8888
2009	99.5%	0.5%	8893
2010	99.6%	0.4%	8892

V. Fuel Economy Trends by Vehicle Type, Size, and Weight

Figure 8 shows production share trends by vehicle type and size. Of the five vehicle classes: cars, wagons, sports utility vehicles (SUVs), vans, and pickups, the biggest overall increase in production share since 1975 has been for SUVs, which increased from less than two percent in 1975 to 25% in MY2010 . The biggest overall decrease has been for cars, down from 71% of the fleet in 1975 to 54% in MY2010. By comparison, the production fraction for pickup trucks has remained relatively constant at about 12% of overall production.

Figure 9 (within vehicle type) and Table 7 (across the entire market) compares production fractions by vehicle type and size with the fleet again stratified into five vehicle types: cars, station wagons, vans, SUVs, and pickup trucks; and three vehicle sizes: small, midsize, and large. Small cars have historically been the leading car segment, though midsize cars have nearly pulled even with small cars in the last few years and the overall market share of small cars has fallen from 40% to less than 25%. Wagons have decreased from about 10% of production in 1975 to about 5% of production today, with small wagons dominating the low-volume segment.

Since 1975, the largest increases in production fractions have been for midsize and large SUVs (including crossovers). These two classes are expected to account for 24% of all light vehicles built this year, compared to combined totals of about 1.3 and 4.5% in 1975 and 1988, respectively. Minivans and vans, whose popularity peaked in the 1990s, now account for less than 5% of production, similar to 1975 levels. Almost all of the vans sold today are midsize minivans. Pickups are now dominated by large pickups.

Figure 8

Production Share by Vehicle Type

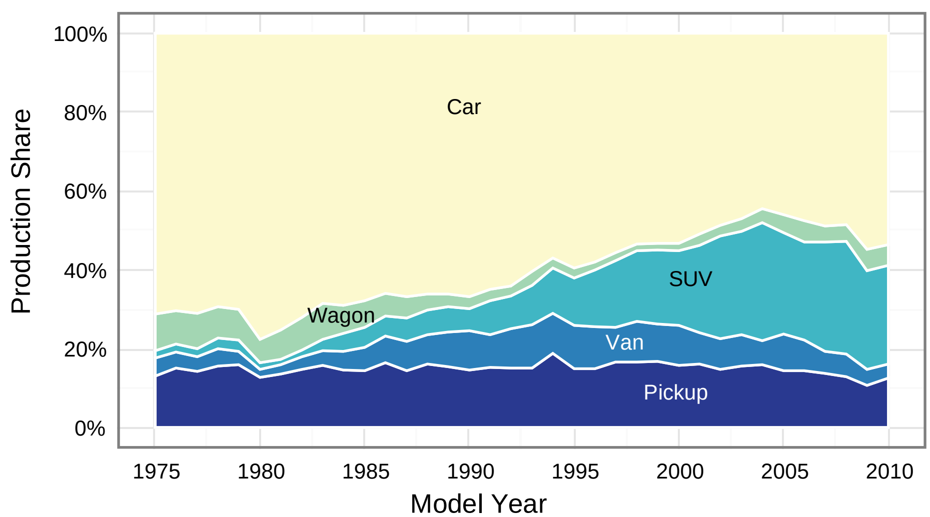


Figure 9

Production Share by Vehicle Size

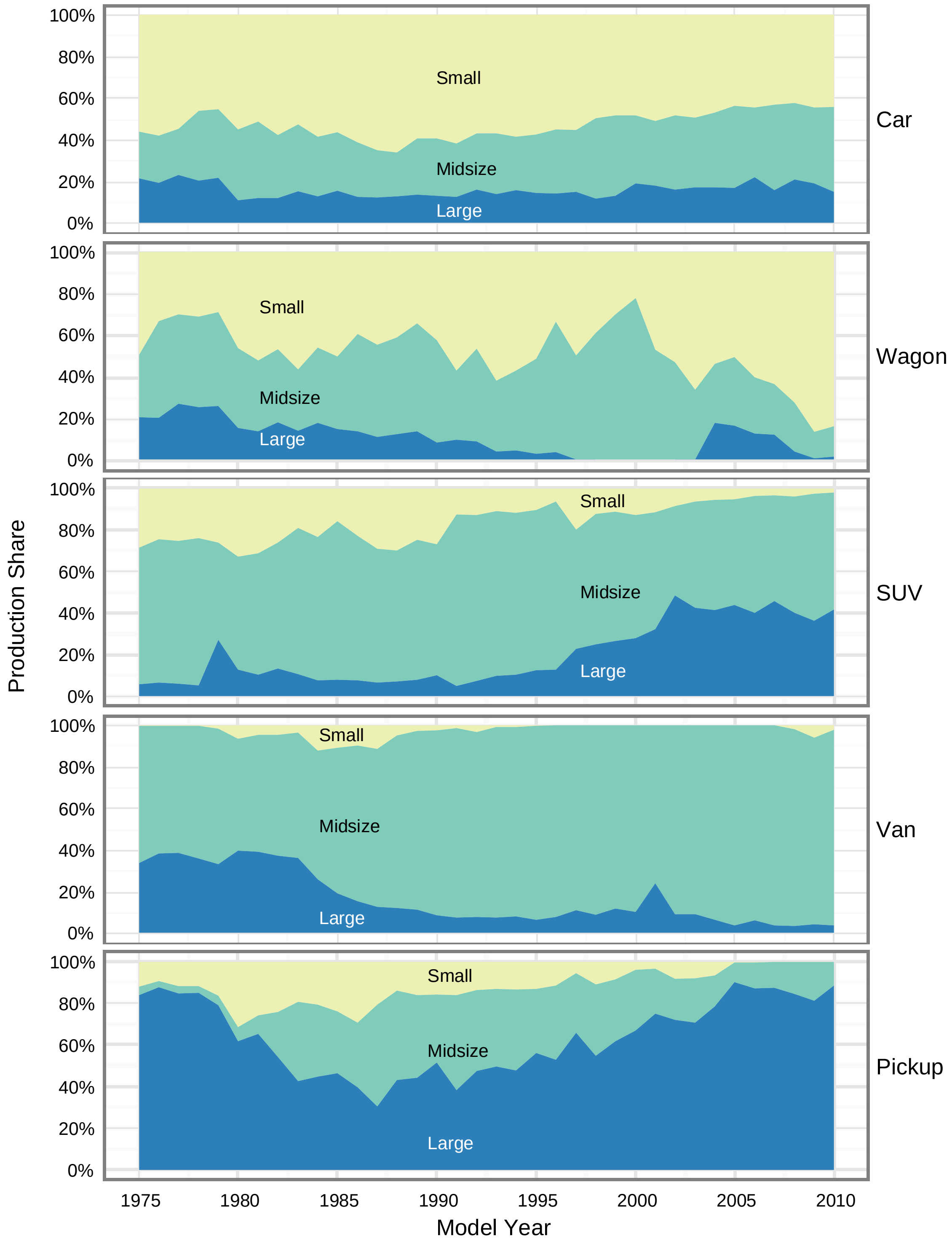


Table 7

Production Shares of Model Years 1975, 1988, and 2010 by Vehicle Size and Type

Vehicle Type	Size	1975	1988	2010	Difference 1975 to 2010	Difference 1975 to 1988	Difference 1988 to 2010
Car	Small	40.0%	43.8%	23.7%	-16.3%	3.9%	-20.2%
Car	Midsize	16.0%	13.8%	21.9%	5.9%	-2.1%	8.1%
Car	Large	15.2%	8.5%	8.0%	-7.2%	-6.7%	-0.5%
Car	All	71.1%	66.2%	53.6%	-17.6%	-5.0%	-12.6%
Wagon	Small	4.7%	1.7%	4.5%	-0.2%	-3.0%	2.8%
Wagon	Midsize	2.8%	1.9%	0.8%	-2.1%	-1.0%	-1.1%
Wagon	Large	1.9%	0.5%	0.1%	-1.8%	-1.4%	-0.4%
Wagon	All	9.4%	4.0%	5.3%	-4.1%	-5.4%	1.3%
Van	Small	0.0%	0.4%	0.1%	0.1%	0.3%	-0.3%
Van	Midsize	3.0%	6.2%	3.3%	0.3%	3.2%	-2.8%
Van	Large	1.5%	0.9%	0.1%	-1.4%	-0.6%	-0.8%
Van	All	4.5%	7.4%	3.5%	-1.0%	2.9%	-3.9%
SUV	Small	0.5%	1.9%	0.5%	0.0%	1.4%	-1.4%
SUV	Midsize	1.2%	4.0%	14.0%	12.8%	2.8%	10.0%
SUV	Large	0.1%	0.5%	10.4%	10.3%	0.3%	10.0%
SUV	All	1.8%	6.3%	25.0%	23.1%	4.5%	18.6%
Pickup	Small	1.6%	2.2%	-	-1.6%	0.7%	-2.2%
Pickup	Midsize	0.5%	6.9%	1.4%	0.9%	6.3%	-5.5%
Pickup	Large	11.0%	7.0%	11.2%	0.2%	-4.1%	4.3%
Pickup	All	13.1%	16.1%	12.7%	-0.5%	2.9%	-3.4%
	All Trucks	19.4%	29.8%	41.1%	21.7%	10.4%	11.3%

Figure 10 shows annual trends in adjusted fuel economy, weight, and performance 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 most types.

Table 8 shows the lowest, average, and highest adjusted mpg performance by vehicle class and size for three selected years. For both 1988 and 2010, 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 9, the percentage changes obtainable from the entries in Table 8 are presented. Average mpg for five classes (midsize cars, large cars, midsize wagons, midsize SUVs, and large SUVs) has improved over 80% since 1975. Since 1988, average fuel economy has decreased for large wagons, small SUVs, and midsize pickups with the largest improvements in average mpg being over 30% for midsize and large SUVs, respectively. Tables 10 and 11 present this same data in terms of fuel consumption.

Figure 10

Fuel Economy and Performance by Vehicle Type

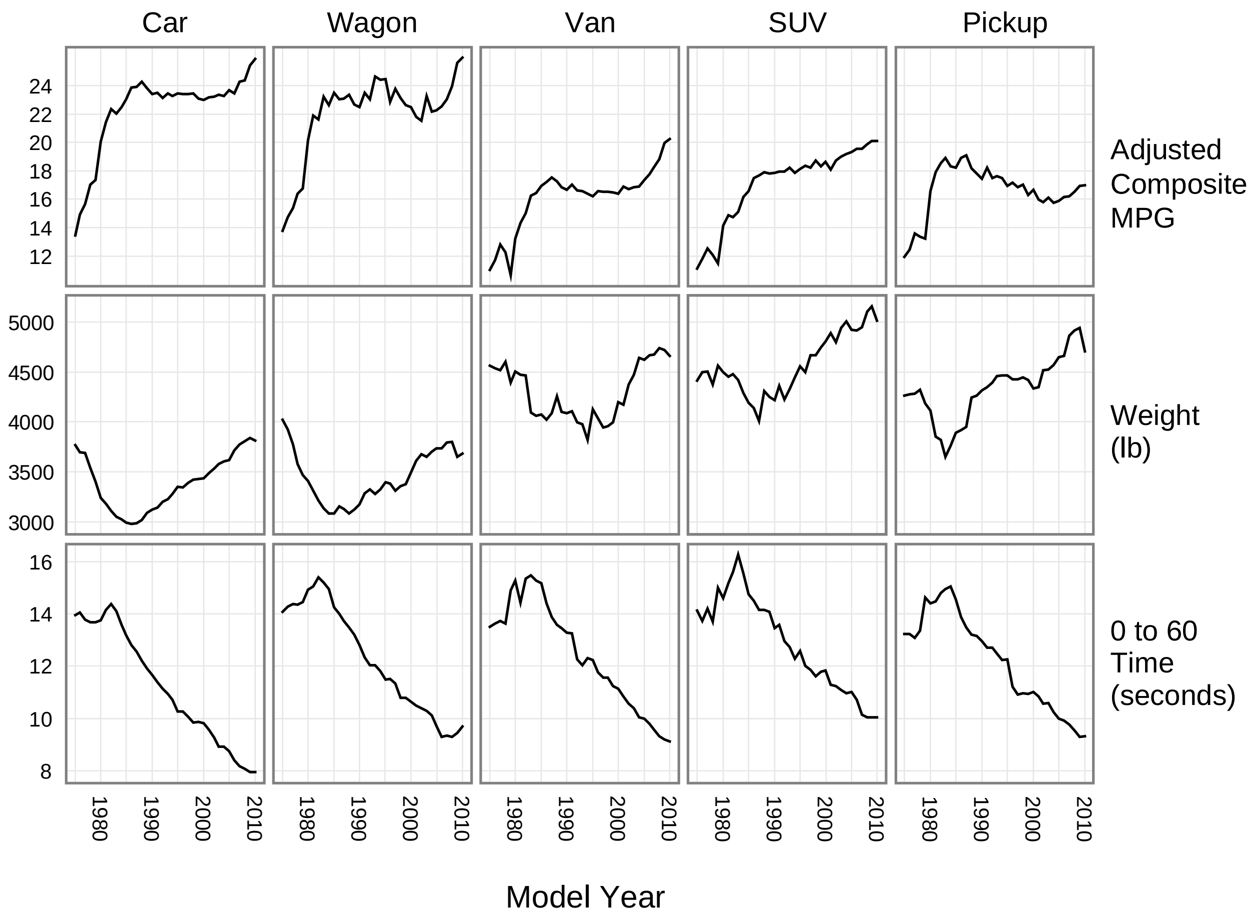


Table 8

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

Car or Truck	Vehicle Type	Size	1975 Low	1975 Average	1975 High	1988 Low	1988 Average	1988 High	2010 Low	2010 Average	2010 High
Car	Car	Small	8.6	15.6	28.3	7.5	25.7	54.4	10.1	26.7	42.9
Car	Car	Midsize	8.6	11.6	18.4	10.5	22.6	27.7	12.2	26.1	49.4
Car	Car	Large	8.4	11.2	14.6	10.0	20.6	26.0	12.6	22.7	26.4
Car	Car	All	8.4	13.4	28.3	7.5	24.2	54.4	10.1	25.8	49.4
Car	Wagon	Small	11.8	19.1	24.1	17.1	26.3	33.2	20.0	26.8	35.7
Car	Wagon	Midsize	8.4	11.3	25.0	17.5	22.2	27.7	18.5	22.6	25.5
Car	Wagon	Large	8.4	10.2	12.8	19.2	19.4	19.4	16.5	16.8	20.9
Car	Wagon	All	8.4	13.8	25.0	17.1	23.3	33.2	16.5	25.9	35.7
Truck	Van	Small	16.2	17.5	18.5	15.5	20.6	25.0	24.1	24.1	24.8
Truck	Van	Midsize	8.2	11.3	18.4	11.3	18.4	23.4	18.4	20.2	23.5
Truck	Van	Large	8.9	10.7	14.5	9.9	14.3	16.8	14.7	16.0	17.4
Truck	Van	All	8.2	11.1	18.5	9.9	17.9	25.0	14.7	20.1	24.8
Truck	SUV	Small	10.2	13.7	16.3	15.6	20.4	27.7	17.0	17.1	17.6
Truck	SUV	Midsize	8.2	10.2	18.4	10.2	16.5	23.6	13.4	21.6	31.9
Truck	SUV	Large	7.9	10.3	13.7	12.2	14.0	18.8	12.4	18.7	27.0
Truck	SUV	All	7.9	11.0	18.4	10.2	17.2	27.7	12.4	20.2	31.9
Truck	Pickup	Small	13.0	19.2	20.8	13.3	21.0	24.6	-	-	-
Truck	Pickup	Midsize	17.8	17.9	18.0	15.3	21.3	25.9	15.9	19.9	24.3
Truck	Pickup	Large	7.6	11.1	18.5	9.8	15.2	21.0	14.4	16.6	21.8
Truck	Pickup	All	7.6	11.9	20.8	9.8	18.1	25.9	14.4	16.9	24.3
Car	All	All	8.4	13.5	28.3	7.5	24.1	54.4	10.1	25.8	49.4
Truck	All	All	7.6	11.6	20.8	9.8	17.9	27.7	12.4	19.1	31.9
	All	All	7.6	13.1	28.3	7.5	21.9	54.4	10.1	22.5	49.4

Table 9

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

Car or Truck	Vehicle Type	Size	1975 to 2010 Low	1975 to 2010 Average	1975 to 2010 High	1975 to 1988 Low	1975 to 1988 Average	1975 to 1988 High	1988 to 2010 Low	1988 to 2010 Average	1988 to 2010 High
Car	Car	Small	17%	71%	52%	-13%	65%	92%	35%	4%	-21%
Car	Car	Midsize	42%	125%	168%	22%	95%	51%	16%	15%	78%
Car	Car	Large	50%	103%	81%	19%	84%	78%	26%	10%	2%
Car	Car	All	20%	93%	75%	-11%	81%	92%	35%	7%	-9%
Car	Wagon	Small	69%	40%	48%	45%	38%	38%	17%	2%	8%
Car	Wagon	Midsize	120%	100%	2%	108%	96%	11%	6%	2%	-8%
Car	Wagon	Large	96%	65%	63%	129%	90%	52%	-14%	-13%	8%
Car	Wagon	All	96%	88%	43%	104%	69%	33%	-4%	11%	8%
Truck	Van	Small	49%	38%	34%	-4%	18%	35%	55%	17%	-1%
Truck	Van	Midsize	124%	79%	28%	38%	63%	27%	63%	10%	0%
Truck	Van	Large	65%	50%	20%	11%	34%	16%	48%	12%	4%
Truck	Van	All	79%	81%	34%	21%	61%	35%	48%	12%	-1%
Truck	SUV	Small	67%	25%	8%	53%	49%	70%	9%	-16%	-36%
Truck	SUV	Midsize	63%	112%	73%	24%	62%	28%	31%	31%	35%
Truck	SUV	Large	57%	82%	97%	54%	36%	37%	2%	34%	44%
Truck	SUV	All	57%	84%	73%	29%	56%	51%	22%	17%	15%
Truck	Pickup	Small	-	-	-	2%	9%	18%	-	-	-
Truck	Pickup	Midsize	-11%	11%	35%	-14%	19%	44%	4%	-7%	-6%
Truck	Pickup	Large	89%	50%	18%	29%	37%	14%	47%	9%	4%
Truck	Pickup	All	89%	42%	17%	29%	52%	25%	47%	-7%	-6%
Car	All	All	20%	91%	75%	-11%	79%	92%	35%	7%	-9%
Truck	All	All	63%	65%	53%	29%	54%	33%	27%	7%	15%
	All	All	33%	72%	75%	-1%	67%	92%	35%	3%	-9%

Table 10

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

Car or Truck	Vehicle Type	Size	1975 Low	1975 Average	1975 High	1988 Low	1988 Average	1988 High	2010 Low	2010 Average	2010 High
Car	Car	Small	11.6	6.4	3.5	13.3	3.9	1.8	9.9	3.7	2.3
Car	Car	Midsize	11.6	8.6	5.4	9.5	4.4	3.6	8.2	3.8	2.0
Car	Car	Large	11.9	8.9	6.8	10.0	4.9	3.8	7.9	4.4	3.8
Car	Car	All	11.9	7.5	3.5	13.3	4.1	1.8	9.9	3.9	2.0
Car	Wagon	Small	8.5	5.2	4.1	5.8	3.8	3.0	5.0	3.7	2.8
Car	Wagon	Midsize	11.9	8.8	4.0	5.7	4.5	3.6	5.4	4.4	3.9
Car	Wagon	Large	11.9	9.8	7.8	5.2	5.2	5.2	6.1	6.0	4.8
Car	Wagon	All	11.9	7.2	4.0	5.8	4.3	3.0	6.1	3.9	2.8
Truck	Van	Small	6.2	5.7	5.4	6.5	4.9	4.0	4.1	4.1	4.0
Truck	Van	Midsize	12.2	8.8	5.4	8.8	5.4	4.3	5.4	5.0	4.3
Truck	Van	Large	11.2	9.3	6.9	10.1	7.0	6.0	6.8	6.2	5.7
Truck	Van	All	12.2	9.0	5.4	10.1	5.6	4.0	6.8	5.0	4.0
Truck	SUV	Small	9.8	7.3	6.1	6.4	4.9	3.6	5.9	5.8	5.7
Truck	SUV	Midsize	12.2	9.8	5.4	9.8	6.1	4.2	7.5	4.6	3.1
Truck	SUV	Large	12.7	9.7	7.3	8.2	7.1	5.3	8.1	5.3	3.7
Truck	SUV	All	12.7	9.1	5.4	9.8	5.8	3.6	8.1	5.0	3.1
Truck	Pickup	Small	7.7	5.2	4.8	7.5	4.8	4.1	-	-	-
Truck	Pickup	Midsize	5.6	5.6	5.6	6.5	4.7	3.9	6.3	5.0	4.1
Truck	Pickup	Large	13.2	9.0	5.4	10.2	6.6	4.8	6.9	6.0	4.6
Truck	Pickup	All	13.2	8.4	4.8	10.2	5.5	3.9	6.9	5.9	4.1
Car	All	All	11.9	7.4	3.5	13.3	4.1	1.8	9.9	3.9	2.0
Truck	All	All	13.2	8.6	4.8	10.2	5.6	3.6	8.1	5.2	3.1
	All	All	13.2	7.6	3.5	13.3	4.6	1.8	9.9	4.4	2.0

Table 11

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

Car or Truck	Vehicle Type	Size	1975 to 2010 Low	1975 to 2010 Average	1975 to 2010 High	1975 to 1988 Low	1975 to 1988 Average	1975 to 1988 High	1988 to 2010 Low	1988 to 2010 Average	1988 to 2010 High
Car	Car	Small	15%	42%	34%	-15%	39%	49%	26%	5%	-28%
Car	Car	Midsize	29%	56%	63%	18%	49%	33%	14%	14%	44%
Car	Car	Large	34%	51%	44%	16%	45%	44%	21%	10%	0%
Car	Car	All	17%	48%	43%	-12%	45%	49%	26%	5%	-11%
Car	Wagon	Small	41%	29%	32%	32%	27%	27%	14%	3%	7%
Car	Wagon	Midsize	55%	50%	3%	52%	49%	10%	5%	2%	-8%
Car	Wagon	Large	49%	39%	38%	56%	47%	33%	-17%	-15%	8%
Car	Wagon	All	49%	46%	30%	51%	40%	25%	-5%	9%	7%
Truck	Van	Small	34%	28%	26%	-5%	14%	26%	37%	16%	0%
Truck	Van	Midsize	56%	43%	20%	28%	39%	20%	39%	7%	0%
Truck	Van	Large	39%	33%	17%	10%	25%	13%	33%	11%	5%
Truck	Van	All	44%	44%	26%	17%	38%	26%	33%	11%	0%
Truck	SUV	Small	40%	21%	7%	35%	33%	41%	8%	-18%	-58%
Truck	SUV	Midsize	39%	53%	43%	20%	38%	22%	23%	25%	26%
Truck	SUV	Large	36%	45%	49%	35%	27%	27%	1%	25%	30%
Truck	SUV	All	36%	45%	43%	23%	36%	33%	17%	14%	14%
Truck	Pickup	Small	-	-	-	3%	8%	15%	-	-	-
Truck	Pickup	Midsize	-13%	11%	27%	-16%	16%	30%	3%	-6%	-5%
Truck	Pickup	Large	48%	33%	15%	23%	27%	11%	32%	9%	4%
Truck	Pickup	All	48%	30%	15%	23%	35%	19%	32%	-7%	-5%
Car	All	All	17%	47%	43%	-12%	45%	49%	26%	5%	-11%
Truck	All	All	39%	40%	35%	23%	35%	25%	21%	7%	14%
Both	All	All	25%	42%	43%	-1%	39%	49%	26%	4%	-11%

*Note: A negative change indicates that fuel consumption has increased.

Cars and light trucks with conventional drive trains have a fuel consumption and weight relationship which is well known and is shown in Figure 11. 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 trend lines shown on the graphs. At constant weight, MY2009 cars consume about 40% less fuel per mile than their MY1975 counterparts.

On this same constant weight basis, this year's vehicles with diesel engines nominally consume 20 – 25% less fuel than the conventionally powered ones, while this year's hybrid vehicles are about 30 – 40% better. Similarly, at constant weight this year's conventionally powered trucks achieve about 50% better fuel consumption than MY1975 vehicles did.

Figure 11

Laboratory 55/45 Fuel Consumption vs. Vehicle Weight, MY1975 and MY2010

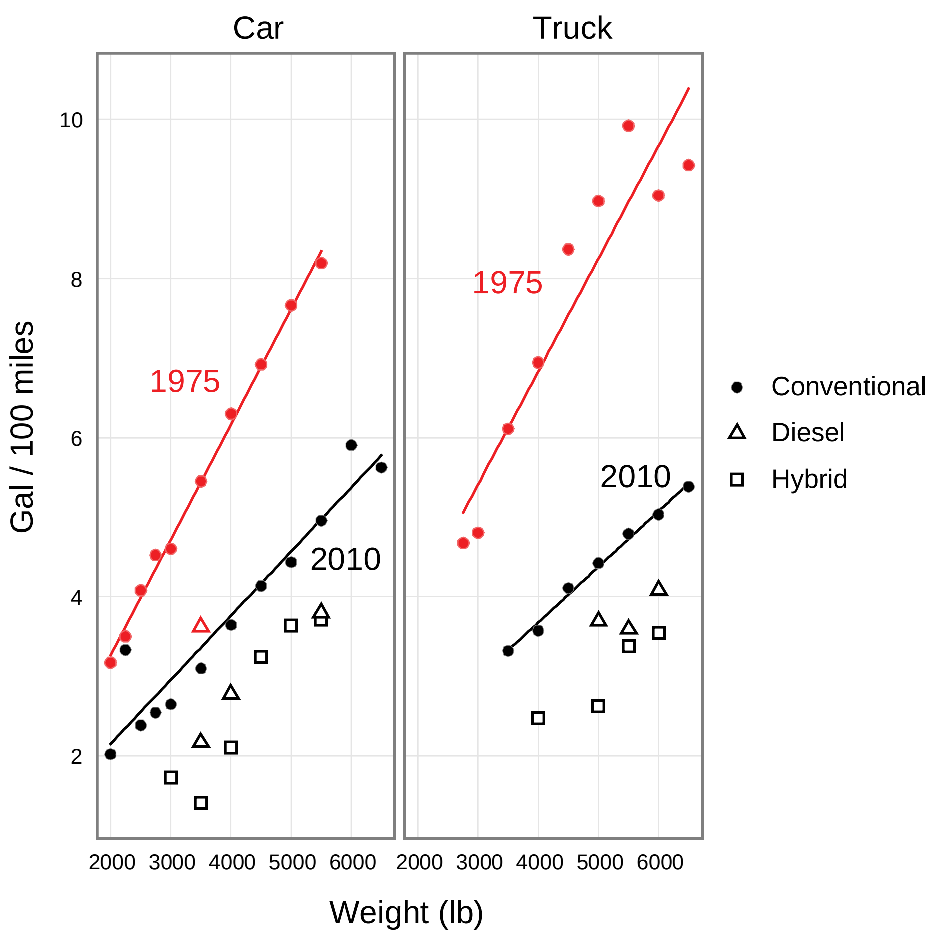


Figure 12 shows that the relationship between interior volume and fuel consumption is currently not as important as in the past. The data points on both of these graphs exclude two seaters and represent production weighted average fuel consumption calculated at increments of 1.0 cu. ft. As was done for Figure 11, the data points for hybrid and diesel vehicles were plotted separately from those for the conventionally powered vehicles.

Figure 12

Laboratory 55/45 Fuel Consumption vs. Interior Volume, MY1978 and MY2010 Cars

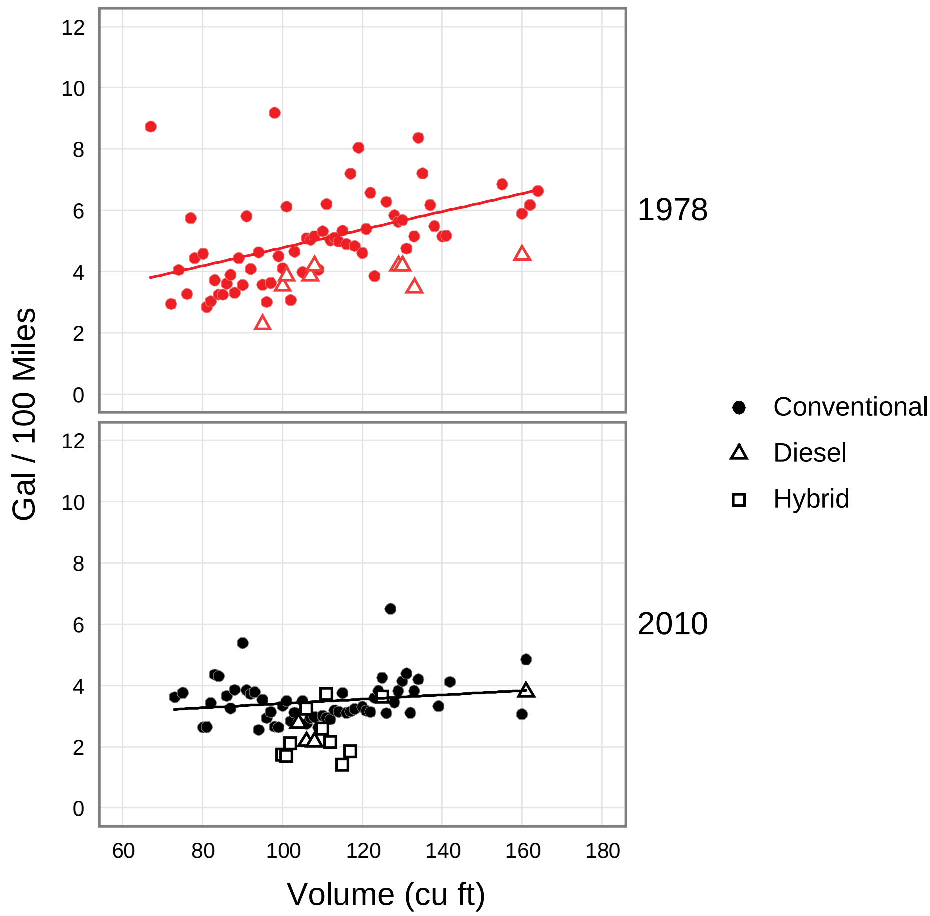


Figure 13 shows laboratory 55/45 fuel consumption versus footprint for cars and trucks, respectively, again with the regression lines excluding the hybrid and diesel data points. Car fuel consumption is more sensitive to footprint than truck fuel consumption. For a given footprint, trucks generally have somewhat higher fuel consumption than cars, though this is not the case at the very highest footprint levels.

Figure 13

Laboratory 55/45 Fuel Consumption vs. Footprint, MY2010 Vehicles

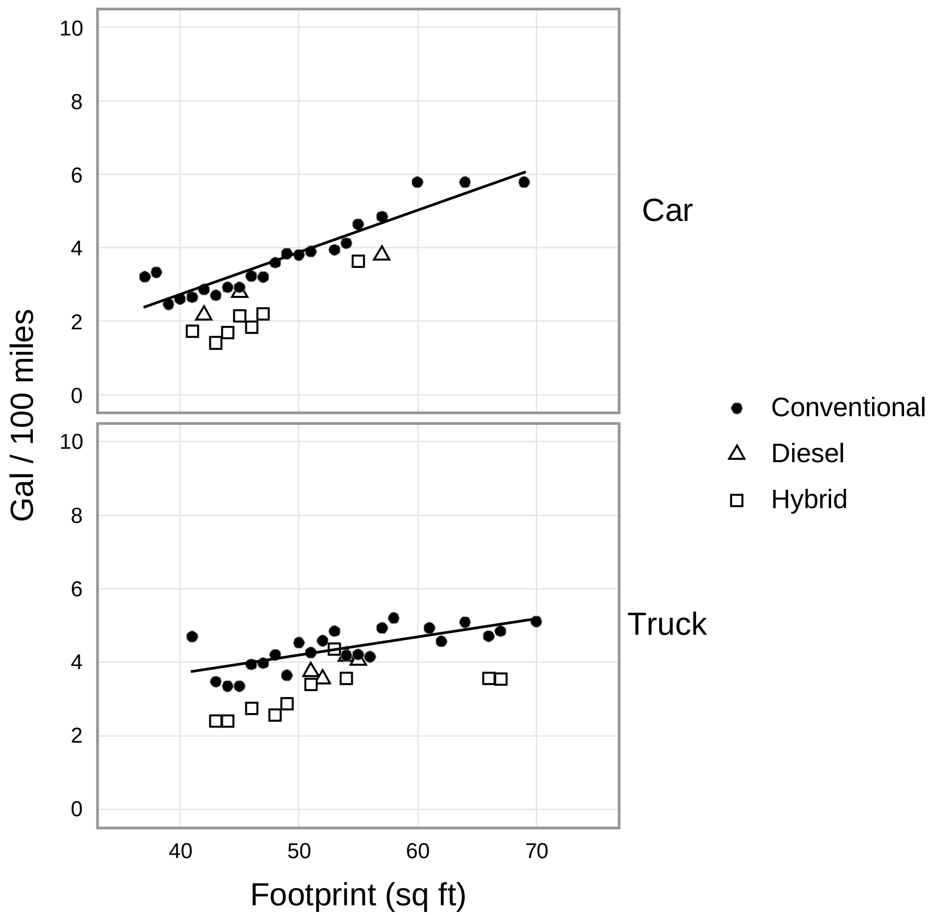


Figure 14 shows the improvement that occurred between 1975 and 2010 for fuel consumption as a function of 0-to-60 acceleration time for cars and trucks.

Figure 14

Laboratory 55/45 Fuel Consumption vs. 0-to-60 Time, MY1975 and MY2010 Vehicles

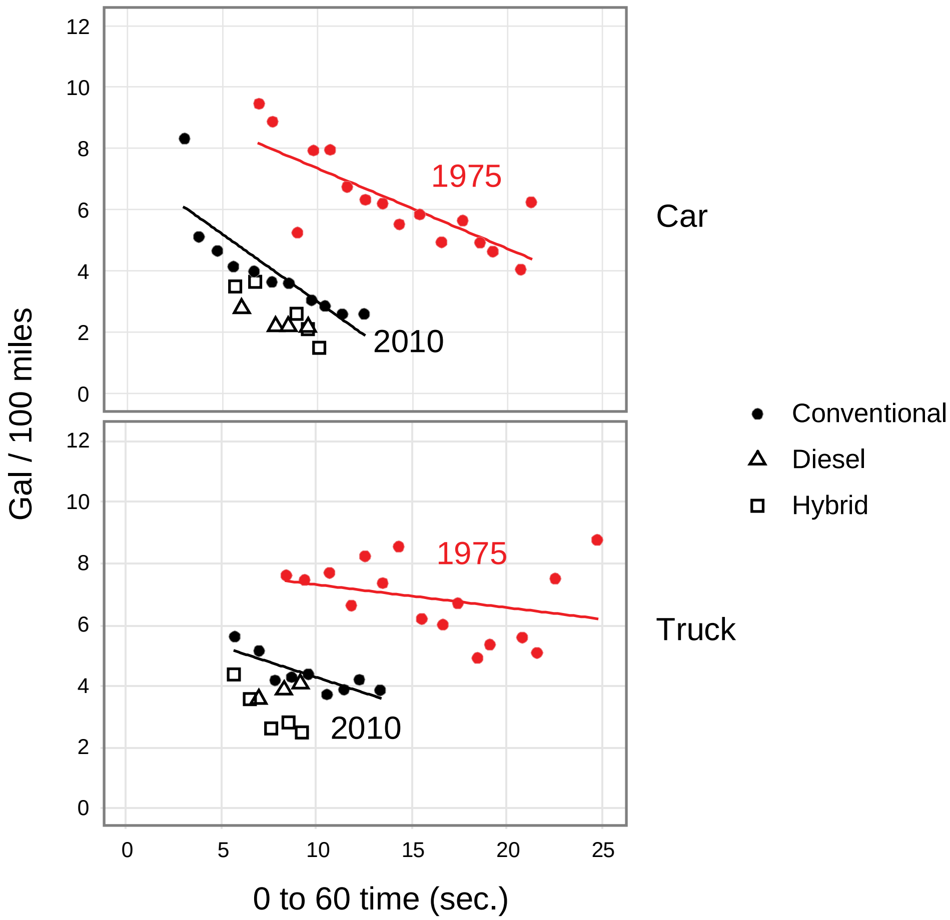


Figure 15 compares Ton-MPG data versus 0-to-60 time and shows that at constant vehicle performance, there has been substantial improvement in Ton-MPG, particularly for hybrid and diesel vehicles.

Figure 15

Ton-MPG vs. 0-to-60 Time, MY1975 and MY2010 Vehicles

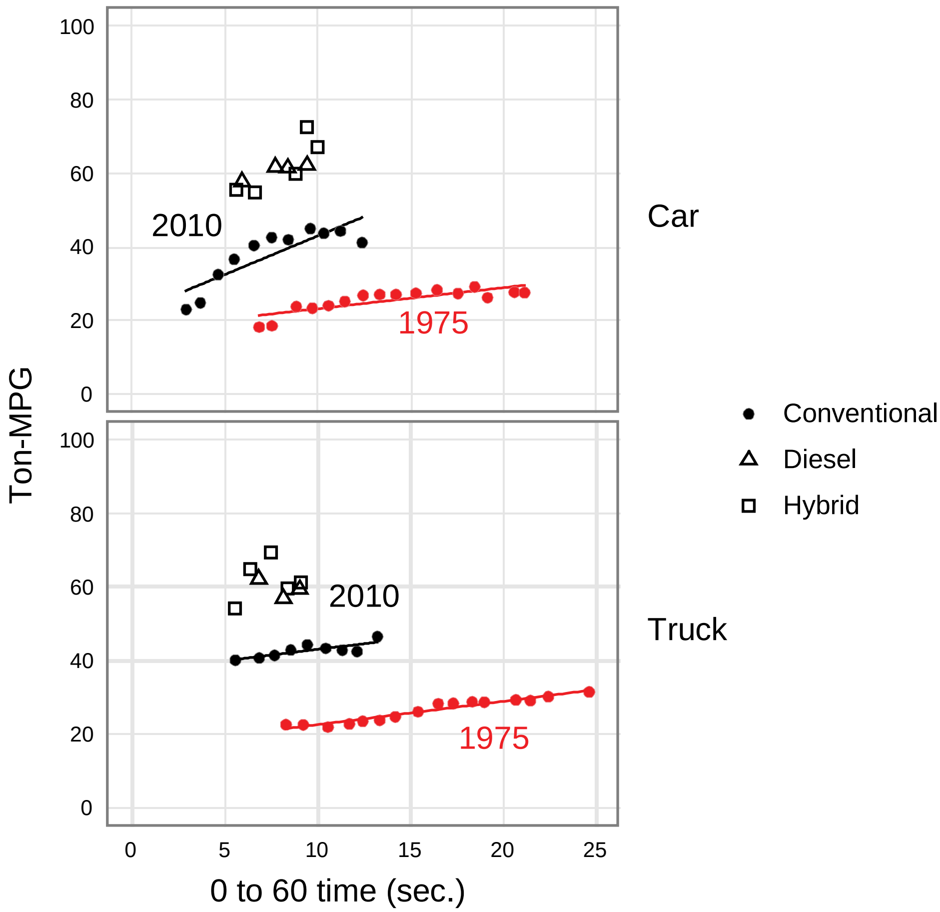


Figure 16 and Table 12 show some of the changes in the distribution of weight that have occurred over the years for the light-duty fleet. In 1975, 13% of all light-duty vehicles had weights of less than 3000 lb compared to less than 4% in 2010. Since 1988, production share for vehicles with weights of 5000 pounds or more has increased from 3% to 20%.

Figure 16

Distribution of Light Vehicle Weight for Three Model Years

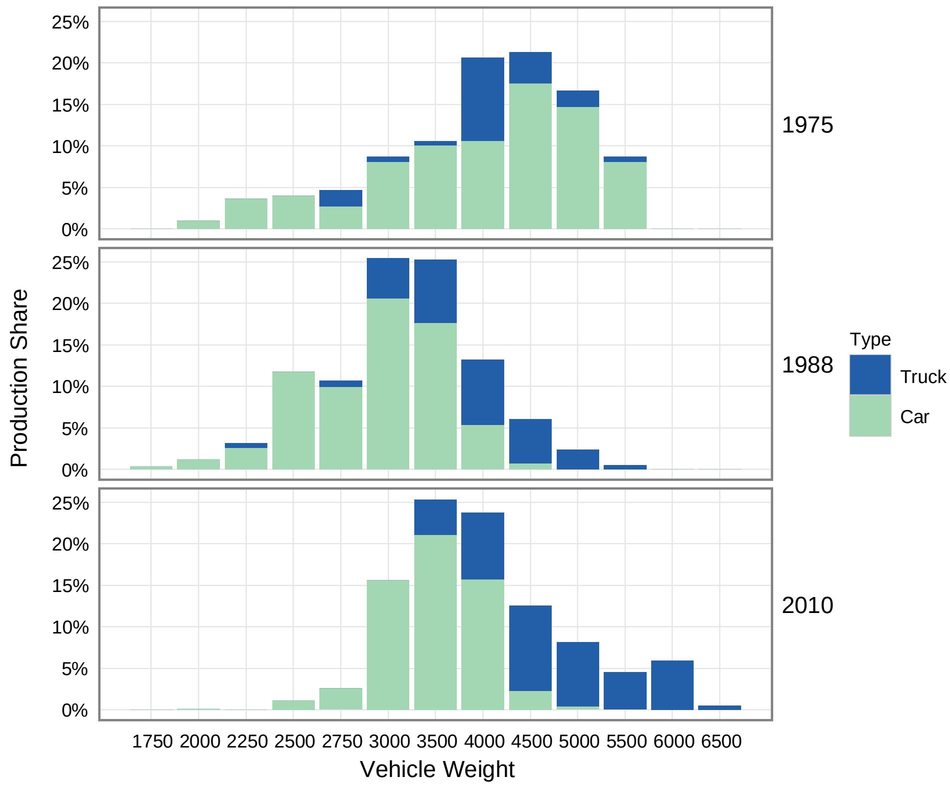


Table 12

Light Vehicle Production Share by Weight Class for Three Model Years

Weight (lb)	MY1975	MY1988	MY2010
<3000	13.4%	27.2%	3.8%
3000	8.7%	25.4%	15.6%
3500	10.6%	25.2%	25.3%
4000	20.6%	13.2%	23.7%
4500	21.3%	6.0%	12.5%
5000	16.7%	2.4%	8.2%
5500	8.7%	0.5%	4.5%
>5500	0.0%	0.0%	6.4%
Avg Wt	4060	3283	4009

Figure 17 provides data for the annual production share of different weight vehicles for cars and trucks. In 1975, about 40% of the cars were in weight classes greater than 4000 pounds, compared to less than 5% this year. For MY2009, three weight classes (3000, 3500, and 4000 lbs) account for over 90% of all cars. Conversely, the production share of trucks in the weight classes of 4500 lb or more have increased substantially, and these vehicles currently account for over 70% of all trucks, compared to about 30% in 1975. Figure 18 provides additional details of the truck data presented in Figure 17 for vans, SUVs, and pickups respectively. Appendices 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 weight class.

Figure 17

Production Share by Vehicle Weight Class

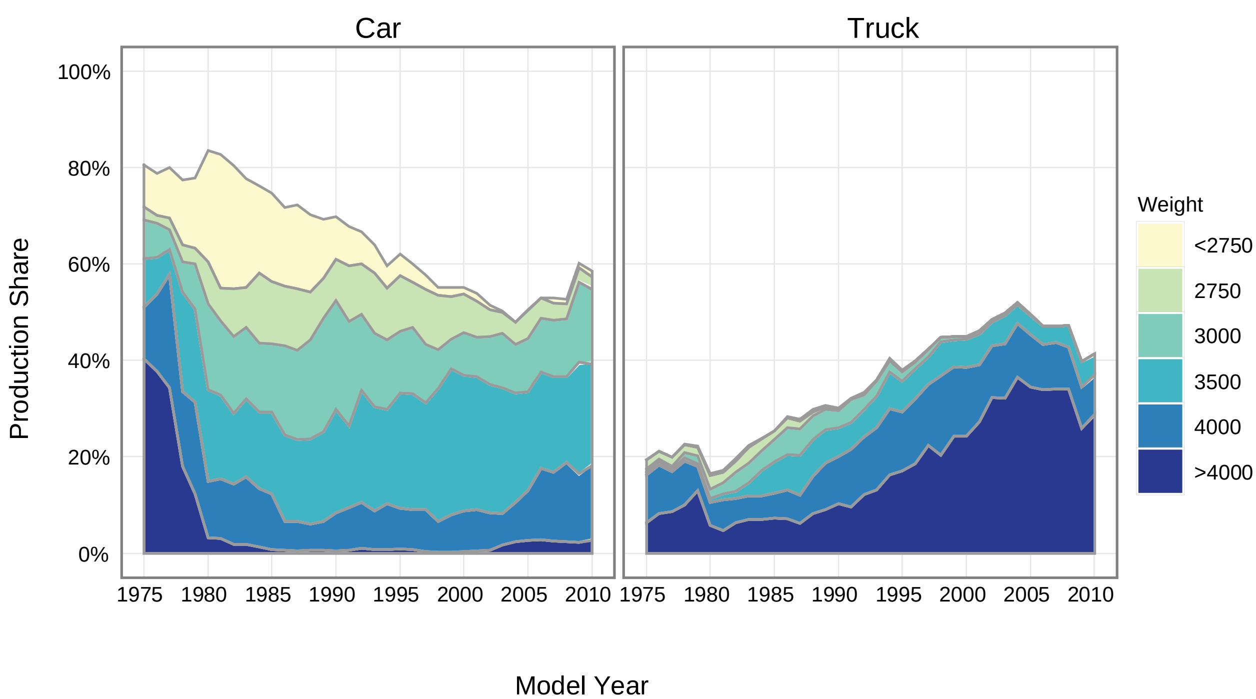
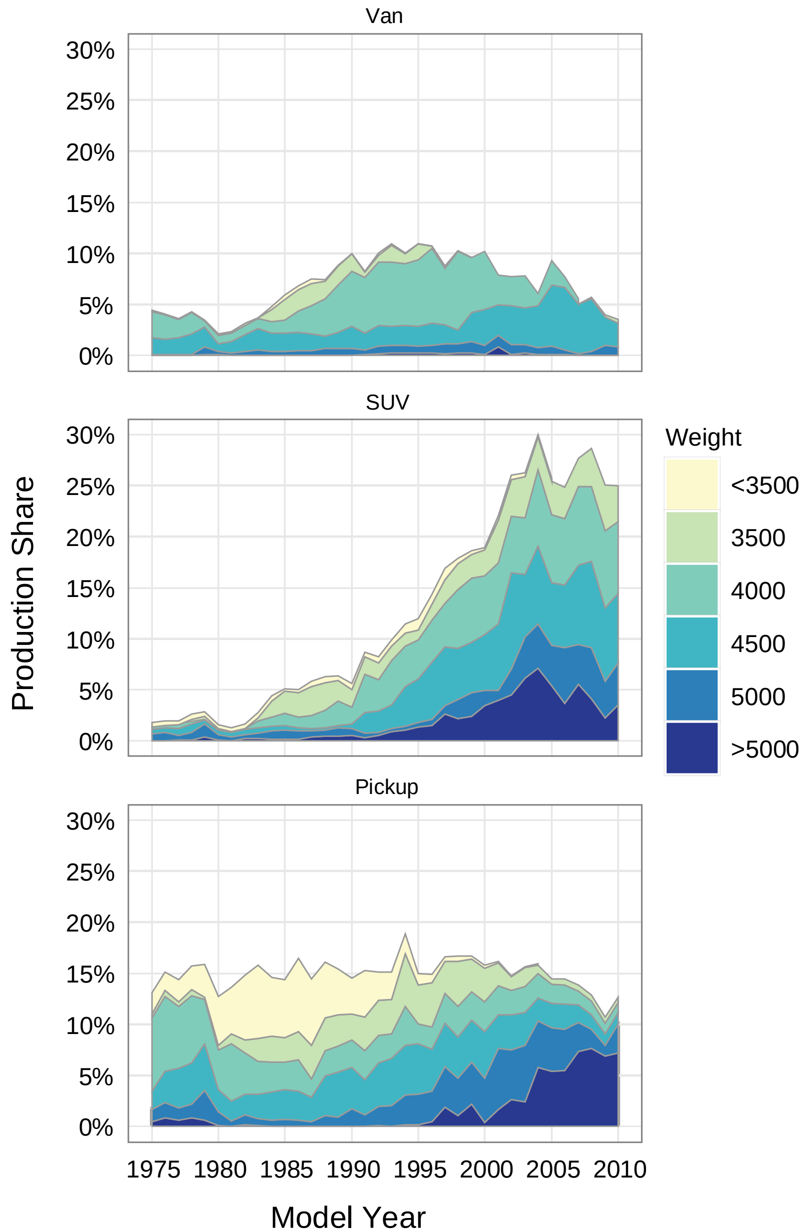


Figure 18

Production Share by Vehicle Type and Vehicle Weight Class



VI. <u>Fuel Economy Technology Trends</u>

Table 13 repeats the production 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 production fraction data which specifies the percent of vehicles that: have front-wheel drive (FWD) or four-wheel drive (4WD); have manual, lockup, or continuously variable transmissions (CVT); have gasoline direct injection (GDI), port fuel injection 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); have turbochargers; use cylinder deactivation (CD); and use hybrid technology.

For the overall MY2010 fleet, FWD accounts for about 60% of production and 4WD for nearly one-quarter of the fleet. Regarding transmissions, manuals represent about seven percent of production, while CVTs have grown to over ten percent. Multi-valve engines and VVT both account for about 85% of the MY2010 vehicles produced. Turbochargers are used on about three percent of the fleet. Hybrids represent about four percent of the fleet, while diesels represent 0.4% of the projected MY2010 production. Appendix K contains additional data on fuel metering and number of valves per cylinder.

Table 14 compares technology usage for MY2010 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 pickups, because none have been produced for several years.

Front-wheel drive (FWD) is used heavily in all of the car classes, small wagons and small and midsize vans. 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, some sports cars, and midsize pickups. Engines with more than two valves per cylinder and VVT are now prevalent for nearly all vehicle types and sizes.

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

Table 13

Powertrain Characteristics of 1975 to 2010 Light Duty Vehicles (Percentage Basis)

Cars

Model Year	Production Share	Adj Comp MPG	CID	HP	HP/ CID	Front Wheel Drive	Four Wheel Drive	Manual Trans	Lockup Trans	CVT	GDI Metering	Port Metering	TBI Metering	Diesel	Multi-Valve	VVT	Turbo	CD	Hybrid
1975	80.6%	13.5	288	136	0.515	6.5%	-	19.6%	0.3%	-	-	5.1%	-	0.2%	-	-	-	-	-
1976	78.8%	14.9	287	134	0.502	5.8%	-	17.1%	-	-	-	3.2%	-	0.3%	-	-	-	-	-
1977	80.0%	15.6	279	133	0.516	6.8%	-	16.8%	-	-	-	4.2%	-	0.5%	-	-	-	-	-
1978	77.3%	16.9	251	124	0.538	9.6%	-	19.8%	7.1%	-	-	5.1%	-	0.9%	-	-	-	-	-
1979	77.8%	17.2	238	119	0.545	11.9%	0.3%	21.1%	8.8%	-	-	4.7%	-	2.1%	-	-	-	-	-
1980	83.5%	20.0	188	100	0.583	29.7%	0.9%	30.9%	16.8%	-	-	6.2%	0.7%	4.4%	-	-	-	-	-
1981	82.7%	21.4	182	99	0.594	37.0%	0.7%	29.9%	33.3%	-	-	6.1%	2.6%	5.9%	-	-	-	-	-
1982	80.3%	22.2	175	99	0.609	45.6%	0.8%	29.2%	51.4%	-	-	7.2%	9.8%	4.7%	-	-	-	-	-
1983	77.7%	22.1	182	104	0.615	47.3%	3.1%	26.1%	56.7%	-	-	9.5%	18.9%	2.1%	-	-	-	-	-
1984	76.1%	22.4	179	106	0.637	53.7%	1.0%	24.1%	58.3%	-	-	15.0%	24.4%	1.7%	-	-	-	-	-
1985	74.6%	23.0	177	111	0.671	61.6%	2.1%	22.8%	58.7%	-	-	21.4%	32.0%	0.9%	-	-	-	-	-
1986	71.7%	23.7	167	111	0.701	71.1%	1.1%	24.8%	58.0%	-	-	36.7%	28.4%	0.3%	4.8%	-	-	-	-
1987	72.2%	23.8	162	112	0.732	77.0%	1.1%	24.9%	59.5%	-	-	42.5%	30.5%	0.3%	14.7%	-	-	-	-
1988	70.2%	24.1	160	116	0.759	81.7%	0.8%	24.3%	66.1%	-	-	53.7%	30.0%	0.0%	19.9%	-	-	-	-
1989	69.3%	23.7	163	121	0.783	82.5%	1.0%	21.0%	69.3%	0.1%	-	62.4%	27.8%	0.0%	24.4%	-	-	-	-
1990	69.8%	23.3	163	129	0.829	84.6%	1.0%	19.6%	72.9%	0.0%	-	77.5%	21.1%	0.0%	33.0%	0.6%	-	-	-
1991	67.8%	23.4	163	132	0.851	83.2%	1.4%	20.5%	73.6%	0.0%	-	78.0%	21.8%	0.1%	34.1%	2.4%	-	-	-
1992	66.6%	23.1	170	141	0.868	80.8%	1.1%	17.4%	76.4%	0.0%	-	89.5%	10.4%	0.1%	35.0%	4.6%	-	-	-
1993	64.0%	23.5	166	138	0.865	85.1%	1.2%	17.8%	77.0%	0.0%	-	91.6%	8.4%	-	36.7%	4.8%	-	-	-
1994	59.6%	23.3	168	143	0.884	84.4%	0.4%	16.7%	79.3%	-	-	94.9%	5.1%	0.0%	41.0%	8.0%	-	-	-
1995	62.0%	23.4	167	152	0.945	82.0%	1.2%	16.3%	81.9%	-	-	98.8%	1.2%	0.1%	52.2%	9.8%	-	-	-
1996	60.0%	23.3	165	154	0.958	86.5%	1.5%	14.9%	83.6%	0.0%	-	98.8%	1.1%	0.1%	57.3%	11.7%	0.3%	-	-
1997	57.6%	23.4	164	156	0.974	86.5%	1.7%	13.5%	85.8%	0.1%	-	99.1%	0.8%	0.1%	58.6%	11.3%	0.7%	-	-
1998	55.1%	23.4	164	159	0.993	87.0%	2.3%	12.3%	87.3%	0.1%	-	99.7%	0.1%	0.2%	61.4%	18.4%	2.4%	-	-
1999	55.1%	23.0	166	164	1.009	87.2%	2.2%	10.9%	88.4%	0.0%	-	99.7%	0.1%	0.2%	64.6%	17.1%	3.3%	-	-
2000	55.1%	22.9	165	168	1.032	84.9%	2.1%	11.2%	87.7%	0.0%	-	99.7%	0.1%	0.2%	65.1%	23.4%	2.3%	-	0.1%
2001	53.9%	23.0	165	168	1.042	84.1%	3.2%	11.4%	87.5%	0.2%	-	99.7%	-	0.3%	67.2%	28.3%	3.6%	-	0.0%
2002	51.5%	23.1	166	173	1.066	84.9%	3.8%	11.2%	88.1%	0.4%	-	99.6%	-	0.4%	69.9%	33.9%	4.2%	-	0.3%
2003	50.2%	23.3	165	176	1.086	82.0%	3.5%	11.2%	87.9%	0.9%	-	99.6%	-	0.4%	73.8%	41.3%	2.1%	-	0.6%
2004	48.0%	23.1	168	182	1.106	80.8%	5.4%	10.2%	88.2%	1.4%	-	99.7%	-	0.3%	77.2%	44.2%	4.0%	-	0.9%
2005	50.5%	23.5	166	182	1.115	79.8%	5.8%	9.3%	88.0%	2.6%	-	99.6%	-	0.4%	78.2%	51.6%	2.7%	1.1%	2.1%
2006	52.9%	23.3	172	194	1.146	75.8%	5.8%	9.4%	88.1%	2.4%	-	99.4%	-	0.6%	80.8%	60.6%	3.6%	2.2%	1.5%
2007	52.9%	24.1	165	189	1.157	80.5%	5.7%	8.5%	81.1%	10.4%	-	99.6%	-	0.0%	84.8%	65.2%	3.7%	1.0%	3.4%
2008	52.7%	24.3	165	193	1.178	77.8%	7.3%	8.0%	80.2%	11.5%	3.2%	96.8%	-	0.1%	87.8%	63.5%	4.7%	2.3%	3.4%
2009	60.2%	25.4	155	184	1.190	82.5%	6.8%	6.7%	81.9%	11.0%	4.6%	94.7%	-	0.7%	91.9%	80.7%	4.4%	2.1%	3.0%
2010	58.9%	25.8	159	192	1.205	79.8%	6.5%	10.0%	76.0%	13.8%	6.7%	92.7%	-	0.5%	93.4%	91.5%	3.9%	3.1%	6.1%

Table 13 (continued)

Powertrain Characteristics of 1975 to 2010 Light Duty Vehicles (Percentage Basis)

Trucks

Model Year	Production Share	Adj Comp MPG	CID	HP	HP/ CID	Front Wheel Drive	Four Wheel Drive	Manual Trans	Lockup Trans	CVT	GDI Metering	Port Metering	TBI Metering	Diesel	Multi-Valve	VVT	Turbo	CD	Hybrid
1975	19.4%	11.6	311	142	0.476	-	17.1%	37.0%	-	-	-	-	0.1%	-	-	-	-	-	-
1976	21.2%	12.2	319	141	0.458	-	22.9%	34.8%	-	-	-	-	0.1%	-	-	-	-	-	-
1977	20.0%	13.3	318	147	0.482	-	23.6%	32.0%	-	-	-	-	0.1%	-	-	-	-	-	-
1978	22.7%	12.9	314	146	0.481	-	29.0%	32.4%	-	-	-	-	0.1%	0.8%	-	-	-	-	-
1979	22.2%	12.5	298	138	0.486	-	18.0%	35.2%	2.1%	-	-	-	0.3%	1.8%	-	-	-	-	-
1980	16.5%	15.8	248	121	0.528	1.4%	25.0%	53.0%	24.6%	-	-	-	1.7%	3.5%	-	-	-	-	-
1981	17.3%	17.1	247	119	0.508	1.9%	20.1%	51.6%	31.1%	-	-	-	1.1%	5.6%	-	-	-	-	-
1982	19.7%	17.4	243	120	0.524	1.7%	20.0%	45.7%	33.2%	-	-	-	0.7%	9.3%	-	-	-	-	-
1983	22.3%	17.8	231	118	0.543	1.4%	25.8%	45.9%	36.1%	-	-	-	0.6%	4.7%	-	-	-	-	-
1984	23.9%	17.4	224	118	0.557	4.9%	31.0%	42.1%	35.1%	-	-	1.9%	0.6%	2.3%	-	-	-	-	-
1985	25.4%	17.5	224	124	0.586	7.1%	30.6%	37.1%	42.2%	-	-	8.7%	3.5%	1.1%	-	-	-	-	-
1986	28.3%	18.2	211	123	0.621	5.9%	30.3%	42.7%	42.0%	-	-	21.8%	18.7%	0.7%	-	-	-	-	-
1987	27.8%	18.3	210	131	0.654	7.4%	31.5%	39.9%	44.8%	-	-	33.3%	33.6%	0.3%	-	-	-	-	-
1988	29.8%	17.9	227	141	0.650	9.0%	33.3%	35.5%	53.1%	-	-	43.3%	44.4%	0.2%	-	-	-	-	-
1989	30.7%	17.6	234	146	0.653	9.9%	32.0%	32.7%	56.8%	-	-	45.9%	47.6%	0.2%	-	-	-	-	-
1990	30.2%	17.4	237	151	0.668	15.5%	31.3%	28.2%	67.4%	-	-	55.2%	40.8%	0.2%	-	-	-	-	-
1991	32.2%	17.8	228	150	0.681	9.7%	35.3%	31.0%	67.4%	-	-	55.0%	43.2%	0.1%	-	-	-	-	-
1992	33.4%	17.4	234	155	0.685	13.6%	31.4%	27.3%	71.5%	-	-	65.9%	32.5%	0.1%	-	-	-	-	-
1993	36.0%	17.5	235	162	0.710	15.1%	29.4%	23.3%	75.7%	-	-	73.4%	25.7%	-	-	-	-	-	-
1994	40.4%	17.2	239	166	0.717	13.1%	36.9%	23.5%	75.1%	-	-	77.2%	22.5%	-	5.6%	-	-	-	-
1995	38.0%	17.0	244	168	0.715	17.7%	40.7%	20.5%	78.6%	-	-	79.8%	20.2%	-	8.4%	-	-	-	-
1996	40.0%	17.2	243	179	0.757	20.1%	37.1%	15.6%	83.5%	-	-	99.9%	-	0.1%	12.4%	-	-	-	-
1997	42.4%	17.0	248	187	0.775	13.9%	43.2%	14.6%	85.0%	-	-	100.0%	-	0.0%	13.7%	-	-	-	-
1998	44.9%	17.1	242	187	0.795	18.7%	42.0%	13.4%	86.0%	-	-	100.0%	-	0.0%	15.8%	-	-	-	-
1999	44.9%	16.7	249	197	0.814	17.4%	44.6%	9.1%	90.5%	-	-	100.0%	-	0.0%	17.3%	-	-	-	-
2000	44.9%	16.9	242	197	0.832	19.4%	42.4%	8.0%	91.7%	-	-	100.0%	-	-	19.9%	4.7%	-	-	-
2001	46.1%	16.7	243	209	0.882	18.5%	43.8%	6.3%	93.4%	-	-	100.0%	-	-	27.6%	9.3%	-	-	-
2002	48.5%	16.7	244	219	0.918	18.5%	47.6%	5.0%	94.7%	0.0%	-	100.0%	-	-	35.6%	16.2%	-	-	-
2003	49.8%	16.9	243	221	0.927	19.1%	46.7%	4.8%	93.7%	1.2%	-	100.0%	-	-	37.1%	19.7%	0.2%	-	-
2004	52.0%	16.7	252	236	0.953	17.2%	52.3%	3.7%	95.0%	1.0%	-	100.0%	-	0.0%	48.4%	33.3%	0.8%	-	0.0%
2005	49.5%	17.2	244	237	0.983	25.7%	48.3%	3.0%	95.0%	2.0%	-	99.9%	-	0.1%	52.8%	39.8%	0.6%	0.5%	0.1%
2006	47.1%	17.5	240	235	0.992	25.1%	48.4%	3.2%	93.5%	3.3%	-	99.9%	-	0.1%	61.4%	49.6%	0.5%	5.3%	1.4%
2007	47.1%	17.7	244	248	1.034	24.9%	49.0%	2.5%	93.9%	3.7%	-	99.9%	-	0.1%	57.0%	48.5%	1.3%	14.3%	0.9%
2008	47.3%	18.2	237	247	1.059	28.0%	49.6%	2.0%	94.1%	3.9%	1.2%	98.6%	-	0.2%	63.6%	52.3%	1.1%	11.7%	1.4%
2009	39.8%	19.0	226	245	1.103	32.7%	49.3%	1.8%	91.0%	7.3%	3.8%	96.0%	-	0.2%	71.1%	58.9%	1.6%	15.3%	1.2%
2010	41.1%	19.1	236	259	1.121	30.2%	48.2%	2.0%	92.8%	5.2%	11.0%	88.8%	-	0.2%	75.6%	79.2%	2.2%	12.5%	1.6%

Table 13 (continued)

Powertrain Characteristics of 1975 to 2010 Light Duty Vehicles (Percentage Basis)

Cars and Trucks

Model Year	Adj Comp MPG	CID	HP	HP/ CID	Front Wheel Drive	Four Wheel Drive	Manual Trans	Lockup Trans	CVT	GDI Metering	Port Metering	TBI Metering	Diesel	Multi-Valve	VVT	Turbo	CD	Hybrid
1975	13.1	293	137	0.507	5.3%	3.3%	23.0%	0.2%	-	-	4.1%	0.0%	0.2%	-	-	-	-	-
1976	14.2	294	135	0.493	4.6%	4.8%	20.9%	-	-	-	2.5%	0.0%	0.2%	-	-	-	-	-
1977	15.1	287	136	0.510	5.5%	4.7%	19.8%	-	-	-	3.4%	0.0%	0.4%	-	-	-	-	-
1978	15.8	266	129	0.525	7.4%	6.6%	22.7%	5.5%	-	-	3.9%	0.0%	0.9%	-	-	-	-	-
1979	15.9	252	124	0.532	9.2%	4.3%	24.2%	7.3%	-	-	3.7%	0.1%	2.0%	-	-	-	-	-
1980	19.2	198	104	0.574	25.0%	4.9%	34.6%	18.1%	-	-	5.2%	0.8%	4.3%	-	-	-	-	-
1981	20.5	193	102	0.580	31.0%	4.0%	33.6%	33.0%	-	-	5.1%	2.4%	5.9%	-	-	-	-	-
1982	21.1	188	103	0.593	37.0%	4.6%	32.4%	47.8%	-	-	5.8%	8.0%	5.6%	-	-	-	-	-
1983	21.0	193	107	0.599	37.0%	8.1%	30.5%	52.1%	-	-	7.3%	14.8%	2.7%	-	-	-	-	-
1984	21.0	190	109	0.618	42.1%	8.2%	28.4%	52.8%	-	-	11.9%	18.7%	1.8%	-	-	-	-	-
1985	21.3	189	114	0.650	47.8%	9.3%	26.5%	54.5%	-	-	18.2%	24.8%	0.9%	-	-	-	-	-
1986	21.8	180	114	0.678	52.6%	9.3%	29.8%	53.5%	-	-	32.5%	25.7%	0.4%	-	-	-	-	-
1987	22.0	175	118	0.710	57.7%	9.6%	29.1%	55.4%	-	-	39.9%	31.4%	0.3%	-	-	-	-	-
1988	21.9	180	123	0.726	60.0%	10.5%	27.6%	62.2%	-	-	50.6%	34.3%	0.1%	-	-	-	-	-
1989	21.4	185	129	0.743	60.2%	10.5%	24.6%	65.5%	0.1%	-	57.3%	33.9%	0.1%	-	-	-	-	-
1990	21.2	185	135	0.781	63.8%	10.1%	22.2%	71.2%	0.0%	-	70.8%	27.0%	0.1%	-	-	-	-	-
1991	21.2	184	138	0.796	59.6%	12.3%	23.9%	71.6%	0.0%	-	70.6%	28.7%	0.1%	-	-	-	-	-
1992	20.8	191	145	0.807	58.4%	11.2%	20.7%	74.8%	0.0%	-	81.6%	17.8%	0.1%	-	-	-	-	-
1993	20.9	191	147	0.809	59.9%	11.3%	19.8%	76.5%	0.0%	-	85.0%	14.6%	-	-	-	-	-	-
1994	20.4	197	152	0.816	55.6%	15.2%	19.5%	77.6%	-	-	87.7%	12.1%	0.0%	26.7%	-	-	-	-
1995	20.5	196	158	0.857	57.6%	16.2%	17.9%	80.7%	-	-	91.6%	8.4%	0.0%	35.6%	-	-	-	-
1996	20.4	197	164	0.878	60.0%	15.7%	15.2%	83.5%	0.0%	-	99.3%	0.7%	0.1%	39.3%	-	0.2%	-	-
1997	20.1	199	169	0.890	55.8%	19.3%	14.0%	85.5%	0.0%	-	99.5%	0.5%	0.1%	39.6%	-	0.4%	-	-
1998	20.1	199	171	0.904	56.4%	20.1%	12.8%	86.7%	0.0%	-	99.8%	0.1%	0.1%	40.9%	-	1.4%	-	-
1999	19.7	203	179	0.921	55.8%	21.3%	10.1%	89.4%	0.0%	-	99.9%	0.1%	0.1%	43.4%	-	1.8%	-	-
2000	19.8	200	181	0.942	55.5%	20.2%	9.7%	89.5%	0.0%	-	99.8%	0.0%	0.1%	44.8%	15.0%	1.3%	-	0.0%
2001	19.6	201	187	0.968	53.8%	21.9%	9.0%	90.2%	0.1%	-	99.9%	-	0.1%	49.0%	19.6%	2.0%	-	0.0%
2002	19.4	203	195	0.994	52.7%	25.0%	8.2%	91.3%	0.2%	-	99.8%	-	0.2%	53.3%	25.3%	2.2%	-	0.2%
2003	19.6	204	199	1.007	50.7%	25.0%	8.0%	90.8%	1.1%	-	99.8%	-	0.2%	55.5%	30.6%	1.2%	-	0.3%
2004	19.3	212	211	1.026	47.7%	29.8%	6.8%	91.8%	1.2%	-	99.9%	-	0.1%	62.3%	38.5%	2.3%	-	0.5%
2005	19.9	205	209	1.049	53.0%	26.8%	6.2%	91.4%	2.3%	-	99.7%	-	0.3%	65.6%	45.8%	1.7%	0.8%	1.1%
2006	20.1	204	213	1.073	51.9%	25.8%	6.5%	90.6%	2.8%	-	99.6%	-	0.4%	71.7%	55.4%	2.1%	3.6%	1.5%
2007	20.6	203	217	1.099	54.3%	26.1%	5.6%	87.1%	7.2%	-	99.8%	-	0.1%	71.7%	57.3%	2.6%	7.3%	2.2%
2008	21.0	199	219	1.122	54.2%	27.3%	5.2%	86.8%	7.9%	2.3%	97.6%	-	0.1%	76.4%	58.2%	3.0%	6.7%	2.5%
2009	22.4	183	208	1.156	62.7%	23.7%	4.7%	85.5%	9.5%	4.2%	95.2%	-	0.5%	83.6%	72.0%	3.3%	7.4%	2.3%
2010	22.5	191	220	1.170	59.4%	23.6%	6.7%	82.9%	10.3%	8.5%	91.1%	-	0.4%	86.1%	86.4%	3.2%	7.0%	4.3%

Table 14

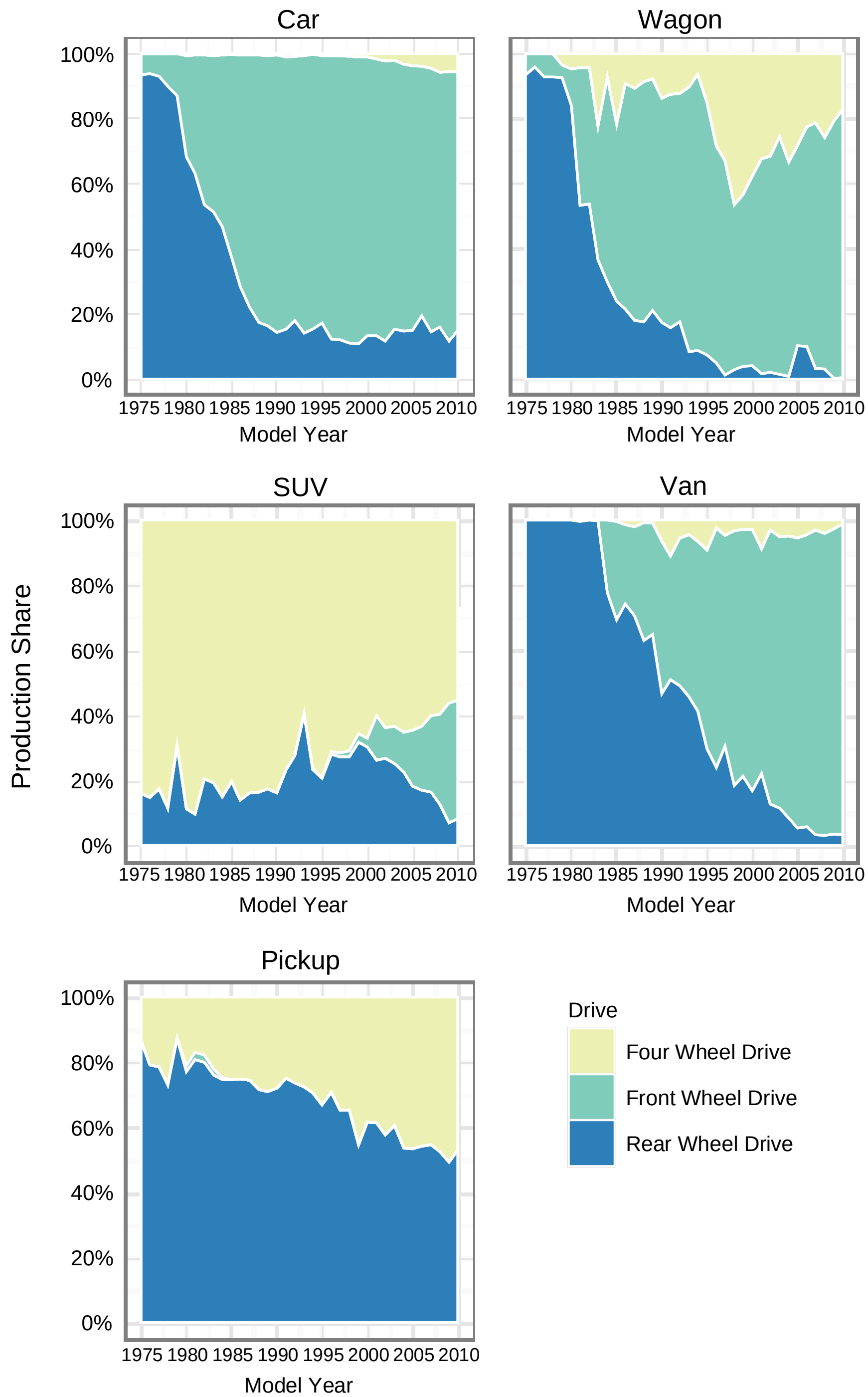
MY2010 Technology Usage by Vehicle Type and Size (Percent of Vehicle Type/Size Strata)

Vehicle Type	Vehicle Size	Front Wheel Drive	Four Wheel Drive	Manual Trans	Multi-Valve	VVT
Car	Small	74%	4%	17%	92%	88%
Car	Midsize	88%	7%	4%	99%	99%
Car	Large	74%	6%	1%	78%	84%
Car	All	80%	5%	9%	93%	92%
Wagon	Small	93%	7%	22%	100%	94%
Wagon	Midsize	33%	67%	5%	100%	48%
Wagon	Large	-	100%	-	100%	100%
Wagon	All	83%	17%	19%	100%	88%
Van	Small	100%	-	6%	100%	100%
Van	Midsize	99%	1%	-	59%	46%
Van	Large	-	12%	-	-	49%
Van	All	96%	1%	0%	58%	47%
SUV	Small	-	96%	28%	-	-
SUV	Midsize	40%	57%	1%	96%	87%
SUV	Large	33%	52%	0%	83%	84%
SUV	All	36%	55%	1%	89%	84%
Pickup	Midsize	-	32%	28%	100%	100%
Pickup	Large	-	49%	1%	49%	75%
Pickup	All	-	47%	4%	55%	78%

Figure 19 shows trends in drive use for the five vehicle classes. Cars and wagons used to be nearly all rear-wheel drive, but are now more than 80% front-wheel drive. 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. Over 90% of vans currently use front-wheel drive, compared to essentially none before 1984, which coincides with the introduction of minivans to the U.S. market. SUVs are mostly 4WD; but a trend toward front-wheel drive SUVs started in MY2000, concurrent with the increased production of crossover vehicles. Pickups remain the bastion of rear-wheel drive, but 4WD is approaching 50% of pickup production.

Figure 19

Front, Rear, and Four Wheel Drive Usage - Production Share by Vehicle Type



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 often. For many conventional engines, this point is approximately 2000 RPM and two-thirds 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) torque converter transmissions; and

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

Table 15 compares Ton-MPG by transmission and vehicle type for 1988 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. Figure 20 indicates that the L4 transmission has lost its position as the predominant transmission type for all vehicle classes. L5 and L6 transmissions combined now account for over half of all production in all classes except cars, with the car market a diverse mix of L4, L5, L6, M5, M6, and CVTs. Manual transmissions are used essentially only in cars and pickups, and the 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.

Table 15

Ton-MPG by Transmission and Vehicle Type (Conventionally Powered Vehicles)

Transmission	Car 1988	Car 2010	Van 1988	Van 2010	SUV 1988	SUV 2010	Pickup 1988	Pickup 2010
M4	37.0	-	33.6	-	38.0	-	32.4	-
M5	37.7	42.8	37.7	43.4	33.1	42.2	35.3	41.0
M6	-	40.7	-	-	-	38.2	-	36.3
CVT	-	46.1	-	-	-	43.1	-	-
L3	36.1	-	37.1	-	33.5	-	31.4	-
L4	37.9	43.6	36.6	43.7	33.8	41.9	33.8	42.2
L5	-	44.3	-	47.3	-	43.7	-	40.0
L6	-	45.0	-	44.8	-	46.8	-	46.9

Figure 20

Transmission Production Share by Model Year

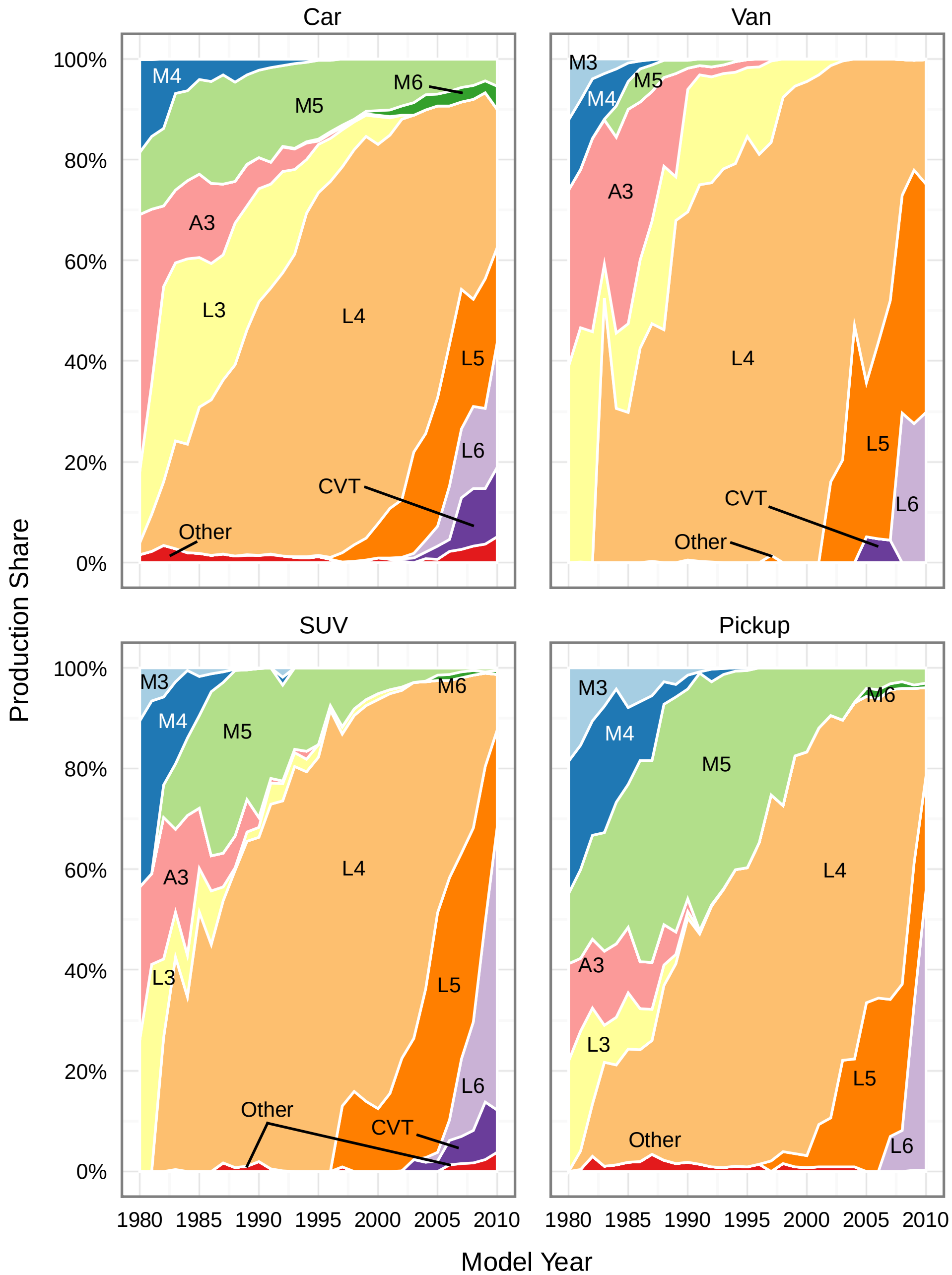


Table 16 and Figure 21 show production share stratified by number of engine cylinders. Engines with 8, 6, and 4 cylinders have accounted for 97 to 99% of all engines produced since 1975. The 8-cylinder engine was dominant in the mid and late 1970s, accounting for over half of production. Subsequently, while production share stratified by number of engine cylinders varied over time, there were two years with notable production shifts. The first major shift was in MY1980, when 8-cylinder engine production share dropped from 54% to 26%, and 4-cylinder production share increased from 26% to 45%. The 4-cylinder engine continued to lead the market until overtaken by 6-cylinder engines in MY1992. The second major shift was in MY2009, when 4-cylinder engines once again became the production leader with 51% (an increase of 13% in a single year), followed by 6-cylinder engines with 35%, and 8-cyinder engines at an all-time low of 12%. Figure 22 breaks out the data for engine cylinders by vehicle type. It can be seen that 4-cylinder engines account for nearly 70% of cars and about 30% of SUVs, but are used only rarely in pickups and vans. Vans are almost exclusively powered by 6-cylinder engines, and pickups use mostly 8-cylinder engines. Over one-half of all SUVs use 6-cylinder engines.

Table 16

Production Share by Number of Cylinders

Model Year	Other	8 Cylinder	6 Cylinder	4 Cylinder
1975	0.6%	61.9%	17.7%	19.8%
1976	0.4%	62.2%	19.3%	18.2%
1977	0.2%	65.4%	16.0%	18.4%
1978	0.3%	57.1%	20.0%	22.6%
1979	0.7%	53.6%	19.5%	26.2%
1980	1.1%	25.6%	28.3%	45.1%
1981	0.9%	23.1%	28.7%	47.3%
1982	1.1%	21.9%	28.0%	49.0%
1983	1.2%	25.9%	25.3%	47.6%
1984	1.1%	24.1%	26.1%	48.7%
1985	1.4%	23.7%	25.7%	49.2%
1986	1.4%	18.4%	26.5%	53.8%
1987	1.2%	15.4%	28.1%	55.3%
1988	1.1%	16.3%	33.0%	49.6%
1989	0.8%	15.8%	36.4%	47.0%
1990	0.7%	15.0%	39.2%	45.1%
1991	1.1%	13.2%	39.9%	45.7%
1992	1.2%	14.8%	45.6%	38.4%
1993	1.2%	13.6%	47.7%	37.6%
1994	1.2%	16.5%	46.0%	36.4%
1995	0.6%	16.7%	46.0%	36.7%
1996	0.9%	16.1%	46.9%	36.2%
1997	0.5%	20.1%	42.1%	37.4%
1998	0.8%	17.9%	45.4%	35.9%
1999	0.4%	19.9%	47.2%	32.4%
2000	0.5%	19.0%	48.9%	31.7%
2001	0.6%	20.4%	47.1%	32.0%
2002	0.5%	19.6%	48.8%	31.1%
2003	0.3%	21.3%	46.6%	31.8%
2004	2.0%	23.9%	46.1%	28.0%
2005	2.1%	20.0%	46.2%	31.7%
2006	2.6%	18.9%	47.0%	31.5%
2007	2.1%	19.3%	42.1%	36.5%
2008	2.1%	16.8%	43.4%	37.7%
2009	1.9%	12.4%	35.0%	50.8%
2010	1.1%	16.5%	34.0%	48.4%

Figure 21

Production Share by Number of Cylinders

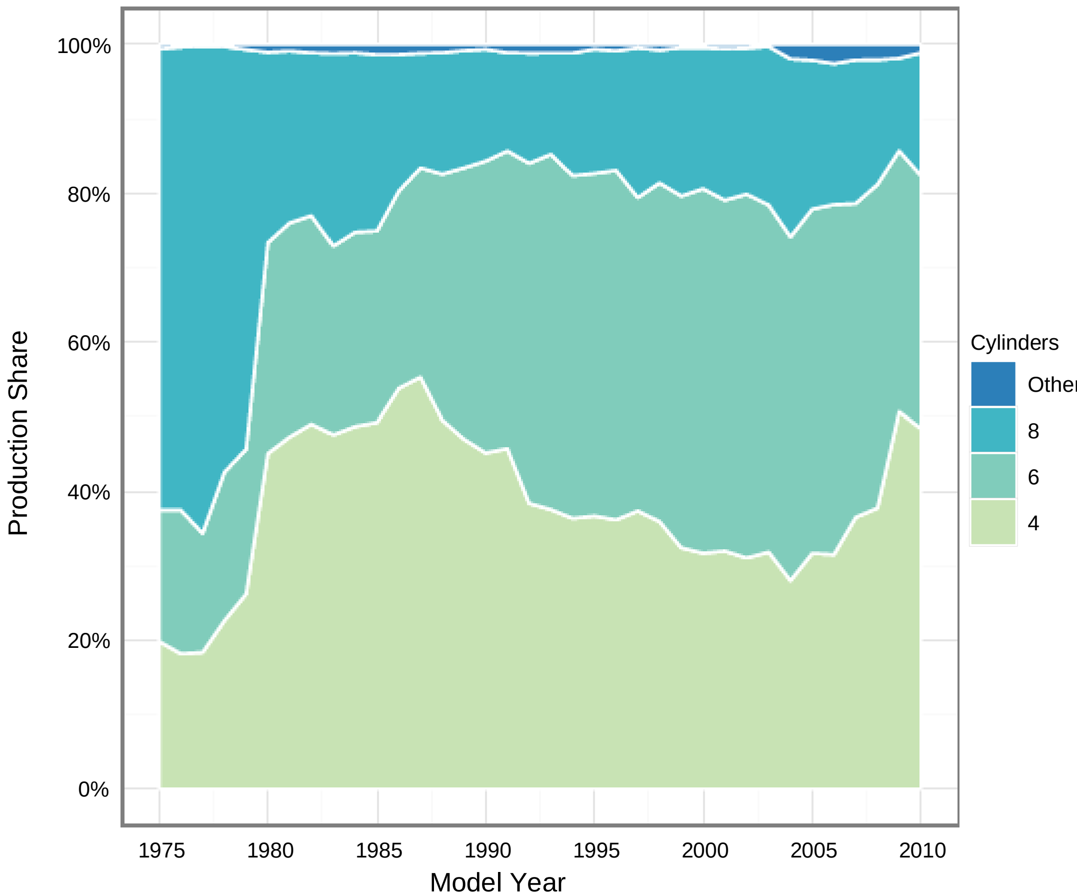


Figure 22

Production Share by Cylinder Count and Vehicle Type

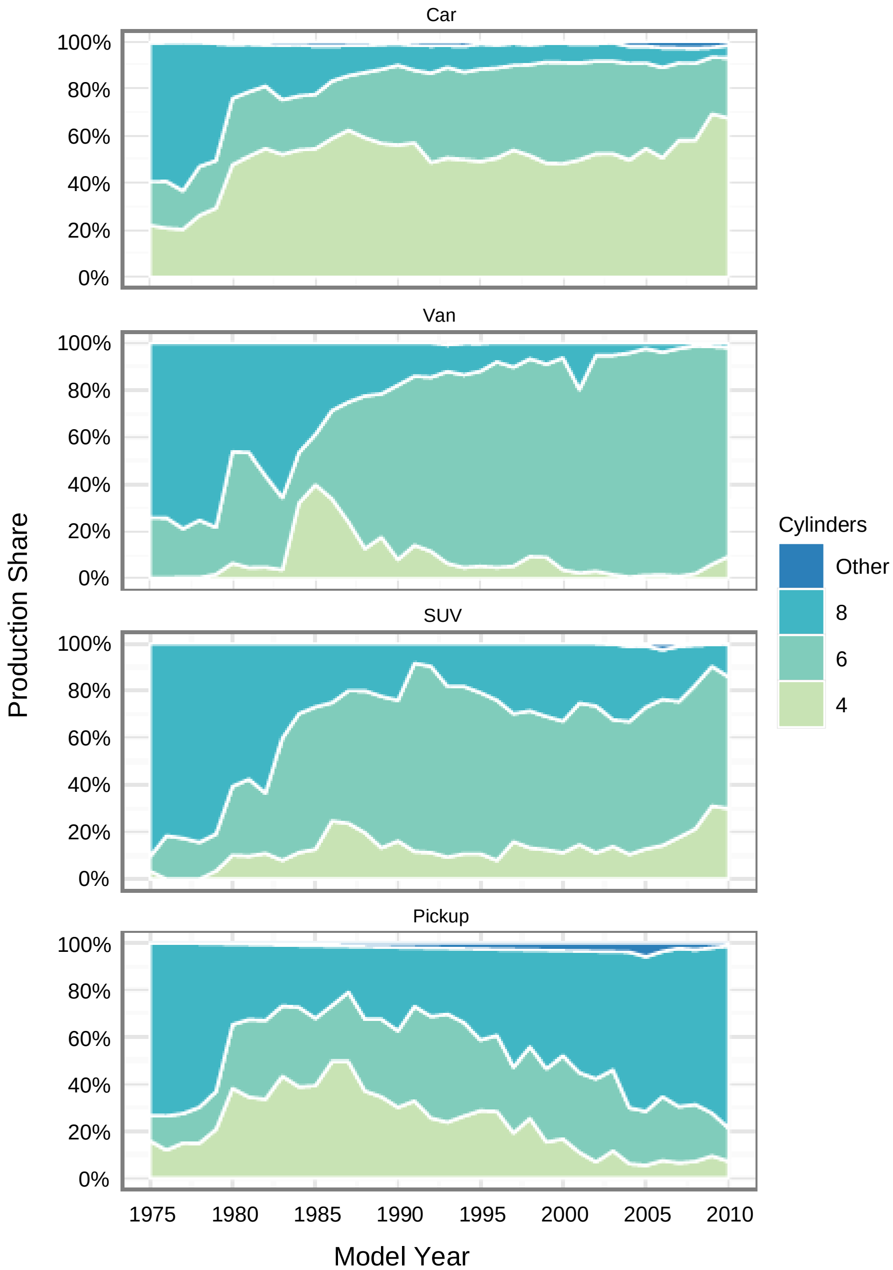


Table 17 and Figure 23 compare horsepower (HP), displacement (CID), and specific power or horsepower per cubic inch (HP/CID) for cars, vans, SUVs, and pickups. For all four vehicle types, significant CID reductions occurred in the late 1970s and early 1980s. Engine displacement has been flat for cars and vans since the mid-1980s and has declined 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 a small decrease in MY2009) with the highest increase occurring for pickups whose HP is now more than double what it was then (i.e., 295 HP 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 and SUVs.

Table 17

MY2010 Engine Characteristics by Vehicle Type

Vehicle Type	HP	CID	HP/CID	Multi-Valve	VVT	Cylinder Deactivation
Car	192	159	1.21	93%	92%	3%
Van	217	215	1.01	58%	47%	15%
SUV	247	209	1.20	89%	84%	6%
Pickup	295	295	1.00	55%	78%	25%
All	220	191	1.17	86%	86%	7%

Figure 23

Horsepower, CID, and Horsepower per CID

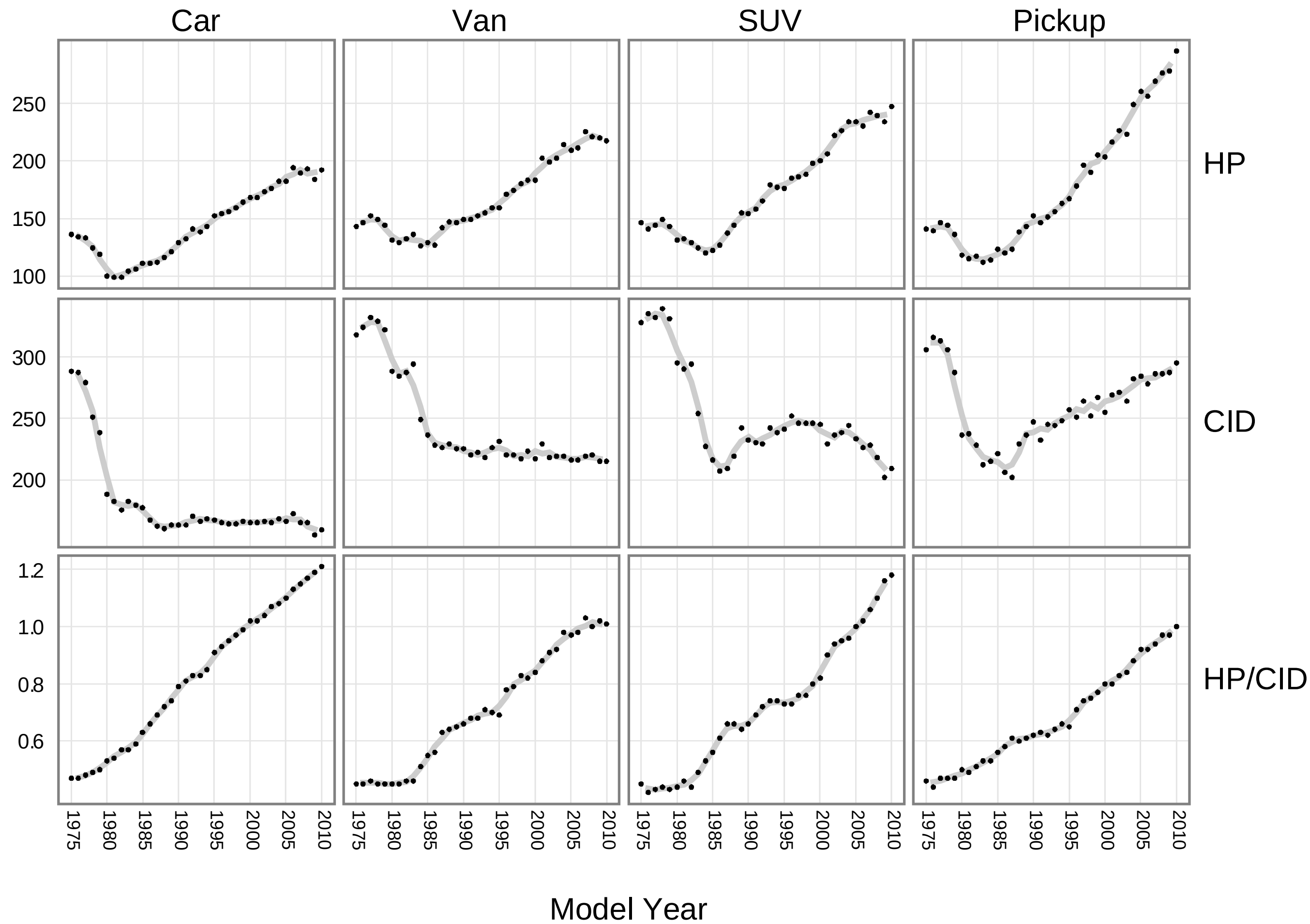


Table 18 compares HP, CID, and HP/CID by vehicle type and number of cylinders for model years 1988 and 2010. Table 18 shows that the increase in horsepower shown for the fleet in Table 13extends to all vehicle type and cylinder number strata. These increases in horsepower range from 46 to 123%. Because displacement has remained relatively constant, it can be seen that the primary reason for the horsepower increase is increased specific power -- up between 39 and 111% from 1988 to 2010.

At the number-of-cylinders level of stratification, model year 2010 cars and SUVs generally achieve higher specific power than vans 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.

Table 18

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

Vehicle Type	Cylinders	HP 1988	HP 2010	Percent Change	CID 1988	CID 2010	Percent Change	HP/ CID 1988	HP/ CID 2010	Percent Change
Car	4	95	152	60%	118	128	8%	0.805	1.190	48%
Car	6	142	261	84%	193	209	8%	0.744	1.253	68%
Car	8	164	365	123%	301	319	6%	0.544	1.148	111%
Van	4	98	143	46%	145	126	-13%	0.678	1.134	67%
Van	6	149	222	49%	213	222	5%	0.722	1.001	39%
Van	8	168	320	90%	322	323	0%	0.520	0.991	91%
SUV	4	94	180	91%	122	148	21%	0.773	1.219	58%
SUV	6	147	259	76%	212	212	0%	0.706	1.224	73%
SUV	8	183	348	90%	338	329	-3%	0.541	1.061	96%
Pickup	4	97	159	64%	142	159	12%	0.685	1.001	46%
Pickup	6	142	229	61%	229	240	5%	0.644	0.957	49%
Pickup	8	180	320	78%	329	320	-3%	0.544	1.000	84%

Table 19 shows similar data to those in Table 18, but the stratification is based on vehicle weight. This table clearly shows that, for nearly every case for which a comparison can be made between 1988 and 2010, there were increases in HP, decreases in CID, and substantial increases in specific power ranging from 40 to 198%.

Table 19

Changes in Horsepower and Specific Power by Vehicle Type and Weight

Cars

Weight (lb)	HP 1988	HP 2010	Percent Change	CID 1988	CID 2010	Percent Change	HP/CID 1988	HP/CID 2010	Percent Change
2000	59	70	19%	77	61	-21%	0.770	1.148	49%
2250	73	225	208%	90	110	22%	0.808	2.045	153%
2500	79	106	34%	100	91	-9%	0.785	1.165	48%
2750	97	115	19%	123	97	-21%	0.804	1.182	47%
3000	114	139	22%	145	115	-21%	0.797	1.208	52%
3500	151	180	19%	212	152	-28%	0.732	1.184	62%
4000	160	255	59%	289	209	-28%	0.569	1.230	116%
4500	144	329	128%	305	274	-10%	0.474	1.231	160%
5000	207	363	75%	408	275	-33%	0.509	1.329	161%
5500	205	300	46%	412	236	-43%	0.498	1.263	154%
6000	205	381	86%	412	313	-24%	0.498	1.181	137%

Vans

Weight (lb)	HP 1988	HP 2010	Percent Change	CID 1988	CID 2010	Percent Change	HP/CID 1988	HP/CID 2010	Percent Change
3500	123	143	16%	166	126	-24%	0.736	1.134	54%
4500	169	216	28%	321	222	-31%	0.528	0.975	85%
5000	156	241	54%	312	225	-28%	0.500	1.081	116%
5500	195	320	64%	347	323	-7%	0.562	0.991	76%
6000	126	320	154%	379	323	-15%	0.332	0.991	198%

SUVs

Weight (lb)	HP 1988	HP 2010	Percent Change	CID 1988	CID 2010	Percent Change	HP/CID 1988	HP/CID 2010	Percent Change
3500	147	179	22%	210	151	-28%	0.712	1.180	66%
4000	135	209	55%	190	169	-11%	0.723	1.250	73%
4500	148	258	74%	312	214	-31%	0.494	1.211	145%
5000	181	269	49%	330	223	-32%	0.545	1.217	123%
5500	200	314	57%	350	259	-26%	0.572	1.229	115%
6000	162	345	113%	368	329	-11%	0.445	1.050	136%

Pickups

Weight (lb)	HP 1988	HP 2010	Percent Change	CID 1988	CID 2010	Percent Change	HP/CID 1988	HP/CID 2010	Percent Change
3500	130	155	19%	184	154	-16%	0.719	1.010	40%
4000	154	206	34%	282	212	-25%	0.555	0.972	75%
4500	174	240	38%	322	239	-26%	0.539	1.009	87%
5000	193	304	58%	342	307	-10%	0.565	0.985	74%
5500	178	308	73%	363	315	-13%	0.495	0.979	98%
6000	140	335	139%	379	328	-13%	0.369	1.024	178%

Figure 24 shows that increases in HP per CID apply to all of the engines, except for a few cases of 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 approximately twice as much horsepower per CID than they used to. The increases in HP and HP/CID are due to changes in engine technologies.

Figure 24

HP/CID by Number of Valves per Cylinder (with Three Year Moving Average)

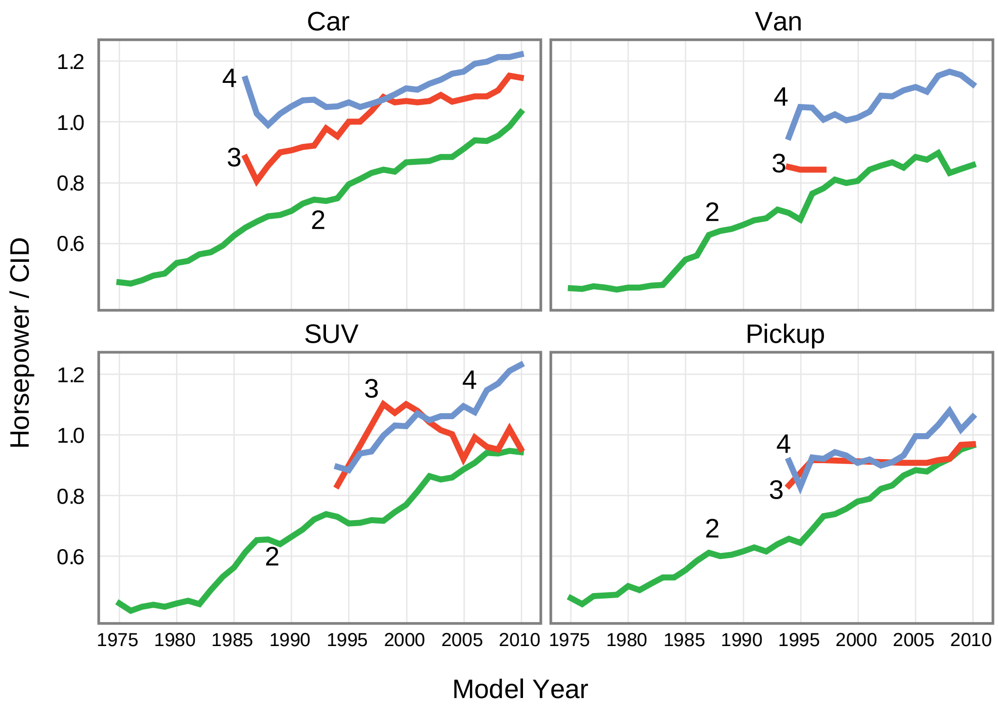


Figure 25 shows that usage of multi-valve engines is increasing for all vehicle types and as shown in Table 17 for MY2010, is now about 90% for cars and SUVs, and over 50% for vans and pickups.

Figure 25

Production Share by Valves per Cylinder

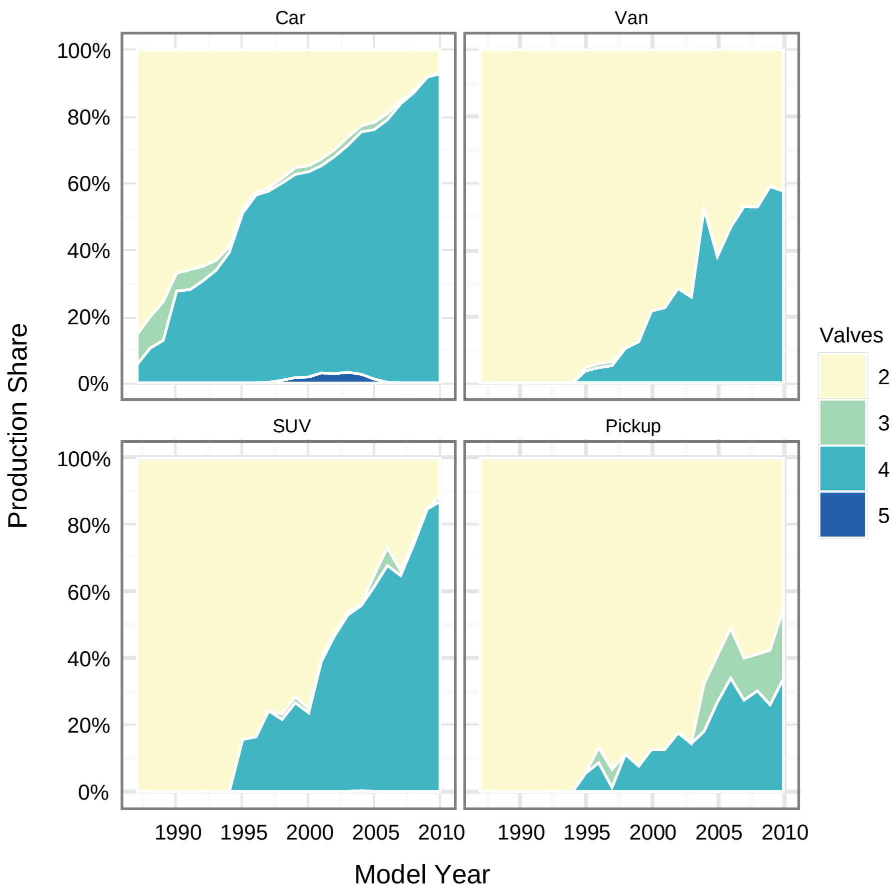


Figure 26 and Table 20 show how the car and truck fleet have evolved from one that consisted almost entirely of carbureted engines in the 1970s and early 1980s, to one which is now almost entirely port fuel injected, and increasingly dominated by variable valve timing.

Figure 26

Production Share by Engine Type

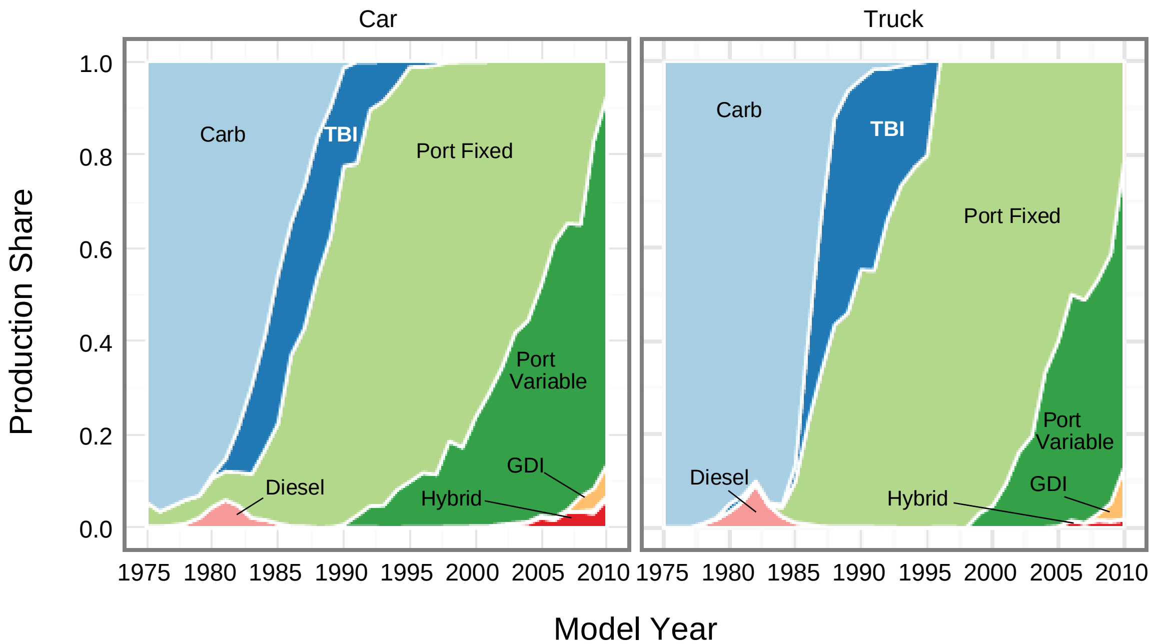


Table 20

Production Share of MY1988 and MY2010 Light Vehicles by Engine Type and Valve Timing

Engine Type	Cars 1988	Cars 2010	Vans 1988	Vans 2010	SUVs 1988	SUVs 2010	Pickups 1988	Pickups 2010	All 1988	All 2010
Carb	16%	-	0%	-	16%	-	16%	-	15%	-
TBI	30%	-	43%	-	37%	-	48%	-	34%	-
Port Fixed	54%	8%	57%	53%	47%	16%	35%	22%	51%	13%
Port Variable	-	79%	-	47%	-	63%	-	78%	-	74%
GDI Fixed	-	0%	-	-	-	-	-	-	-	0%
GDI Variable	-	7%	-	-	-	18%	-	-	-	8%
Diesel	0%	1%	0%	-	0%	0%	0%	-	0%	0%
Hybrid	-	6%	-	-	-	3%	-	0%	-	4%

Over the last decade, automotive manufacturers have been increasingly using engines which use either cams or electric solenoids to provide variable intake and/or exhaust valve timing and in some cases valve lift (earlier engines used camshafts which were permanently synchronized with the engine's crankshaft so that they operated the valves at a specific fixed point in each combustion cycle regardless of the speed and load at which the engine was 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 database used to generate this 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 2010, while for trucks the augmentation covered model years 1999 to 2010.

Table 21 compares horsepower, engine size (CID), specific power (HP/CID), Ton- mpg, and estimated 0-to-60 acceleration time for two selected MY1988 and five 2010 engine types.

Table 21

Comparison of MY1988 and MY2010 Cars by Engine Fuel Metering, Number of Valves and Valve Timing

Fuel Metering	Number of Valves	Valve Timing	HP 1988	HP 2010	CID 1988	CID 2010	HP/CID 1988	HP/CID 2010	Ton MPG 1988	Ton MPG 2010	0-to-60 Time 1988	0-to-60 Time 2010
Carb		Fixed	88	-	131	-	0.75	-	37.2	-	14.3	-
TBI	2	Fixed	97	-	141	-	0.71	-	36.9	-	13.7	-
Port	2	Fixed	137	313	193	301	0.74	1.07	36.6	37.6	11.9	7.5
Port	4	Fixed	137	191	131	168	1.05	1.14	37.9	42.8	11.1	9.8
Port	4	Variable	-	184	-	151	-	1.21	-	44.3	-	9.7
GDI	4	Fixed	-	200	-	121	-	1.65	-	45.9	-	8.9
GDI	4	Variable	-	261	-	177	-	1.50	-	45.0	-	8.2

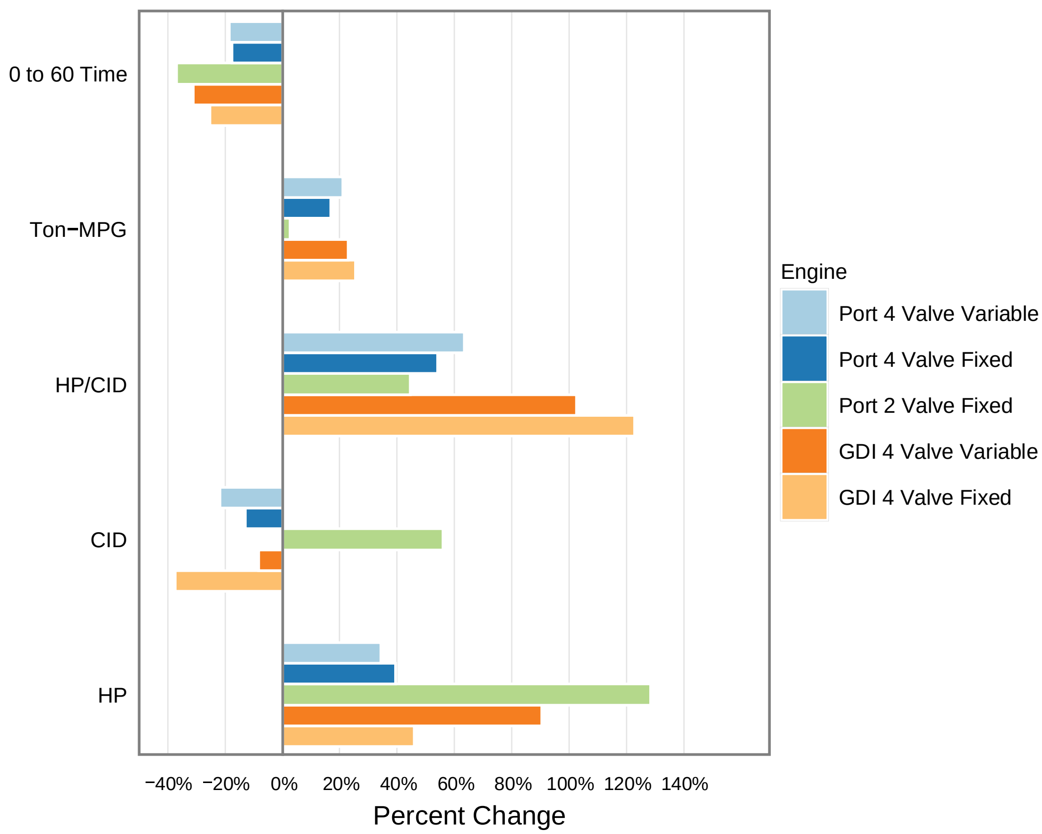
Percent Change over 1988 Port Two Valve, Fixed Valve Timing Base Model

Fuel Metering	Number of Valves	Valve Timing	HP 1988	HP 2010	CID 1988	CID 2010	HP/CID 1988	HP/CID 2010	Ton MPG 1988	Ton MPG 2010	0-to-60 Time 1988	0-to-60 Time 2010
Carb		Fixed	-35.8%	-	-32.1%	-	1.4%	-	1.6%	-	20.2%	-
TBI	2	Fixed	-29.2%	-	-26.9%	-	-4.1%	-	0.8%	-	15.1%	-
Port	2	Fixed	-	128.5%	-	56.0%	-	44.6%	-	2.7%	-	-37.0%
Port	4	Fixed	-	39.4%	-32.1%	-13.0%	41.9%	54.1%	3.6%	16.9%	-6.7%	-17.6%
Port	4	Variable	-	34.3%	-	-21.8%	-	63.5%	-	21.0%	-	-18.5%
GDI	4	Fixed	-	46.0%	-	-37.3%	-	123.0%	-	25.4%	-	-25.2%
GDI	4	Variable	-	90.5%	-	-8.3%	-	102.7%	-	23.0%	-	-31.1%

Because 1988 was the peak year for car fuel economy until recently, and because the two valve, fixed valve timing, port injected engine accounted for about half of the car engines built that year, the 1988 version of this engine was selected as a baseline engine with its average characteristics compared to five MY2010 engine configurations. As shown in Figure 27, all of these MY2010 engine types had substantially higher horsepower than the baseline MY1988 engine, and substantially higher specific power. Not all of these improvements in engine design for these engine types that occurred between 1988 and 2010 were used to improve fuel economy as indicated by the nominal 20% 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 27

Percent Difference in MY2010 Vehicle Characteristics from MY1988 Port 2 Valve Fixed Car Engine



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. Higher HP/CID is associated with: (a) more valves per cylinder, (b) higher octane fuel, (c) intake boost, and (d) use of variable valve timing. The technical approaches result in specific power ranges for cars and trucks from about .9 to about 1.9. The relative production fractions in Table 22 are just for each technical option in the table and exclude hybrids.

Table 22 shows the incremental effect, on a production weighted basis, of adding each technical option, but not all of the technical options are production significant. The effect of the use of higher octane fuel cannot be discounted, because roughly 15% of the current car fleet is comprised of vehicles which use engines for which high octane fuel is recommended. By comparison, about 12% 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 22

HP/CID and Production Share by Fuel and Engine Technology

Model Year 2010 Cars

Fuel	Boost	Valve Timing	2 Valve HP / CID	2 Valve Production Fraction	3 Valve HP / CID	3 Valve Production Fraction	4 Valve HP / CID	4 Valve Production Fraction	Total Production Fraction
Regular	No Boost	Fixed	0.94	1.5%	-	-	1.12	6.0%	7.5%
Regular	No Boost	Variable	1.07	4.8%	1.12	0.6%	1.18	71.4%	76.8%
Regular	Boost	Fixed	-	-	-	-	1.72	0.0%	0.0%
Regular	Boost	Variable	-	-	-	-	1.73	0.7%	0.7%
Premium	No Boost	Fixed	1.88	0.2%	-	-	1.35	0.0%	0.2%
Premium	No Boost	Variable	1.16	0.0%	1.06	0.0%	1.33	11.3%	11.3%
Premium	Boost	Fixed	1.49	0.1%	-	-	1.64	0.2%	0.3%
Premium	Boost	Variable	-	-	1.56	0.0%	1.72	2.6%	2.6%
Diesel	Boost		-	-	-	-	1.17	0.5%	0.5%
Total		-	-	6.6%	-	0.7%	-	92.7%	100.0%

Model Year 2010 Trucks

Fuel	Boost	Valve Timing	2 Valve HP / CID	2 Valve Production Fraction	3 Valve HP / CID	3 Valve Production Fraction	4 Valve HP / CID	4 Valve Production Fraction	Total Production Fraction
Regular	No Boost	Fixed	0.88	11.4%	1.01	3.2%	1.16	6.2%	20.7%
Regular	No Boost	Variable	0.98	13.0%	0.94	4.1%	1.18	49.4%	66.6%
Regular	Boost	Variable	-	-	-	-	1.6	0.2%	0.2%
Premium	No Boost	Fixed	-	-	-	-	0.96	0.0%	0.0%
Premium	No Boost	Variable	1.13	0.0%	-	-	1.24	10.3%	10.3%
Premium	Boost	Variable	-	-	1.51	0.0%	1.72	1.9%	1.9%
Diesel	Boost		-	-	-	-	1.24	0.2%	0.2%
Total		-	-	24.4%	-	7.3%	-	68.2%	100.0%

A relatively 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 or during idle. 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 is deactivated. Challenges to the engine designer for this type of engine include mode transitions, idle quality, and noise and vibration. For MY2010, as shown previously in Table 17, it is estimated that about seven percent of all vehicles are equipped with cylinder deactivation.

Table 23 compares six examples of individual MY2010 vehicles with and without cylinder deactivation. For the Dodge Charger, cylinder deactivation is offered with a smaller, less powerful engine, resulting in 19% higher fuel economy relative to the larger engine without cylinder deactivation. The Dodge Challenger is offered with an engine of the same size, though slightly less powerful, resulting in a 2% higher fuel economy. In the three cases shown where cylinder deactivation was coupled with a larger, more powerful engine, this combination led to 4-15% lower fuel economy compared to the smaller engine.

Table 23

Comparison of MY2010 Vehicles with Engines with Cylinder Deactivation

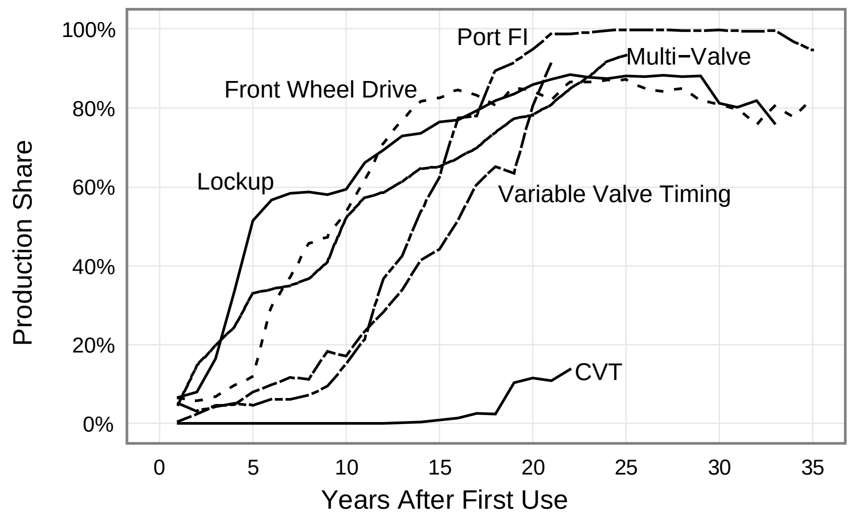
Model Year 2010 Cars and Trucks

Car Class	Model Name	Drive	Transmission	Weight	CID	HP	Lab 55/45 mpg	Cylinders	Cylinder Deactivation	HP % Change	Lab MPG % Change
Small Car	Challenger	Rear	L5	4500	348	359	24.1	8	Yes	-5%	2%
	Challenger	Rear	M6	4500	348	376	23.6	8	No		
Small Car	TSX	Front	L5	4000	214	280	28.0	6	Yes	28%	-15%
	TSX	Front	L5	3500	146	201	32.3	4	No		
Large Car	Charger	Rear	L5	4500	348	359	24.1	8	Yes	-18%	19%
	Charger	Rear	L5	4500	372	425	19.6	8	No		
Large Car	Accord 4DR Sedan	Front	L5	4000	214	280	29.4	6	Yes	32%	-11%
	Accord 4DR Sedan	Front	L5	3500	146	190	32.6	4	No		
Large Pickup	Ram 1500 Pickup 2WD	Rear	L5	5000	348	390	20.4	8	Yes	23%	3%
	Ram 1500 Pickup 2WD	Rear	L5	5500	287	302	19.8	8	No		
Large SUV	C1500 Yukon 2WD	Rear	L6	6000	378	403	21.0	8	Yes	25%	-4%
	C1500 Yukon 2WD	Rear	L6	6000	323	301	21.8	8	No		

Figure 28 compares market 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 production 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 production fraction of 40 to 50% and as long as another five or ten years to reach maximum market penetration.

Figure 28

Car Engine Technology Penetration After First Significant Use



A similar comparison of five technologies whose production fraction peaked out is shown in Figure 29. 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 production 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 production share of about 40 to 50% 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 production fractions and, thus, are likely to disappear from the new vehicle fleet.

Figure 29

Car Engine Technology Penetration After First Significant Use

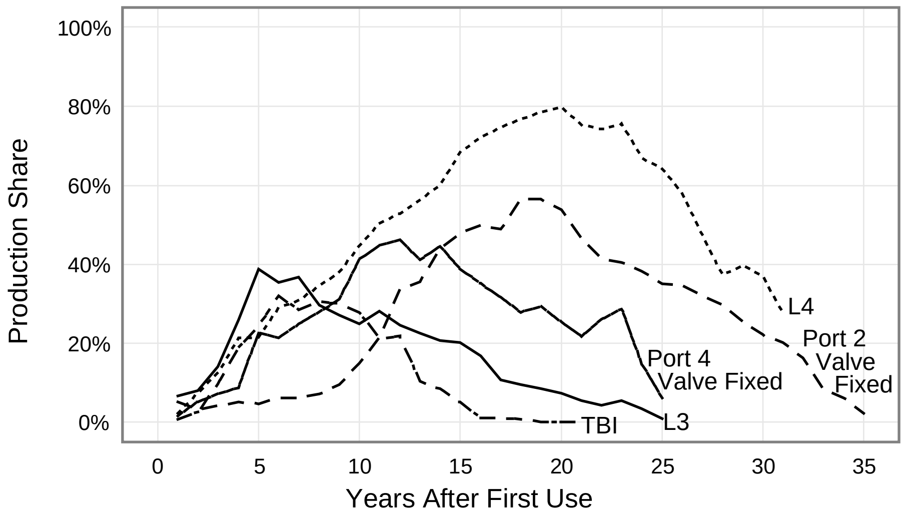


Table 24 compares fuel economy ratings, the ratio of highway to city fuel economy, and ton-mpg of the MY2010 hybrid and diesel vehicles with those for the average MY2010 car and truck. All of the hybrid vehicles in the table have a lower highway/city ratio than the average car or truck.

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 MY2010, the Toyota Prius achieves 86 Ton-mpg, which is 87% higher than that of the average car.

Table 24

Characteristics of MY 2010 Hybrid and Diesel Vehicles

Hybrid Cars

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
CAMRY HYBRID	CVT	4000	144	45.9	33.4	34.1	33.8	67.6	1.0
CIVIC HYBRID	CVT	3000	79	58.8	40.2	45.3	42.9	64.4	1.1
FUSION HYBRID FWD	CVT	4000	153	54.2	41.4	36.4	38.4	76.8	0.9
GS 450h	CVT	4500	211	30.8	21.9	25.3	23.8	53.5	1.2
HS 250h	CVT	4000	144	47.3	35.3	33.6	34.3	68.6	0.9
INSIGHT	CVT	3000	79	57.6	40.1	43.3	41.9	62.8	1.1
LS 600h L	CVT	5500	303	26.9	19.6	21.8	20.8	57.2	1.1
MALIBU HYBRID	Other	4000	146	38.6	25.8	34.0	29.9	59.8	1.3
MILAN HYBRID FWD	CVT	4000	153	54.2	41.4	36.4	38.4	76.8	0.9
PRIUS	CVT	3500	110	70.9	50.9	48.3	49.4	86.4	0.9
S400 HYBRID	Other	5000	213	27.5	18.6	25.1	21.8	54.6	1.3
All 2010 Cars		**3499**	**159**	**32.7**	**21.7**	**30.1**	**25.8**	**46.1**	**1.4**

Hybrid Trucks

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
ActiveHybrid X6	Other	6000	269	23.1	16.7	19.2	18.0	54.1	1.2
C15 SIERRA 2WD HYBRID	CVT	6000	366	28.4	21.2	22.0	21.6	64.9	1.0
C15 SILVERADO 2WD	CVT	6000	366	28.4	21.2	22.0	21.6	64.9	1.0
C1500 TAHOE 2WD HYBRID	CVT	6000	366	28.4	21.2	22.0	21.6	64.9	1.0
C1500 YUKON HYBRID 2WD	CVT	6000	366	28.4	21.2	22.0	21.6	64.9	1.0
ESCALADE 2WD HYBRID	CVT	6000	366	28.4	21.2	22.0	21.6	64.9	1.0
ESCAPE HYBRID 4WD	CVT	4000	153	38.8	30.2	27.1	28.4	56.7	0.9
ESCAPE HYBRID FWD	CVT	4000	153	44.1	34.0	30.5	31.9	63.9	0.9
HIGHLANDER HYBRID 4WD	CVT	5000	202	35.2	27.3	25.1	26.0	65.0	0.9
K15 SILVERADO 4WD	CVT	6000	366	28.3	21.1	21.8	21.5	64.6	1.0
K1500 TAHOE 4WD HYBRID	CVT	6000	366	28.3	21.1	21.8	21.5	64.6	1.0
K1500 YUKON 4WD HYBRID	CVT	6000	366	28.3	21.1	21.8	21.5	64.6	1.0
MARINER HYBRID 4WD	CVT	4000	153	38.8	30.2	27.1	28.4	56.7	0.9
MARINER HYBRID FWD	CVT	4000	153	44.1	34.0	30.5	31.9	63.9	0.9
ML450 HYBRID 4MATIC	Other	5500	213	29.6	21.2	24.2	22.8	62.7	1.1
RX 450h	CVT	5000	211	40.4	31.5	27.9	29.4	73.4	0.9
RX 450h AWD	CVT	5000	211	39.2	30.2	27.7	28.7	71.7	0.9
TRIBUTE HYBRID 2WD	CVT	4000	153	44.1	34.0	30.5	31.9	63.9	0.9
TRIBUTE HYBRID 4WD	CVT	4000	153	38.8	30.2	27.1	28.4	56.7	0.9
VUE FWD HYBRID	L4	4000	146	36.7	24.8	32.2	28.5	57.0	1.3
All 2010 Trucks		**4738**	**236**	**23.8**	**16.2**	**22.0**	**19.1**	**45.3**	**1.4**

Table 24 (continued)

Diesel Cars

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
335d	L6	4000	183	36.0	22.7	36.1	28.8	57.6	1.6
A3	L6	3500	120	46.2	29.7	42.0	35.7	62.4	1.4
GOLF	L6	3500	120	46.2	29.7	42.0	35.7	62.4	1.4
GOLF	M6	3500	120	45.7	29.7	41.0	35.2	61.6	1.4
JETTA	L6	3500	120	46.2	29.7	42.0	35.7	62.4	1.4
JETTA	M6	3500	120	45.7	29.7	41.0	35.2	61.6	1.4
JETTA SPORTWAGEN	L6	3500	120	46.2	29.7	42.0	35.7	62.4	1.4
JETTA SPORTWAGEN	M6	3500	120	45.7	29.7	41.0	35.2	61.6	1.4
R 350 BLUETEC	Other	5500	182	26.3	17.9	23.9	20.9	57.5	1.3
All 2010 Cars		**3499**	**159**	**32.7**	**21.7**	**30.1**	**25.8**	**46.1**	**1.4**

Diesel Trucks

Model Name	Transmission	Weight (lb)	CID (cu in)	Lab 55/45 MPG	Adj City MPG	Adj Hwy MPG	Adj Comp MPG	Ton-MPG	Hwy/ City Ratio
GL 350 BLUETEC	Other	6000	182	24.8	16.9	22.7	19.8	59.3	1.3
ML 350 BLUETEC	Other	5000	182	27.1	18.4	24.7	21.5	53.7	1.3
Q7	L6	6000	183	24.2	15.9	23.8	19.6	58.9	1.5
Touareg	L6	5500	183	26.2	17.5	24.7	21.0	57.7	1.4
X5 xDrive35d	L6	5500	183	28.4	19.1	26.2	22.5	62.0	1.4
All 2010 Trucks		**4738**	**236**	**23.8**	**16.2**	**22.0**	**19.1**	**45.3**	**1.4**

Most of the vehicles in Table 24 have conventionally powered counterparts. Table 25 compares 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, weight, transmission, and engine size (CID). Differences in the performance attributes of these vehicles complicate the analysis of the fuel economy improvement potential due to hybridization and dieselization. In particular, hybrid vehicles are sometimes reported to have faster 0-to-60 acceleration times than their conventional counterparts, while vehicles equipped with diesel engines have higher low-end torque, but slower 0-to-60 times. In addition, some hybrid vehicles use technologies such as cylinder deactivation and CVT transmissions that are not offered in their counterparts.

Fuel economy improvements and fuel savings per year for the hybrid vehicles in Table 25 vary considerably from 5-10% for the larger, luxury hybrid vehicles to nearly 50% for several others. Ten years after the introduction for sale in the U.S. of the first hybrid vehicle, the MY2000 Honda Insight (a two-seater that is not comparable to the current Honda Insight), hybrid vehicles now account for about four percent of the combined car/truck fleet. Similarly, Table 26 shows fuel economy improvements for diesels range from 20% to 50%, and these vehicles also offer relatively high fuel savings. In addition, the production fraction for diesels remains at or below 0.5%, an order of magnitude smaller than their 5.9% production fraction in 1981.

Table 25

Comparison of MY 2010 Hybrid Vehicles with Their Conventional Counterparts

	Hybrid Version					Baseline Version					Improvement	
Model Name	Weight	CID	Trans	Adj Comp MPG	Gal Per Year	Weight	CID	Trans	Adj Comp MPG	Gal Per Year	Adj Comp MPG	Gal Per Year
FUSION HYBRID FWD	4000	153	CVT	38.4	391	3500	153	L6	26.0	576	47%	185
MALIBU HYBRID	4000	146	A4	29.9	501	3500	146	L4	25.9	580	16%	78
CIVIC HYBRID	3000	79	CVT	42.9	349	3000	110	L5	29.6	506	45%	157
GS 450h**	4500	211	CVT	23.8	631	4000	211	L6	22.4	669	6%	37
LS 600h L**	5500	303	CVT	20.8	721	5000	281	L8	19.2	781	8%	60
CAMRY HYBRID	4000	144	CVT	33.8	444	3500	152	L6	26.8	560	26%	116
HIGHLANDER HYBRID 4WD	5000	202	CVT	26.0	577	4500	211	L5	19.7	760	32%	183
ActiveHybrid X6	6000	269	L7	18.0	831	5500	269	L6	15.4	977	18%	146
ML450 HYBRID 4MATIC	5500	213	A8	22.8	657	5000	213	L7	17.3	866	32%	209
TRIBUTE HYBRID 2WD	4000	153	CVT	31.9	470	3500	153	L6	24.3	617	31%	147
TRIBUTE HYBRID 4WD	4000	153	CVT	28.4	529	4000	153	L6	23.3	644	22%	115
ESCAPE HYBRID 4WD	4000	153	CVT	28.4	529	4000	153	L6	22.9	656	24%	127
ESCAPE HYBRID FWD	4000	153	CVT	31.9	470	3500	153	L6	24.3	617	31%	147
MARINER HYBRID 4WD	4000	153	CVT	28.4	529	4000	153	L6	22.9	656	24%	127
MARINER HYBRID FWD	4000	153	CVT	31.9	470	3500	153	L6	24.3	617	31%	147
MILAN HYBRID FWD	4000	153	CVT	38.4	391	3500	153	L6	26.0	576	47%	185
ESCALADE 2WD HYBRID	6000	366	CVT	21.6	693	6000	378	L6	17.1	878	27%	185
C15 SILVERADO 2WD HYBRID	6000	366	CVT	21.6	693	5000	323	L6	17.9	840	21%	146
K15 SILVERADO 4WD HYBRID	6000	366	CVT	21.5	697	5000	323	L6	17.6	850	22%	153
C1500 TAHOE 2WD HYBRID	6000	366	CVT	21.6	693	6000	323	L6	17.6	850	23%	157
K1500 TAHOE 4WD HYBRID	6000	366	CVT	21.5	697	6000	323	L6	17.6	850	22%	154
C15 SIERRA 2WD HYBRID	6000	366	CVT	21.6	693	5500	323	L6	17.9	839	21%	146
C1500 YUKON HYBRID 2WD	6000	366	CVT	21.6	693	6000	323	L6	17.6	850	23%	157
K1500 YUKON 4WD HYBRID	6000	366	CVT	21.5	697	6000	378	L6	16.7	898	29%	201
VUE FWD HYBRID	4000	146	A4	28.5	526	4000	146	L4	22.6	663	26%	136
RX 450h	5000	211	CVT	29.4	511	4500	211	L6	21.5	699	37%	188
RX 450h AWD	5000	211	CVT	28.7	523	4500	211	L6	21.1	712	36%	189
S400 HYBRID**	5000	350	A7	21.8	688	5000	546	L7	17.6	852	24%	164

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

**Note: Baseline version used for the GS 450h comparison is the GS 350. Baseline vehicle used for the LS 600HL comparison is the LS 460L. Baseline versions used for the Rx 450h and Rx 450h AWD comparison were the Rx 350 and the Rx 350 AWD. Baseline version used for the S400 comparison is the S550 4MATIC

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Table 26

Comparison of MY 2010 Diesel Vehicles with Their Conventional Counterparts

	Diesel Version					Baseline Version					Improvement	
Model Name	Weight	CID	Trans	Adj Comp MPG	Gal Per Year*	Weight	CID	Trans	Adj Comp MPG	Gal Per Year*	Adj Comp MPG	Gal Per Year*
335d	4000	183.0	L6	28.8	521	4000	183.0	L6	21.3	704	35%	183
A3	3500	120.0	L6	35.7	420	3500	121.0	L6	24.6	610	45%	190
Golf	3500	120.0	L6	35.7	420	3000	151.0	L6	25.1	598	42%	177
Golf	3500	120.0	M6	35.7	420	3000	151.0	M5	24.0	625	49%	205
Jetta	3500	120.0	L6	35.7	420	3500	121.0	L6	27.2	551	31%	131
Jetta	3500	120.0	M6	35.7	420	3500	121.0	M6	24.9	602	43%	182
Jetta Sportwagen	3500	120.0	L6	35.7	420	3500	151.0	L6	24.9	602	43%	182
Jetta Sportwagen	3500	120.0	M6	35.7	420	3500	151.0	M6	23.8	630	50%	210
GL 350 Bluetec**	6000	182.0	L7	19.8	758	6000	285.0	L7	15.0	1000	32%	242
ML 350 Bluetec**	5000	182.0	L7	21.5	698	5000	213.0	L7	17.3	867	24%	169
Q7	6000	183.0	L6	19.6	765	5500	219.0	L6	16.3	920	20%	155
R 350 Bluetec**	5500	182.0	L7	20.9	718	5500	213.0	L7	16.5	909	27%	191
Touareg	5500	183.0	L6	21.0	714	5500	219.0	L6	16.3	920	29%	206
X5 xDrive35d**	5500	183.0	L6	22.5	667	5000	183.0	L6	18.3	820	23%	153

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

**Note: Baseline version used for the R350 Bluetec comparison is the R350 4MATIC. Baseline version used for the GL350 Bluetec comparison is the GL450 4MATIC. Baseline version used for the ML350 Bluetec comparison is the ML350 4MATIC. Baseline version used for the X5 xDrive 35d comparison is the X5 xDrive 30i.

VII. Fuel Economy by Manufacturer and Make

This report adopts a new approach for grouping vehicles, by manufacturer and make, compared to previous reports in this series. The initial reports in this series examined fuel economy and technology trends for the "Domestic" and "Import" vehicle categories which are part of the corporate average fuel economy (CAFE) program. Over time, 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." More recent reports in this series used “Marketing Groups” to better reflect the financial arrangements and transnational nature of the modern automobile industry.

This report is the first in this series to group vehicles by “Manufacturer” and “Make.” The manufacturer definition is that used by the National Highway Traffic Safety Administration (NHTSA) for purposes of implementation of and manufacturer compliance with the CAFE program. Table 27 lists the 14 manufacturers which had MY2009 production of 100,000 vehicles or more, which together accounted for approximately 99% of total industry-wide production, and for which data are shown in Tables 28 through 32 (industry-wide tables in the rest of this report also include production from those manufacturers that do not meet the 100,000 production threshold).

Make is typically included in the model name and is generally equivalent to the “brand” of the vehicle. Table 27 also lists the 32 makes for which data are shown in Tables 28 and 29. The MY2009 production threshold for makes to be included in Tables 28 and 29 is 40,000 vehicles, though the Smart was included as well because of the high interest in this make. The Pontiac and Saturn makes no longer exist in 2010, but are included since Tables 28 and 29 also provide data for model years 2008 and 2009, during which Pontiacs and Saturns were produced. General Motors provided projected production volumes for both Pontiac and Saturn for MY2010, since the pre-model year projections were submitted to EPA prior to the corporate decision to end the Pontiac and Saturn brands. EPA has retained the projected production volumes for Pontiac and Saturn in the MY2010 database and concluded that the impact of the combined Pontiac/Saturn data on GM’s projected overall MY2010 fuel economy performance is very small.

Table 27

Manufacturers and Makes in This Report

Manufacturer	Makes Above Threshold	Makes Below Threshold
General Motors	Chevrolet, Cadillac, Buick, GMC, Pontiac, Saturn	Hummer, Isuzu, Daewoo
Ford	Ford, Lincoln, Mercury, Volvo	Saleen, Roush, Shelby
Chrysler	Chrysler, Dodge, Jeep, Ram	
Toyota	Toyota, Lexus, Scion	
Honda	Honda, Acura	
Nissan	Nissan, Infiniti	
Hyundai	Hyundai	
Volkswagen	Volkswagen, Audi	Lamborghini, Bentley, Bugatti
Kia	Kia	
Subaru	Subaru	
BMW	BMW, Mini	Rolls Royce, Phantom
Mitsubishi	Mitsubishi	
Daimler	Mercedes-Benz, Smart	Maybach
Mazda	Mazda	
Others		Jaguar, Land Rover, Spyker, Saab, Ferrari, Maserati, Aston Martin, Lotus, Suzuki, Porsche

It is important to note that when a manufacturer or make grouping is changed to reflect a change in the industry's current financial structure, EPA makes the same adjustment for the entire historical database back to 1975. This maintains a consistent manufacturer or make definition over time, which allows a better identification of long-term trends. On the other hand, this also means that the current database does not necessarily reflect actual financial or structural arrangements in the past. For example, the 2010 database no longer accounts for the fact that Chrysler was combined with Daimler for several years, and Tables 28 and 29 show a separate Chrysler Ram make for 2008 and 2009, even though Ram did not become a separate make until MY2010.

Automakers submit vehicle production data, rather than vehicle sales data, in formal end-of-year CAFE compliance reports to EPA. Accordingly, the vehicle production data in this report may differ from sales data reported by press sources. In addition, the vehicle production data presented in this report are tabulated on a model year basis. In years past, manufacturers typically used a more consistent approach for model year designations, i.e., from fall of one year to the fall of the following year. More recently, however, many manufacturers have used a more flexible approach and it is not uncommon to see a new or redesigned model be introduced in the spring or summer, with a new model year designation, rather than the fall. This means that a model year for an individual vehicle can be either shortened or lengthened. Accordingly, year-to-year comparisons can be affected by these model year anomalies, though, of course, these even out over a multi-year period.

Tables 28 and 29 give laboratory and adjusted fuel economy values for cars, trucks, and cars and trucks combined for MY2008-2010, for the 14 manufacturers and 32 makes shown in Table 27. Due to the higher-than-usual uncertainty associated with the MY2010 projections (because they were submitted by automakers to EPA during the market turmoil of 2009), three years of data are shown in these tables. By including data from both MY2008 and MY2009, with formal end-of-year data for both years, it is possible to identify meaningful changes from year-to-year (though MY2009 was admittedly a very unusual year in terms of economic recession and industry sales). Because of the uncertainty associated with the MY2010 projections, changes from MY2009 to MY2010 may be less meaningful.

The relative fuel economy comparisons for manufacturers and makes in Tables 28 and 29 will be similar, of course, since the relative offset between laboratory and adjusted values will be similar across manufacturers and makes. The following discussion will be based on the adjusted composite fuel economy data from Table 29.

For MY2008, Hyundai’s overall, adjusted composite fuel economy of 24.4 mpg was the highest of any manufacturer, followed by Honda at 23.9 mpg and Mazda at 23.1 mpg. Chrysler, Daimler, and Ford all had the lowest adjusted composite fuel economy values of 19.3 mpg.

MY2009 was a landmark year for fuel economy, with 13 of the 14 highest-selling manufacturers increasing fuel economy and the industry reaching an all-time high of 22.4 mpg. In terms of manufacturers, Toyota had the highest MY2009 adjusted composite fuel economy of 25.4 mpg, followed by Hyundai at 25.1 mpg and Honda at 24.6 mpg. Chrysler had the lowest MY2009 adjusted fuel economy for any manufacturer, 19.2 mpg, and was followed by Daimler at 19.5 mpg and Ford at 20.3 mpg. In terms of improvement from MY2008 to MY2009, Toyota had the largest improvement of 2.6 mpg, followed by Nissan at 1.7 mpg and Volkswagen at 1.5 mpg. While Toyota improved both its car mpg (the highest in the industry) and its truck mpg in MY2009, a major factor in its 2.6 mpg overall improvement was a 17% decrease in its truck production share, from 48% in MY2008 to 31% in MY2009, which was the largest decrease in truck production share in the industry (see Table 30).

In terms of makes in MY2009, the Smart make was the leader at 37.1 mpg. Of course, the Smart Fourtwo is the smallest and lightest car in the U.S. market and has relatively low production. The make with the second-highest fuel economy in MY2009 was the Mini, which produces a relatively low number of small vehicles, at 30.3

mpg. Of the makes with higher production, Toyota (that is, Toyota manufacturer vehicles sold under the Toyota brand) had the highest overall fuel economy at 26.1 mpg, followed by Honda and Hyundai, both at 25.1 mpg.

Preliminary projections suggest that 10 of the 14 manufacturers will improve fuel economy further in MY2010, though EPA will not have actual data for MY2010 until next year. Hyundai, Honda, and Kia are projected to be the overall fuel economy leaders for MY2010, with the same three manufacturers and Volkswagen projected to make the biggest gains in MY2010.

Table 30 shows footprint by manufacturer for MY2008-2010, along with truck production share by manufacturer. GM, Ford, and Chrysler had the largest footprint values in MY2009 at 51-52 square feet, with most of the other manufacturers having average footprint values in the 44-46 square feet range. Overall footprint declined by 0.8 square feet in MY2009, with the largest decreases for Toyota, Nissan, and BMW. Chrysler had the largest increase in footprint, followed by Mazda and Hyundai. Chrysler had the highest MY2009 truck share at 70%, followed by Ford at 61%, while Volkswagen, Mitsubishi, and BMW had the lowest truck shares, all between 13% and 16%. Industry-wide footprint and truck share is projected to grow in MY2010, but these projections are very uncertain this year.

Table 31 (actual MY2009) and Table 32 (MY2010 projections) show the adjusted fuel economy values broken out by manufacturer and vehicle size and type. For example, Kia had the highest small car fuel economy in MY2009 at 30.5 mpg. Of course, these tables rely on the threshold definitions for small/midsize/large vehicle sizes that have been discussed earlier in this report, and a vehicle that just crosses the threshold into the next largest class can be a fuel economy leader in that class, while it may have been a relatively poor performer in the next smaller class.

For a long-term perspective going back to 1975, Figure 30 shows the adjusted fuel economy values (cars, trucks, and both cars and trucks) and truck production shares for each of the 14 highest-selling manufacturers. More information for the historic database stratified by manufacturer can be found in Appendices L through P.

Table 28

Laboratory 55/45 Fuel Economy by Manufacturer and Make for MY2008-2010

Manufacturer	Make	2008 Cars	2008 Trucks	2008 Cars and Trucks	2009 Cars	2009 Trucks	2009 Cars and Trucks	2010 Cars	2010 Trucks	2010 Cars and Trucks
Toyota	Toyota	39.5	23.8	29.2	37.5	26.5	33.3	38.8	23.6	31.6
Toyota	Lexus	28.1	24.7	26.5	28.5	24.0	26.2	29.9	27.1	28.5
Toyota	Scion	32.5	-	32.5	32.5	-	32.5	33.0	-	33.0
Toyota	**All**	**36.0**	**23.9**	**29.0**	**36.3**	**26.1**	**32.4**	**37.2**	**24.2**	**31.2**
Hyundai	**All**	**33.8**	**25.6**	**30.9**	**33.8**	**25.9**	**31.7**	**33.5**	**29.5**	**32.8**
Honda	Honda	35.1	25.9	30.7	35.4	26.6	31.7	36.7	27.1	33.3
Honda	Acura	27.6	22.1	25.0	29.2	22.4	26.3	28.2	23.7	26.5
Honda	**All**	**34.3**	**25.5**	**30.1**	**34.6**	**26.1**	**31.1**	**35.7**	**26.7**	**32.5**
Kia	**All**	**33.3**	**24.2**	**28.8**	**34.8**	**25.0**	**30.7**	**35.6**	**25.5**	**31.9**
VW	VW	29.9	20.4	29.2	32.1	25.7	31.3	34.1	25.1	32.9
VW	Audi	27.8	20.0	26.2	28.6	22.9	27.3	30.5	24.3	28.9
VW	**All**	**28.9**	**20.2**	**27.9**	**31.0**	**24.5**	**30.0**	**32.5**	**24.7**	**31.1**
Nissan	Nissan	33.9	22.1	28.3	34.3	25.2	30.5	34.4	24.8	31.0
Nissan	Infiniti	25.1	21.2	23.8	26.5	22.4	25.3	26.8	23.2	25.4
Nissan	**All**	**32.2**	**22.0**	**27.6**	**33.3**	**25.0**	**29.9**	**33.3**	**24.6**	**30.2**
Mitsubishi	**All**	**29.8**	**24.2**	**28.1**	**30.2**	**27.1**	**29.7**	**31.4**	**28.3**	**30.7**
Mazda	**All**	**32.0**	**25.4**	**29.2**	**31.2**	**26.6**	**29.3**	**31.1**	**25.4**	**28.6**
Subaru	**All**	**28.7**	**26.4**	**28.1**	**28.9**	**28.4**	**28.7**	**30.2**	**28.3**	**29.5**
BMW	BMW	26.1	22.9	25.4	26.4	22.7	25.6	25.9	23.0	25.3
BMW	Mini	37.2	-	37.2	39.2	-	39.2	37.9	-	37.9
BMW	**All**	**27.2**	**22.9**	**26.3**	**28.4**	**22.7**	**27.3**	**28.9**	**23.0**	**27.9**
GM	Chevrolet	29.9	21.3	24.7	31.0	21.5	25.7	30.8	23.1	26.3
GM	Pontiac	28.5	25.3	28.2	29.7	25.3	29.5	-	-	-
GM	GMC	-	21.1	21.1	-	21.3	21.3	-	23.5	23.5
GM	Buick	25.5	23.4	24.7	30.5	23.8	28.5	26.2	24.3	25.8
GM	Cadillac	24.0	19.3	22.4	23.6	19.3	22.4	24.8	23.3	24.2
GM	Saturn	29.3	25.3	26.7	31.8	26.1	28.3	-	-	-
GM	**All**	**28.6**	**21.6**	**24.4**	**30.0**	**21.7**	**25.6**	**29.6**	**23.4**	**25.9**
Ford	Ford	28.9	22.0	24.1	31.8	23.2	25.4	31.0	23.0	25.5
Ford	Lincoln	25.4	22.1	23.6	25.2	23.7	24.9	26.2	23.0	25.5
Ford	Mercury	25.8	24.6	25.3	25.3	27.6	26.2	29.4	25.6	27.8
Ford	Volvo	26.0	20.6	24.1	26.7	20.7	25.5	26.9	23.4	25.2
Ford	**All**	**27.9**	**22.1**	**24.1**	**29.4**	**23.4**	**25.4**	**29.7**	**23.1**	**25.6**
Daimler	Mercedes-Benz	24.0	20.8	23.0	24.3	20.8	23.3	24.9	21.2	23.7
Daimler	Smart	49.5	-	49.5	49.5	-	49.5	49.5	-	49.5
Daimler	**All**	**25.3**	**20.8**	**24.0**	**25.6**	**20.8**	**24.3**	**25.6**	**21.2**	**24.1**
Chrysler	Dodge	28.4	22.6	25.6	27.6	23.6	25.9	26.8	23.6	25.1
Chrysler	Chrysler	27.0	24.4	26.0	27.6	24.4	25.4	27.9	24.4	26.0
Chrysler	Jeep	-	22.7	22.7	-	22.6	22.6	-	23.6	23.6
Chrysler	Ram	-	20.2	20.2	-	19.5	19.5	-	19.7	19.7
Chrysler	**All**	**27.8**	**22.4**	**24.2**	**27.6**	**22.5**	**23.9**	**27.1**	**22.6**	**23.9**
Other	All	27.9	20.8	23.9	27.0	20.8	24.4	27.8	20.0	23.1
Fleet		**30.5**	**22.7**	**26.3**	**32.1**	**23.8**	**28.2**	**32.7**	**23.8**	**28.3**

Table 29

Adjusted Composite Fuel Economy by Manufacturer and Make for MY2008-2010

Manufacturer	Make	2008 Cars	2008 Trucks	2008 Cars and Trucks	2009 Cars	2009 Trucks	2009 Cars and Trucks	2010 Cars	2010 Trucks	2010 Cars and Trucks
Toyota	Toyota	30.4	19.0	23.0	29.2	21.0	26.1	30.0	18.9	24.8
Toyota	Lexus	22.4	19.5	21.0	22.8	19.1	20.9	23.7	21.4	22.5
Toyota	Scion	25.4	-	25.4	25.4	-	25.4	25.8	-	25.8
Toyota	**All**	**28.1**	**19.0**	**22.8**	**28.3**	**20.7**	**25.4**	**28.9**	**19.3**	**24.5**
Hyundai	**All**	**26.6**	**20.4**	**24.4**	**26.7**	**20.6**	**25.1**	**26.4**	**23.3**	**25.9**
Honda	Honda	27.7	20.7	24.4	27.9	21.2	25.1	28.8	21.6	26.3
Honda	Acura	22.2	17.6	20.1	23.3	17.9	21.0	22.6	18.8	21.1
Honda	**All**	**27.1**	**20.3**	**23.9**	**27.3**	**20.8**	**24.6**	**28.1**	**21.2**	**25.6**
Kia	**All**	**26.2**	**19.4**	**22.9**	**27.3**	**19.9**	**24.2**	**27.9**	**20.3**	**25.1**
VW	VW	23.8	16.5	23.3	25.4	20.4	24.8	26.9	20.0	25.9
VW	Audi	22.3	16.2	21.0	22.7	18.2	21.7	24.1	19.3	22.9
VW	**All**	**23.1**	**16.3**	**22.3**	**24.6**	**19.5**	**23.8**	**25.7**	**19.6**	**24.6**
Nissan	Nissan	26.6	17.8	22.4	26.8	20.0	24.0	26.9	19.7	24.4
Nissan	Infiniti	20.1	17.1	19.1	21.3	18.1	20.3	21.5	18.7	20.4
Nissan	**All**	**25.3**	**17.7**	**21.9**	**26.1**	**19.9**	**23.6**	**26.2**	**19.5**	**23.8**
Mitsubishi	**All**	**23.5**	**19.3**	**22.3**	**23.8**	**21.4**	**23.5**	**24.7**	**22.3**	**24.2**
Mazda	**All**	**25.2**	**20.2**	**23.1**	**24.7**	**21.1**	**23.2**	**24.6**	**20.3**	**22.7**
Subaru	**All**	**22.7**	**20.9**	**22.3**	**22.8**	**22.4**	**22.6**	**23.8**	**22.3**	**23.3**
BMW	BMW	21.1	18.5	20.5	21.3	18.3	20.6	21.0	18.5	20.4
BMW	Mini	29.0	-	29.0	30.3	-	30.3	29.4	-	29.4
BMW	**All**	**21.9**	**18.5**	**21.2**	**22.8**	**18.3**	**21.9**	**23.1**	**18.5**	**22.3**
GM	Chevrolet	24.0	17.2	19.8	24.8	17.3	20.7	24.6	18.6	21.1
GM	Pontiac	22.9	20.3	22.6	23.6	20.3	23.5	-	-	-
GM	GMC	-	17.0	17.0	-	17.2	17.2	-	19.0	19.0
GM	Buick	20.7	18.9	20.0	24.3	19.2	22.8	21.3	19.6	20.9
GM	Cadillac	19.5	15.9	18.2	19.1	15.8	18.2	20.1	18.7	19.5
GM	Saturn	23.4	20.3	21.4	25.4	20.9	22.6	-	-	-
GM	**All**	**23.0**	**17.4**	**19.6**	**24.0**	**17.5**	**20.6**	**23.7**	**18.8**	**20.8**
Ford	Ford	23.1	17.7	19.3	25.2	18.6	20.3	24.6	18.4	20.4
Ford	Lincoln	20.6	17.8	19.1	20.3	19.1	20.1	21.1	18.5	20.5
Ford	Mercury	20.9	19.6	20.3	20.4	21.9	21.1	23.4	20.4	22.1
Ford	Volvo	21.0	16.7	19.5	21.5	16.8	20.6	21.6	18.8	20.3
Ford	**All**	**22.4**	**17.7**	**19.3**	**23.5**	**18.7**	**20.3**	**23.7**	**18.5**	**20.5**
Daimler	Mercedes-Benz	19.3	16.6	18.6	19.6	16.7	18.8	20.1	17.0	19.1
Daimler	Smart	37.1	-	37.1	37.1	-	37.1	37.1	-	37.1
Daimler	**All**	**20.3**	**16.6**	**19.3**	**20.6**	**16.7**	**19.5**	**20.6**	**17.0**	**19.4**
Chrysler	Dodge	22.6	18.2	20.5	22.0	19.0	20.7	21.5	19.0	20.2
Chrysler	Chrysler	21.6	19.7	20.9	22.0	19.6	20.4	22.3	19.7	20.9
Chrysler	Jeep	-	18.1	18.1	-	18.0	18.0	-	18.8	18.8
Chrysler	Ram	-	16.2	16.2	-	15.8	15.8	-	15.9	15.9
Chrysler	**All**	**22.2**	**18.0**	**19.3**	**22.0**	**18.1**	**19.2**	**21.7**	**18.2**	**19.2**
Other	All	22.3	16.8	19.2	21.6	16.9	19.6	22.2	16.2	18.7
Fleet		**24.3**	**18.2**	**21.0**	**25.4**	**19.0**	**22.4**	**25.8**	**19.1**	**22.5**

Table 30

Footprint (sq ft) and Truck Share by Manufacturer for MY2008-2010

Manufacturer	2008 Cars	2008 Trucks	2008 Cars and Trucks	2008 Percent Trucks	2009 Cars	2009 Trucks	2009 Cars and Trucks	2009 Percent Trucks	2010 Cars	2010 Trucks	2010 Cars and Trucks	2010 Percent Trucks
GM	46.3	56.7	51.8	53.1%	46.6	59.1	52.1	44.6%	46.7	57.4	52.4	53.2%
Toyota	44.1	52.8	48.3	48.3%	44.3	51.0	46.4	30.6%	44.3	54.5	47.9	36.0%
Honda	44.7	48.4	46.2	40.5%	44.6	48.3	45.9	34.7%	44.3	48.5	45.5	29.3%
Ford	46.7	53.7	50.9	59.9%	45.7	54.3	50.9	60.6%	46.1	56.2	51.7	55.9%
Nissan	45.4	53.7	48.4	36.2%	45.0	50.3	46.8	33.7%	44.8	50.8	46.6	29.3%
Chrysler	47.7	51.8	50.3	62.5%	48.1	52.1	50.9	69.6%	49.6	53.5	52.2	67.3%
Hyundai	44.2	47.0	45.0	29.4%	45.0	46.8	45.4	22.1%	45.5	47.0	45.8	14.4%
VW	43.6	52.6	44.3	8.2%	43.4	48.5	44.0	12.7%	43.6	48.1	44.2	14.1%
Kia	45.1	49.3	46.8	41.6%	44.6	49.2	46.2	34.5%	44.4	51.0	46.3	29.7%
BMW	45.4	50.0	46.2	17.4%	44.3	51.2	45.4	16.4%	44.2	50.6	45.1	14.8%
Subaru	44.4	44.5	44.4	24.8%	44.4	43.4	43.9	47.6%	44.8	43.4	44.3	35.6%
Daimler	48.1	52.5	49.1	23.9%	47.7	52.2	48.7	22.8%	47.8	50.7	48.7	29.6%
Mazda	44.0	47.5	45.3	36.8%	45.0	47.2	45.8	36.6%	45.3	48.6	46.6	39.2%
Mitsubishi	43.9	45.8	44.4	25.9%	44.5	44.2	44.5	13.3%	44.1	44.5	44.2	20.3%
Other	41.9	48.0	44.9	48.8%	42.9	49.1	45.2	36.5%	43.4	48.3	46.1	51.3%
All	45.4	53.0	49.0	47.3%	45.2	52.7	48.2	39.8%	45.2	54.0	48.8	41.1%

Table 31

MY2009 Adjusted Composite Fuel Economy by Vehicle Type and Size for Largest Manufacturers

Vehicle Type/Size	GM	Toyota	Honda	Ford	Nissan	Chrysler	Hyundai	VW	Kia	BMW	Subaru	Daimler	Mazda	Mitsubishi	All
Cars															
Small	25.6	30.0	29.4	26.3	23.1	19.1	30.2	24.5	30.5	23.5	23.0	21.4	25.5	24.0	26.4
Midsize	23.8	27.6	21.5	21.5	26.5	25.0	28.5	22.1	27.1	21.1	-	19.9	23.7	23.4	25.6
Large	21.6	23.7	25.1	20.4	19.4	20.7	25.1	19.0	20.2	17.6	-	16.7	-	-	22.8
All Sizes	23.8	28.6	27.0	23.5	26.0	22.1	26.7	24.3	28.0	22.8	23.0	20.7	24.7	23.8	25.4
Wagons															
Small	25.6	25.7	30.6	23.4	28.7	21.8	26.9	27.5	-	21.6	22.8	-	-	-	26.2
Midsize	-	-	-	18.9	-	-	-	22.8	23.0	20.1	22.7	18.4	-	-	22.3
Large	-	-	-	-	-	-	-	-	-	-	-	17.2	-	-	17.2
All Sizes	25.6	25.7	30.6	19.8	28.7	21.8	26.9	27.0	23.0	21.2	22.7	17.4	-	-	25.5
All Cars															
Small	25.6	29.2	29.7	26.2	24.5	20.1	29.8	24.8	30.5	23.5	22.9	21.4	25.5	24.0	26.4
Midsize	23.8	27.6	21.5	21.3	26.5	25.0	28.5	22.2	26.4	21.1	22.7	19.8	23.7	23.4	25.5
Large	21.6	23.7	25.1	20.4	19.4	20.7	25.1	19.0	20.2	17.6	-	16.8	-	-	22.8
All Sizes	24.0	28.3	27.3	23.5	26.1	22.0	26.7	24.6	27.3	22.8	22.8	20.6	24.7	23.8	25.4
Vans															
Small	-	-	-	-	-	-	-	-	-	-	-	-	23.8	-	23.8
Midsize	-	20.8	20.4	19.6	19.7	19.8	-	-	19.2	-	-	-	-	-	20.1
Large	16.0	-	-	-	-	-	-	-	-	-	-	-	-	-	16.0
All Sizes	16.0	20.8	20.4	19.6	19.7	19.8	-	-	19.2	-	-	-	23.8	-	20.1
SUVs															
Small	-	-	-	-	-	16.6	-	-	-	-	-	-	-	-	16.6
Midsize	21.6	21.8	21.0	22.1	22.7	18.7	20.7	21.2	20.6	-	22.4	-	20.6	21.7	21.2
Large	18.2	15.1	-	17.9	19.5	19.1	18.9	18.0	18.7	18.3	-	16.7	18.2	-	18.3
All Sizes	18.4	21.6	21.0	20.6	20.6	18.3	20.6	19.5	20.1	18.3	22.4	16.7	19.5	21.7	19.9
Pickups															
Midsize	19.8	19.3	-	19.9	-	-	-	-	-	-	-	-	23.4	-	19.5
Large	16.6	15.6	17.6	16.3	16.4	15.8	-	-	-	-	-	-	15.1	16.3	16.4
All Sizes	16.8	18.7	17.6	16.8	16.4	15.8	-	-	-	-	-	-	22.3	16.3	16.9
All Trucks															
Small	-	-	-	-	-	16.6	-	-	-	-	-	-	23.8	-	18.1
Midsize	21.0	21.1	20.9	21.6	22.4	19.3	20.7	21.2	20.2	-	22.4	-	20.7	21.7	20.8
Large	17.3	15.5	17.6	16.8	18.7	17.1	18.9	18.0	18.7	18.3	-	16.7	18.2	16.3	17.3
All Sizes	17.5	20.7	20.8	18.7	19.9	18.1	20.6	19.5	19.9	18.3	22.4	16.7	21.1	21.4	19.0
Fleet															
All Sizes	20.6	25.4	24.6	20.3	23.6	19.2	25.1	23.8	24.2	21.9	22.6	19.5	23.2	23.5	22.4

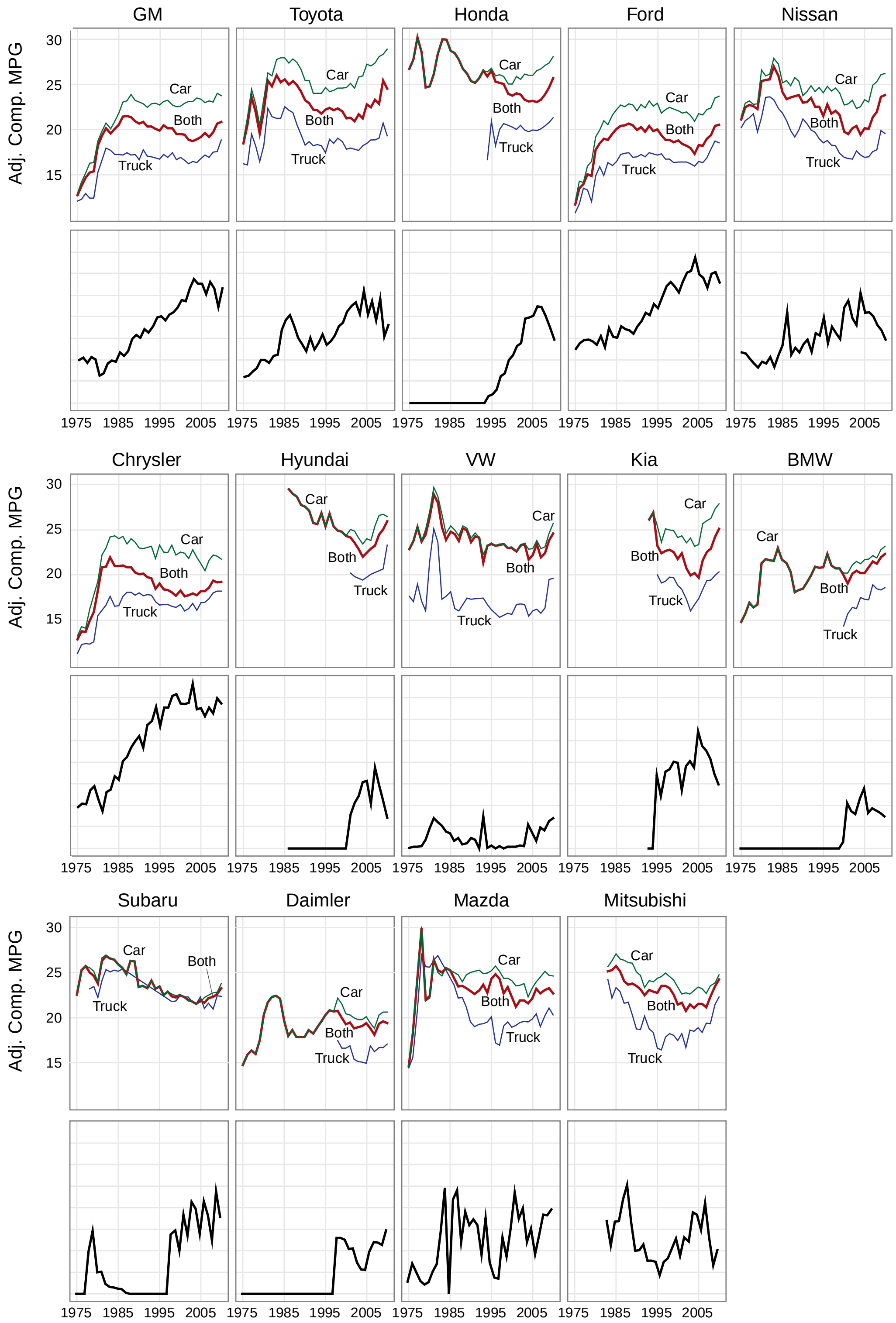
Table 32

MY2010 Adjusted Composite Fuel Economy by Vehicle Type and Size for Largest Manufacturers

Vehicle Type/Size	GM	Toyota	Honda	Ford	Nissan	Chrysler	Hyundai	VW	Kia	BMW	Subaru	Daimler	Mazda	Mitsubishi	All
Cars															
Small	24.4	29.7	30.7	24.5	22.9	20.1	26.6	25.6	29.5	24.7	22.6	21.2	25.9	24.7	26.7
Midsize	23.5	29.0	21.3	24.5	26.8	25.1	30.0	22.2	25.7	20.7	24.7	20.7	23.7	25.4	26.1
Large	22.0	23.7	25.2	20.6	19.5	20.6	24.4	19.2	-	17.8	-	18.3	-	-	22.7
All Sizes	23.5	29.2	27.7	23.8	26.0	21.7	26.4	25.3	28.7	23.2	23.7	20.8	24.6	24.9	25.8
Wagons															
Small	25.5	25.6	30.6	23.4	28.8	21.7	26.9	29.8	27.2	21.6	21.8	-	-	23.5	26.8
Midsize	-	-	-	19.2	-	-	-	24.9	22.3	20.0	24.4	-	-	-	22.6
Large	-	-	-	-	-	-	-	-	-	-	-	16.8	-	-	16.8
All Sizes	25.5	25.6	30.6	19.6	28.8	21.7	26.9	29.1	25.5	20.6	23.9	16.8	-	23.5	25.9
All Cars															
Small	24.7	29.0	30.7	24.5	24.3	20.5	26.7	26.0	29.0	24.7	22.3	21.2	25.9	24.6	26.7
Midsize	23.5	29.0	21.3	24.1	26.8	25.1	30.0	22.7	24.5	20.7	24.5	20.7	23.7	25.4	26.0
Large	22.0	23.7	25.2	20.6	19.5	20.6	24.4	19.2	-	17.8	-	17.8	-	-	22.6
All Sizes	23.7	28.9	28.1	23.7	26.2	21.7	26.4	25.7	27.9	23.1	23.8	20.6	24.6	24.7	25.8
Vans															
Small	-	-	-	-	-	-	-	-	-	-	-	-	24.1	-	24.1
Midsize	-	20.8	20.4	23.5	-	19.7	-	-	19.8	-	-	-	-	-	20.2
Large	16.0	-	-	-	-	-	-	-	-	-	-	-	-	-	16.0
All Sizes	16.0	20.8	20.4	23.5	-	19.7	-	-	19.8	-	-	-	24.1	-	20.1
SUVs															
Small	-	-	-	-	-	17.1	-	-	-	-	-	-	-	-	17.1
Midsize	22.1	22.2	21.8	22.0	22.1	19.5	24.0	21.2	21.5	-	22.3	18.5	21.4	22.3	21.6
Large	19.8	15.6	-	17.9	18.9	19.9	19.5	18.8	18.7	18.5	-	16.4	18.3	-	18.7
All Sizes	19.9	21.0	21.8	20.1	20.4	18.9	23.3	19.6	20.7	18.5	22.3	17.0	20.0	22.3	20.2
Pickups															
Midsize	21.1	19.5	-	21.9	-	-	-	-	-	-	-	-	-	-	19.9
Large	17.4	15.8	17.6	16.6	16.5	16.1	-	-	-	-	-	-	-	-	16.6
All Sizes	17.5	16.9	17.6	16.8	16.5	16.1	-	-	-	-	-	-	-	-	16.9
All Trucks															
Small	-	-	-	-	-	17.1	-	-	-	-	-	-	24.1	-	17.8
Midsize	21.9	21.5	21.5	22.1	22.1	19.6	24.0	21.2	20.5	-	22.3	18.5	21.4	22.3	21.2
Large	18.7	15.7	17.6	17.0	18.0	16.7	19.5	18.8	18.7	18.5	-	16.4	18.3	-	17.5
All Sizes	18.8	19.3	21.2	18.5	19.5	18.2	23.3	19.6	20.3	18.5	22.3	17.0	20.3	22.3	19.1
Fleet															
All Sizes	20.8	24.5	25.6	20.5	23.8	19.2	25.9	24.6	25.1	22.3	23.3	19.4	22.7	24.2	22.5

Figure 30

Manufacturer Adjusted Fuel Economy and Percent Truck by Model Year



VIII. Characteristics of Fleets Comprising Existing Fuel-Efficient Vehicles

This section is limited to a discussion of hypothetical fleets of vehicles composed 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 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 new technology and 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, but does not address 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 by a much higher percentage of consumers.

As was shown in Figure 3, 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 the 1970s.

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 high mpg "role model" vehicles to represent the fuel economy of that class, and then calculating the average characteristics of the resultant fleet using the same relative production proportions for each class as in the baseline fleet.

One potential problem with a BIC analysis is that the high mpg vehicles used in the analysis may be unusual in some way - so unusual that the hypothetical BIC fleet 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 weight classes used for EPA's vehicle testing and certification programs.

The advantage of using and analyzing data from the best-in-size-class methods is that if the production proportions of each class are held constant, the production 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, an advantage of using the weight classes to determine the role models is, if the production proportions in each weight class are held constant, the production 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 production weighting factor, but the original production 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 be different nameplates. Conversely, in the cases where there are technically identical vehicles with different nameplates, 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 (some of which may have the same nameplate) 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 production 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 exist, only one representative vehicle was included. As with the two best-in-size class methods, the production 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 33 to 35 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 2010. 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.

In general, 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.

As shown in Table 33, depending on the BIC scenario chosen, MY2010 cars could have achieved from 16% to 26% better fuel economy than they did. Table 34 shows that the potential truck BIC fuel economy improvement ranges from 12% to 25%, and the combined car and truck fleet could have been 15% to 26% better as shown in Table 35.

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 reflecting the variation in fuel economy levels that results in large part from consumer preferences as opposed to technological availability.

Table 33

Best in Class Results 2010 Cars

Category	Vehicle Characteristic	Actual Data	Best 4 Nameplates in Size Class	Best 12 Vehicles in Size Class	Best 12 Vehicles in Weight Class
Fuel Economy	Lab. 55/45	32.7	42.8	39.4	38.8
	Adjusted City	21.7	29.4	26.5	26.0
	Adjusted Highway	30.1	35.2	34.0	34.0
	Adjusted Composite	25.8	32.4	30.4	30.0
Vehicle Size	Weight (lb.)	3499	3407	3233	3499
	Volume (Cu. Ft.)	110	109	109	106
	CID	159	125	124	129
	HP	192	148	145	162
	HP/CID	1.21	1.19	1.17	1.26
	HP/WT	0.054	0.043	0.044	0.046
	Percent Multivalve	93%	88%	92%	93%
	Percent Variable Valve	92%	98%	94%	81%
	Percent Diesel	0.5%	1.6%	5.5%	14.2%
Performance	0-60 Time (Sec.)	9.5	9.9	10.3	9.9
	Top Speed	136	122	122	125
	Ton-MPG	46.1	57.7	50.3	53.7
	Cu. Ft. MPG	2947	3698	3394	3282
	Cu. Ft. Ton-MPG	5100	6339	5502	5701
Drive	Front	80%	95%	95%	84%
	Rear	14%	5%	4%	6%
	4WD	6%	1%	1%	10%
Transmission	Manual	10%	10%	37%	28%
	Lockup	76%	42%	36%	32%
	CVT	14%	48%	24%	37%
	Hybrid Vehicle	6.1%	46.4%	20.6%	18.9%

Table 34

Best in Class Results 2010 Trucks

Category	Vehicle Characteristic	Actual Data	Best 4 Nameplates in Size Class	Best 12 Vehicles in Size Class	Best 12 Vehicles in Weight Class
Fuel Economy	Lab. 55/45	23.8	31.1	29.5	27.1
	Adjusted City	16.2	22.4	20.5	18.6
	Adjusted Highway	22.0	25.1	25.5	24.2
	Adjusted Composite	19.1	23.9	23.0	21.4
Vehicle Size	Weight (lb.)	4738	4733	4329	4738
	CID	236	221	192	210
	HP	259	232	211	244
	HP/CID	1.12	1.08	1.12	1.18
	HP/WT	0.054	0.048	0.049	0.051
	Percent Multivalve	76%	76%	88%	88%
	Percent Variable Valve	79%	95%	91%	89%
	Percent Diesel	0.2%	-	6.3%	5.8%
Performance	0-60 Time (Sec.)	9.4	8.6	9.3	9.3
	Top Speed	143	135	133	139
	Ton-MPG	45.3	57.7	50.5	51.1
Drive	Front	30%	33%	41%	36%
	Rear	22%	28%	26%	13%
	4WD	48%	40%	33%	52%
Transmission	Manual	2%	4%	25%	6%
	Lockup	93%	33%	45%	75%
	CVT	5%	56%	28%	18%
	Hybrid Vehicle	1.6%	62.7%	28.0%	16.5%

Table 35

Best in Class Results 2010 Light Duty Vehicles

Category	Vehicle Characteristic	Actual Data	Best 4 Nameplates in Size Class	Best 12 Vehicles in Size Class	Best 12 Vehicles in Weight Class
Fuel Economy	Lab. 55/45	28.3	37.2	34.6	33.0
	Adjusted City	19.0	26.1	23.7	22.3
	Adjusted Highway	26.1	30.3	29.9	29.2
	Adjusted Composite	22.5	28.3	26.9	25.8
Vehicle Size	Weight (lb.)	4009	3941	3684	4009
	CID	191	163	152	162
	HP	220	182	173	196
	HP/CID	1.17	1.15	1.15	1.23
	HP/WT	0.054	0.045	0.046	0.048
	Percent Multivalve	86%	83%	90%	91%
	Percent Variable Valve	86%	97%	93%	84%
	Percent Diesel	0.4%	0.9%	5.8%	10.7%
Performance	0-60 Time (Sec.)	9.5	9.4	9.9	9.6
	Top Speed	139	127	127	131
	Ton-MPG	45.8	57.7	50.4	52.6
Drive	Front	59%	70%	73%	64%
	Rear	17%	14%	13%	9%
	4WD	24%	16%	14%	27%
Transmission	Manual	7%	7%	32%	19%
	Lockup	83%	38%	39%	50%
	CVT	10%	51%	26%	29%
	Hybrid Vehicle	4.3%	53.0%	23.6%	17.9%

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 production distributions for each size or weight strata to match those of a baseline year and then calculating the fleet wide averages for the hypothetical fleet using the re-mixed production data. The production distribution of the resultant fleet is by *vehicle type and size*, thus it 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 production proportions in each weight class are held the same as the base years, the production 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 years.

It is important to note that, for Tables 36 and 37 below, both hybrid and diesel vehicles were excluded so that only vehicles with conventional powertrains were considered. Accordingly, the data in the rows for actual 2010, 1981, and 1988 typically differ slightly from data reported elsewhere in this report.

Table 36 compares weight, interior volume, engine CID and HP, estimated 0-to-60 time and laboratory fuel economy for conventionally powered MY2010 cars as calculated from the projected 2010 production 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, until recently, the year with the highest LAB fuel economy. This table includes the actual 1981 and 1988 fleet averages as a point of reference. In both of the weight distribution cases, the fuel economy of the re-mixed MY2010 fleet would have been higher than actually is: 7% if the 1981 weight distribution is used, 12% if the 1988 weight distribution is used. For both re-mixed weight cases, interior volume and horsepower are substantially lower. Using the MY1981 and MY1988 size mix distributions did not change car fuel economy.

Table 36

Characteristics of 2010 Cars

Calculated From:

	Vehicle Weight	Interior Volume	CID	HP	0-to-60 Time	Lab 55/45 MPG
2010 Actual Distribution	3493	110	162	197	9.5	31.7
1981 Weight Distribution	3043	98	133	173	9.6	34.0
1988 Weight Distribution	3053	103	127	156	10.2	35.5
1981 Size Distribution	3482	108	161	198	9.5	31.7
1988 Size Distribution	3449	108	160	194	9.6	32.0
Reference: 1981 Actual	3043	106	178	99	14.1	24.9
Reference: 1988 Actual	3047	107	160	116	12.8	28.6

Percent Change:

	Vehicle Weight	Interior Volume	CID	HP	0-to-60 Time	Lab 55/45 MPG
1981 Weight Distribution	-13%	-11%	-18%	-12%	1%	7%
1988 Weight Distribution	-13%	-6%	-21%	-21%	8%	12%
1981 Size Distribution	0%	-2%	-1%	0%	0%	0%
1988 Size Distribution	-1%	-2%	-2%	-1%	0%	1%
Reference: 1981 Actual	-13%	-4%	9%	-49%	48%	-22%
Reference: 1988 Actual	-13%	-3%	-1%	-41%	34%	-10%

Table 37 shows similar data for trucks, and as with the car class cases using either the 1981 or the 1988 production distribution by weight class, results in higher recalculated fuel economy than using the corresponding size class production distribution. Figure 31 compares actual fuel economy for all model years from 1975 to 2010 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 higher fuel economy improvements than the similar size class cases.

Table 37

Characteristics of 2010 Trucks

Calculated From:

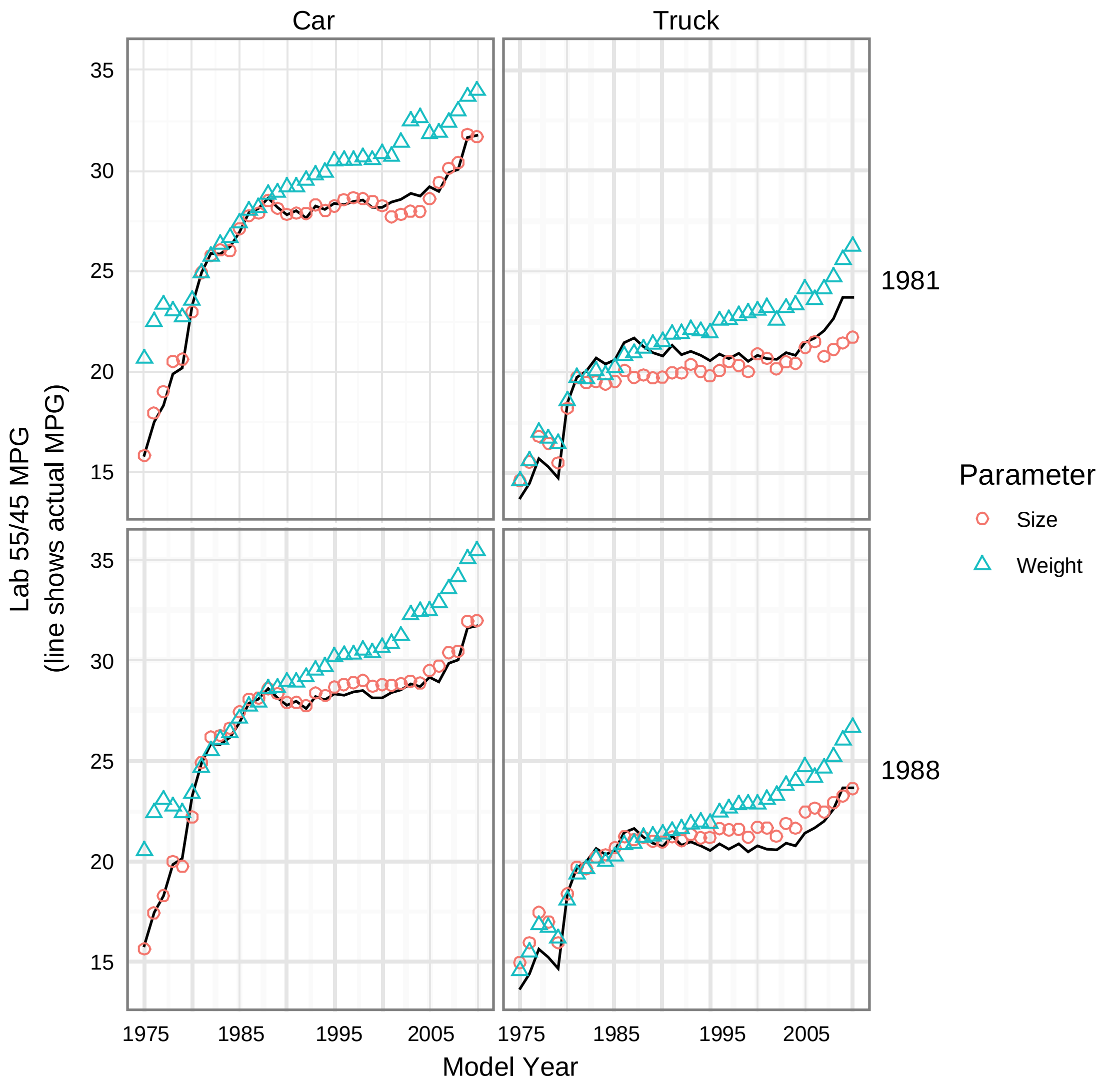
	Vehicle Weight	CID	HP	0-to-60 Time	Lab 55/45 MPG
2010 Actual Distribution	4734	237	260	9.4	23.7
1981 Weight Distribution	4185	192	223	9.7	26.2
1988 Weight Distribution	4083	188	216	9.7	26.7
1981 Size Distribution	5060	277	276	9.5	21.7
1988 Size Distribution	4551	232	235	10.0	23.6
Reference: 1981 Actual	3841	252	121	14.4	19.7
Reference: 1988 Actual	3838	227	141	12.9	21.2

Percent Change:

	Vehicle Weight	CID	HP	0-to-60 Time	Lab 55/45 MPG
1981 Weight Distribution	-12%	-19%	-14%	2%	11%
1988 Weight Distribution	-14%	-21%	-17%	3%	13%
1981 Size Distribution	7%	17%	6%	1%	-8%
1988 Size Distribution	-4%	-2%	-10%	5%	0%
Reference: 1981 Actual	-19%	6%	-53%	52%	-17%
Reference: 1988 Actual	-19%	-4%	-46%	37%	-10%

Figure 31

Effect of Weight and Size on Fuel Economy



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