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Light-Duty Automotive Technology and Fuel Economy Trends

1975 Through 2001

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Light-Duty Automotive Technology and Fuel Economy Trends

1975 Through 2001

by

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EPA's *Green Vehicle Guide* provides information about the air pollution emissions and fuel economy performance of vehicles; it is available on EPA's web site at

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Executive Summary

Introduction

This report summarizes key fuel economy and technology usage trends related to model year 1975 through 2001 light vehicles sold in the United States. Light vehicles are those vehicles that EPA and the U.S. Department of Transportation (DOT) classify as cars or light-duty trucks (sport utility vehicles, vans, and pickup trucks with less than 8,500 pounds gross vehicle weight ratings).

Average new light-vehicle fuel economy continues to decline. Since peaking at 22.1 mpg in 1987 and 1988, average light-vehicle fuel economy has declined nearly eight percent to 20.4 mpg and for 2001 is lower than it has been at any time since 1980. The primary reasons for this decline are the increasing market share of less efficient light trucks, increased vehicle weight, and increased vehicle performance.

The fuel economy values in this report are based on laboratory data but for most tables and analyses in the report have been adjusted downward, by about 15 percent, so that this data is equivalent to the real world estimates used on new vehicle labels, in the EPA/DOE *Fuel Economy Guide,* and in EPA's *Green Vehicle Guide*.

These adjusted fuel economy values, therefore, are significantly lower than those used by the DOT for compliance with fuel economy standards. In addition, the values in this report exclude Corporate Average Fuel Economy (CAFE) credits for alternative fuel capability and corrections for test procedure adjustments that are included in the fuel economy data reported by DOT.

Importance of Fuel Economy

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

1. Light vehicles account for approximately 40 percent of all U.S. oil consumption. Crude oil, from which nearly all light-vehicle fuels are made, is considered to be a finite natural resource.

2. Fuel economy is directly related to the cost of fueling a vehicle and is of greater interest when oil and gasoline prices rise, as has been the case in 2000 and 2001.

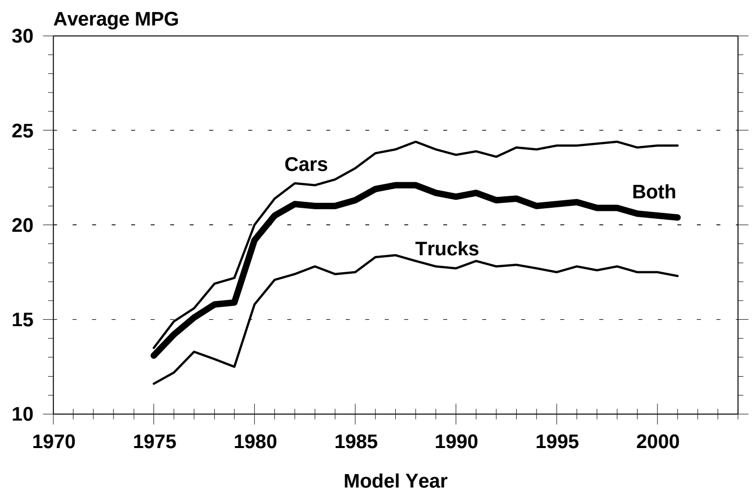
3. Fuel economy is directly related to carbon dioxide emissions from light vehicles which contribute about 20 percent of all U.S. carbon dioxide emissions. Carbon dioxide is the most prevalent emission that many scientists associate with global warming.

Highlight #1: Fuel Economy Is at a 21-Year Low

There has been an overall declining trend in new light-vehicle fuel economy since 1988. The average fuel economy for all model year 2001 light vehicles is 20.4 mpg and is lower than it has been at any time since 1980. This value is 1.7 mpg (almost 8 percent) lower than the peak value of 22.1 mpg achieved in 1987 and 1988. Within the light vehicle category for model year 2001, average fuel economy is 24.2 mpg for cars and 17.3 mpg for light trucks.

New light-vehicle fuel economy improved fleet-wide from the middle 1970s through the late 1980s, but it has been consistently falling since then. Viewed separately, the average fuel economy for new cars has been essentially flat over the last 16 years, varying only from 23.6 mpg to 24.4 mpg. Similarly, the average fuel economy for new light trucks has been largely unchanged for the past 20 years, ranging from 17.3 mpg to 18.4 mpg. The increasing market share of light trucks, which have lower average fuel economy than cars, accounts for much of the decline in fuel economy of the overall new light vehicle fleet.

Fuel Economy by Model Year



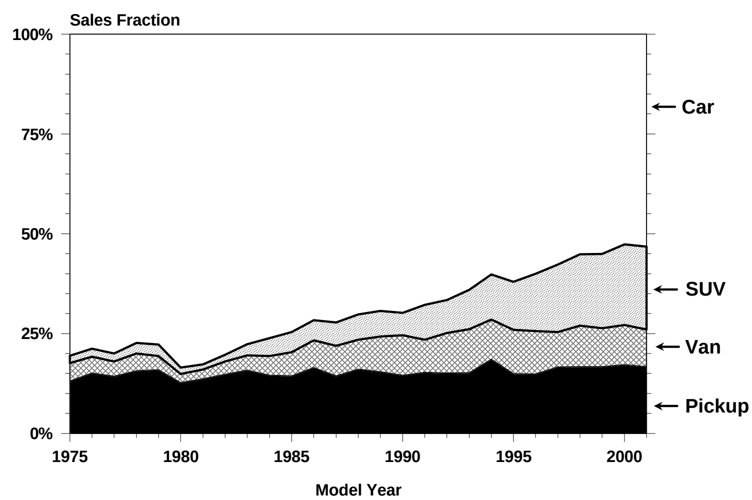
* Note the fuel economy data in this report have been revised since the previous paper in this series was issued and adjusted downward by about 15 percent to be equivalent to the real world estimates used on new vehicle labels, in the *Fuel Economy Guide* and the *Green Vehicle Guide*.

Highlight #2: Trucks Represent Nearly Half of New Vehicle Sales

Sales of light trucks, which include sport utility vehicles (SUVs), vans, and pickup trucks, have risen steadily for over 20 years and now make up nearly 47 percent of the U.S. light vehicle market –- more than twice their market share in 1983.

Growth in the light truck market has been led recently by the explosive popularity of SUVs. The SUV market share increased by more than a factor of ten, from less than 2 percent of the overall new light vehicle market in 1975 to nearly 22 percent of the market in 2001. Over the same period, the market share for vans more than doubled from 4.5 to 9.3 percent, and for pickup trucks, grew from 13 to about 17 percent. Between 1975 and 2001, market share for new passenger cars and station wagons decreased from 81 to 53 percent. For model year 2001, cars average 24.2 mpg, vans 19.3 mpg, SUVs 17.2 mpg and pickups 16.5 mpg.

Sales Fraction by Vehicle Type

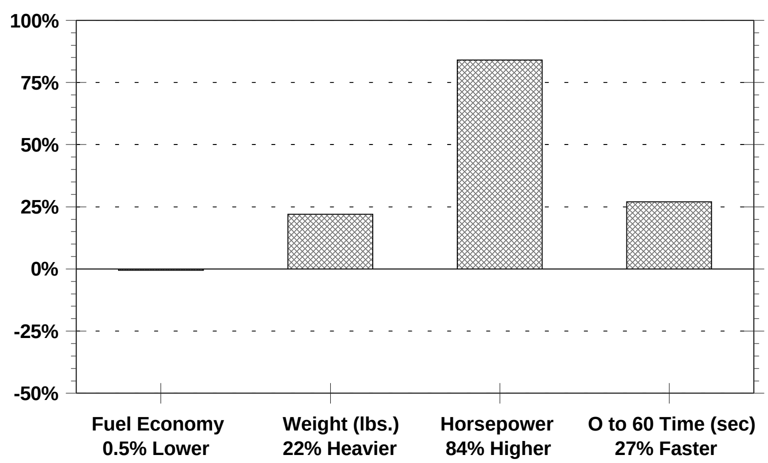


Highlight #3: Over the Past 20 Years, Fuel Economy Is Relatively Constant, While Vehicle Weight and Power Are Increasing

> *More efficient technologies continue to enter the new light vehicle fleet and are being used to increase light vehicle weight and acceleration while fuel economy is not being increased. Model year 2001 light vehicles will have about the same average fuel economy as those built twenty years ago in model year 1981. Based on accepted engineering relationships, however, had the new 2001 light vehicle fleet had the same average weight and performance as in 1981, it could have achieved more than 25-percent higher fuel economy.*

More efficient technologies -- such as engines with more valves and more sophisticated fuel injection systems, and transmissions with lockup torque convertors and extra gears -- continue to penetrate the new light vehicle fleet. The trend has clearly been to apply these new technologies to accommodate increases in average new vehicle weight, power, and performance while maintaining a constant level of fuel economy. This is reflected by heavier average vehicle weight (up 22 percent since 1981), rising average horsepower (up 84 percent since 1981), and lower 0 to 60 mile-per-hour acceleration time (27 percent faster since 1981).

**Percent Change from 1981 to 2001
in Average Vehicle Characteristics**

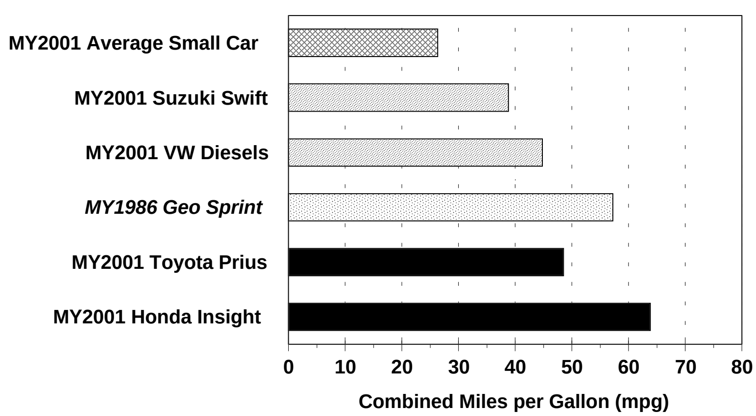


Highlight #4: Vehicles with Highly Fuel Efficient Propulsion Systems Are Beginning to Penetrate the Automotive Fleet

During the past 25 years, the most significant change to light-vehicle fuel economy technologies may be the introduction of vehicles with hybrid propulsion systems.

The model year 2001 light-vehicle fleet includes two hybrid vehicles: the Honda Insight, which was introduced in 2000, and the Toyota Prius, which was introduced in the U.S. market in 2001. Both of these hybrid vehicles are equipped with propulsion systems that include as key components gasoline engines, motor/generators and batteries. The manual transmission equipped two-seater Insight has *Fuel Economy Guide/*label ratings of 61 mpg city and 68 mpg highway. The Prius, a compact car with *Fuel Economy Guide/*label ratings of 52 mpg city and 45 mpg highway, is the second highest fuel economy vehicle on the market in 2001. The Insight's combined fuel economy value is about 12 percent higher than the most fuel efficient, conventionally powered vehicle sold in the United States since 1975, a model year 1986 Geo Sprint mini-compact. The Insight's fuel economy is also more than 40 percent higher than that for the model year 2001 Volkswagen Beetle/Golf/Jetta diesels and a gasoline-powered Suzuki Swift. All of these conventionally powered vehicles are equipped with manual transmissions.

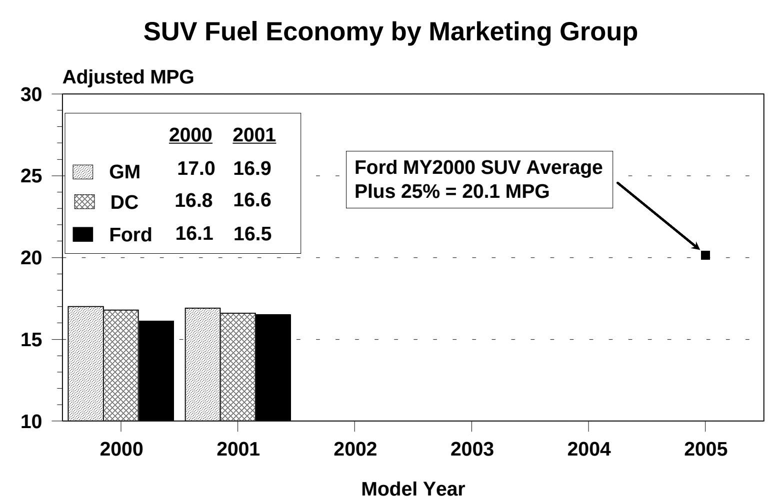
Comparison of the Hybrid Vehicles with Other High Fuel Economy Vehicles



Highlight #5: Recent Pledges to Voluntarily Increase Fuel Economy

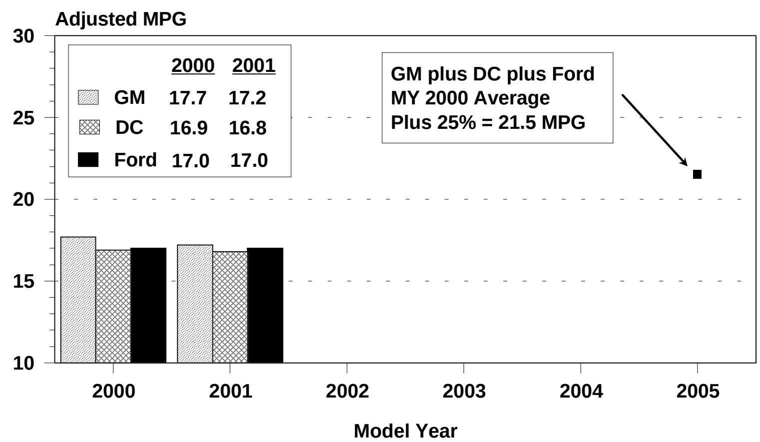
> *On July 27, 2000, Jacques Nasser, Ford Motor Company's chief executive, pledged to increase the fuel economy of its entire line of sport utility vehicles by 25 percent by the 2005 calendar year. A few days later, on August 2, 2000, Harry Pearce, General Motors vice chairman, pledged GM would remain the light-truck fuel economy leader. On April 7, 2001, Jürgen Schrempp chairman of DaimlerChrysler, stated that the fuel economy of their "fleet will match or exceed those of other full-line manufacturers."*
>
> *If all manufacturers were to voluntarily increase the average fuel economy of their entire light-vehicle fleets by 25 percent by 2005, average new light-vehicle fuel economy would increase by five miles per gallon.*

Based on the data available to date, with model year 2000 as the base line, the following graphs show the initial progress the Ford (defined as Ford, Jaguar, Volvo, Land Rover, and Mazda), General Motors (i.e., GM, Suzuki, Saab, Isuzu, and Subaru) and DaimlerChrysler (i.e., Chrysler, Mercedes, and Mitsubishi) marketing groups have made toward meeting their fuel economy improvement pledges.

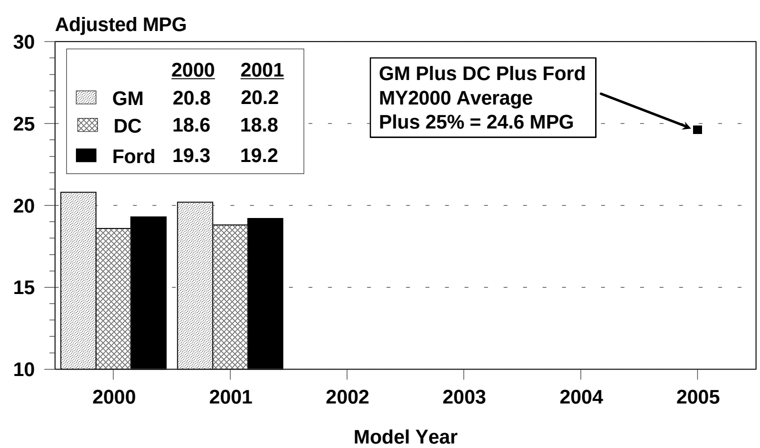


The figures below show the fuel economy (mpg) performance by marketing group for light trucks (i.e., vans, SUVs, and pickups) and personal use (car and light truck) fleets for model years 2000 and 2001 and a projection for model year 2005 that represents a 25-percent increase from the model year 2000 fuel economy average.

Light Truck Fuel Economy by Marketing Group



Personal Use Vehicle Fuel Economy by Marketing Group



I. Summary

The fuel economy of the fleet of cars and light trucks continues to decline. No matter how it is measured, the fuel economy has declined since its peak in the late 1980s and for 2001 is back to where it was 20 years ago.

Fleet MPG

Measure	**Peak Year/Value**	**2001**	**Δ MPG**	**%**
Lab 55/45 MPG	1987/25.9	23.9	-2.0	-7.7
Adjusted MPG	1987/22.1	20.4	-1.7	-7.7

The primary reasons for the decline is the increasing market share of less fuel efficient light-duty trucks, increased performance, and increased weight.

Vehicles equipped with hybrid propulsion systems are beginning to penetrate the fleet. Fuel efficient hybrid technology is the most significant fuel economy technology introduced into the fleet in the last 25 years and the technology with the highest degree of potential for fleet fuel economy improvement.

The fuel economy potential represented by conventional technologies already in the fleet ranges from about 9% to 27%. The fuel economy potential considering hybrid powertrain technology is much higher.

II. General Car and Truck Trends

Table 1 gives sales and fuel economy of passenger cars, light trucks, and all light-duty vehicles (cars and light trucks) for model years 1975 to 2001. As Figure 1 shows, for the past dozen years, the fuel economy of the combined car and light-truck fleet has gradually declined and remains about two MPG, or about 7%, below the peak value of 25.9 MPG attained in 1987 and 1988. Both car and light-truck MPG have been very stable during this period; since 1986, cars have been within 0.5 MPG of 28.1 and light trucks within 0.5 MPG of 21.1 since 1983.

For MY2001, average Laboratory MPG of all cars and trucks combined is projected to be 23.9; or lower than any time since 1980 when the average was 22.5. The decline in the overall combined car/truck average is primarily due to the increasing market share of light trucks which have lower average fuel economy than cars. Using today’s fuel economy values for cars and light trucks and computing a fleet average based on the light-truck market share in 1987--not 2001--, a value of 25.5 MPG can be estimated which is close to the 25.9 obtained in the peak year of 1987, indicating that much of the decline since then can be attributed to the increasing fraction of light-truck sales. The increase in the light-truck share of the market is the most important trend in the light vehicle fleet over recent years and one which has yet to level off.

The figures and tables in this year’s report provide data using two different approaches: the laboratory-based values which have been used previously in this series of reports and “adjusted” MPG values which are based on the adjustments made to the laboratory fuel economy values for the fuel economy information programs: the *Fuel Economy Guide* and new vehicle fuel economy labels. The adjusted city MPG value is 0.90 times the laboratory city value, and the adjusted highway MPG value is 0.78 times the laboratory MPG value. Presenting both MPG values allows those who follow fuel economy issues which are related to both types of MPG values to use the report more easily. Further details about the database and calculations can be found in Appendix A.

Figure 1 shows the trends in Adjusted MPG since 1975. The downward trend seen since the late 1980s continues. Due to the increase in sales of vans and SUVs, the estimated light-truck share of the market has now passed 46%, more than double what it was in any year between 1975 and 1983. Vans and SUVs combined account for nearly 30% of this year’s fleet, compared to about 6% in 1975.

Table 2 shows some of the characteristics of each year’s fleet. At 3909 lb., the average weight of the fleet is 53 lb.

heavier than last year’s, 708 lb. heavier than it was at the minimum in 1981-82, and the fourth heaviest since 1975. It is also the most powerful and estimated to be the fastest since 1975.

Influence of the “City Fraction”

Inherent in the “Combined” or “55/45” MPG calculation is the apportionment of the miles into those for which the “city” MPG number is applicable and those for which the “highway” MPG number is applicable. Appendix D discusses this in more detail. When the combined MPG value was first introduced in the early 1970s, the appropriate value was 55% for the city fraction and 45% for the highway fraction. Even though these values have been institutionalized–for example, in the fuel economy standards–, they were changing before the 1970s and are still changing today. The values, obtained from the Department of Transportation’s VM-1 tables, are listed in Appendix D. Over the years, the city fraction has increased, reflecting the larger growth in urban vehicle miles traveled (VMT). This would be expected to have a larger negative effect on combined MPG since a higher city fraction weights the city MPG more, and the city MPG is almost always lower than the highway MPG.

Figure 2 shows the trends in adjusted city/highway--weighted MPG versus time for cars, trucks, and cars and trucks combined. For each strata on this figure, one line shows the values as estimated with a constant 55/45 value for the city fraction/ highway fraction; the other line shows the value using the actual values from Appendix D.

If the adjusted MPG values provide an improved estimate of the MPG likely to be achieved in actual use, then accounting for the increase in city fraction should improve the estimate. In this way, the combined car and light truck Lab MPG number of 23.9 MPG can be adjusted to 20.4 using the 0.90/0.78 factors, and if the change in city fraction is accounted for, a value of 20.0 MPG for the on-road MPG of the combined model year 2001 new vehicle fleet is obtained, which is currently our best estimate for that value.

Fuel Economy by Model Year

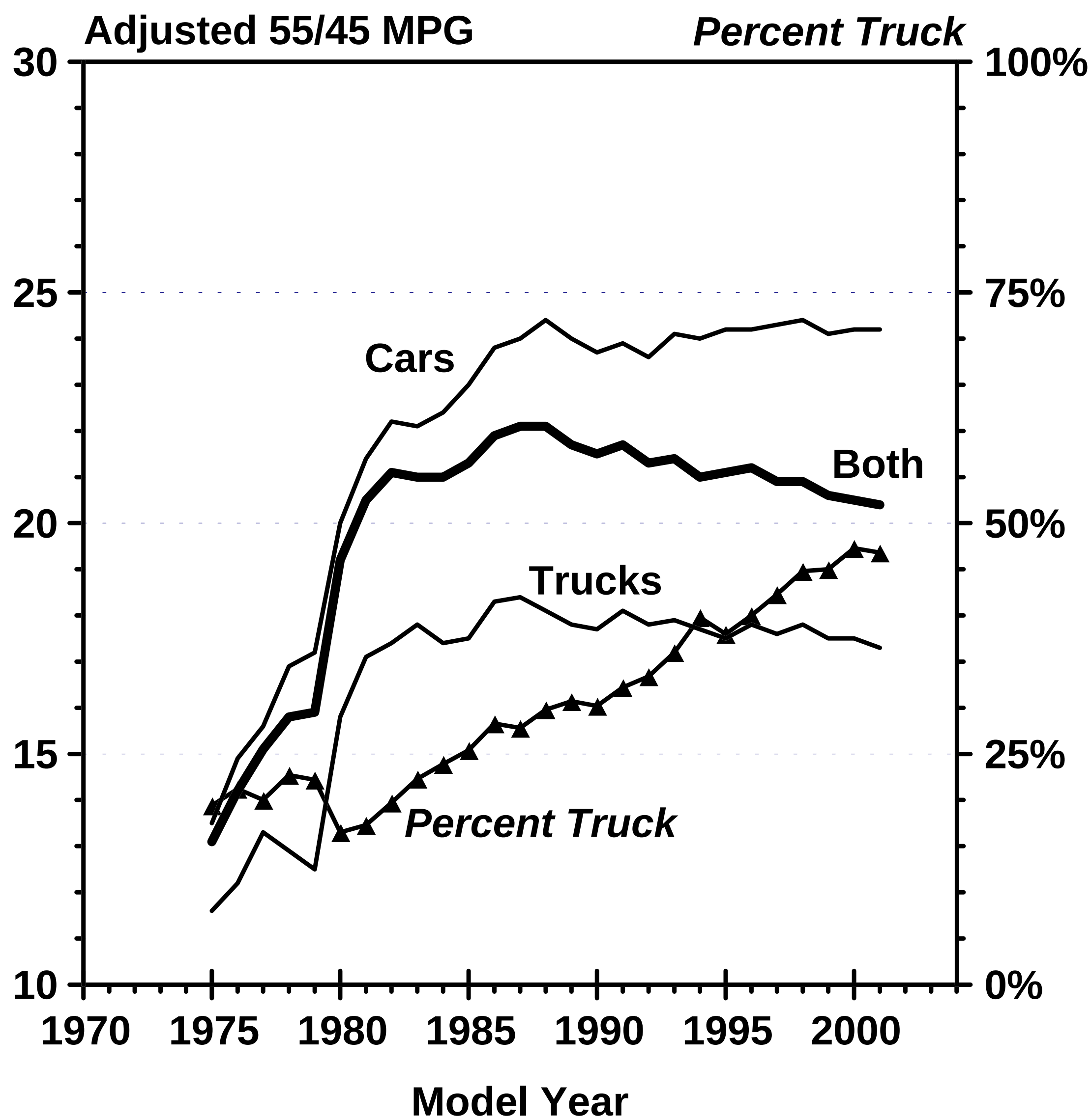


Figure 1

Fuel Economy by Model Year

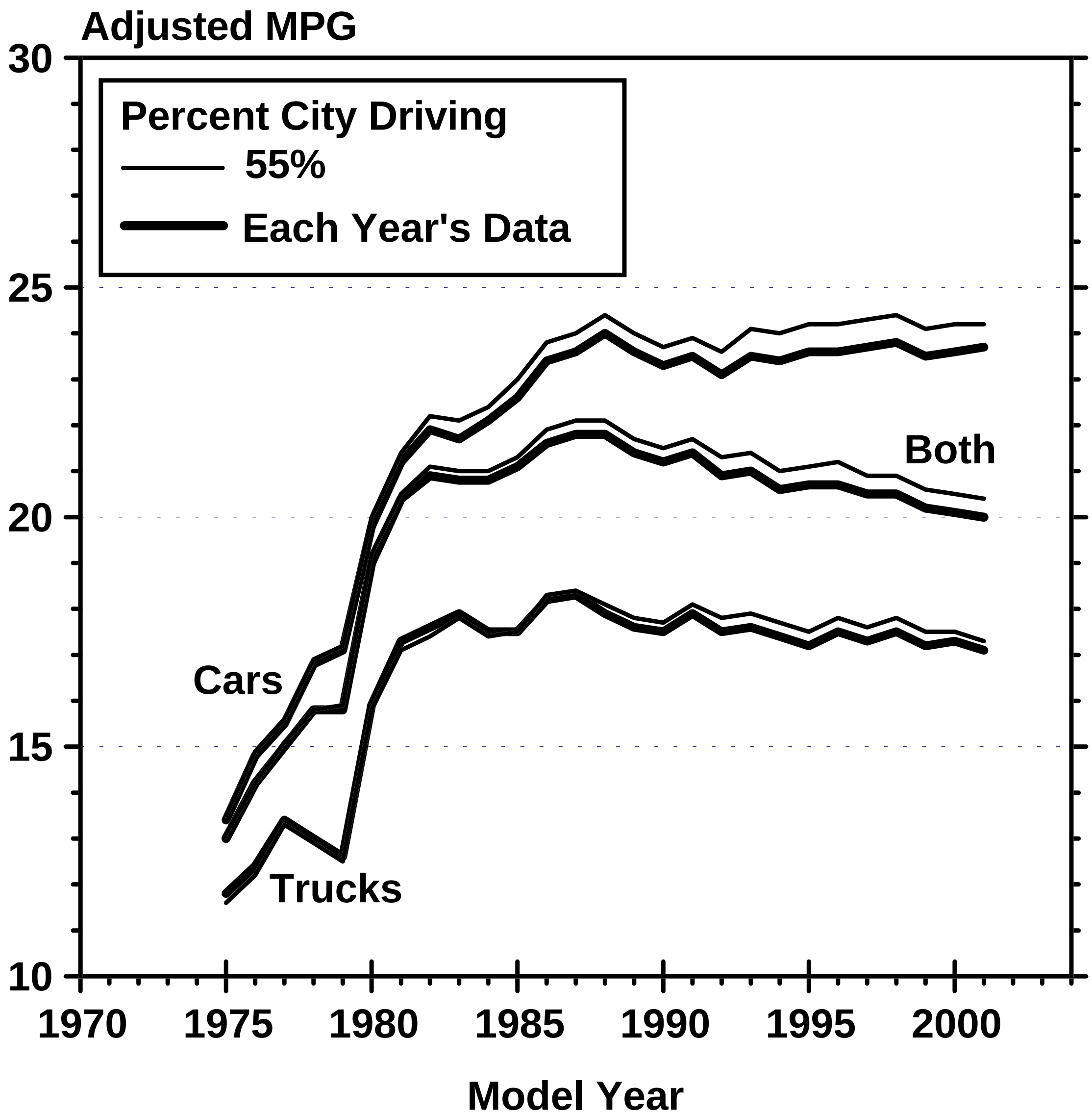


Figure 2

Table 1

Fuel Economy Characteristics of 1975 to 2001 Light-Duty Vehicles

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY ----> LAB 55/45	ADJ CITY	ADJ HWY	ADJ 55/45	TON -MPG	CU-FT -MPG	CU-FT- TON-MPG
Cars									
1975	8237	0.806	15.8	12.3	15.2	13.5	27.6		
1976	9722	0.788	17.5	13.7	16.6	14.9	30.2		
1977	11300	0.800	18.3	14.4	17.4	15.6	31.0	1780	3423
1978	11175	0.773	19.9	15.5	19.1	16.9	30.6	1908	3345
1979	10794	0.778	20.3	15.9	19.2	17.2	30.2	1922	3301
1980	9443	0.835	23.5	18.3	22.6	20.0	31.2	2136	3273
1981	8733	0.827	25.1	19.6	24.2	21.4	33.1	2338	3547
1982	7819	0.803	26.0	20.1	25.5	22.2	34.2	2419	3645
1983	8002	0.777	25.9	19.9	25.5	22.1	34.7	2476	3776
1984	10675	0.761	26.3	20.2	26.0	22.4	35.1	2482	3776
1985	10791	0.746	27.0	20.7	26.8	23.0	35.8	2551	3881
1986	11015	0.717	27.9	21.3	27.7	23.8	36.4	2608	3914
1987	10731	0.722	28.1	21.5	28.0	24.0	36.5	2604	3900
1988	10736	0.702	28.6	21.8	28.5	24.4	37.3	2662	4007
1989	10018	0.693	28.1	21.4	28.3	24.0	37.4	2630	4034
1990	8810	0.698	27.8	21.1	28.1	23.7	37.8	2574	4055
1991	8524	0.678	28.0	21.2	28.3	23.9	37.8	2597	4055
1992	8108	0.666	27.6	20.8	28.3	23.6	38.4	2598	4169
1993	8457	0.640	28.2	21.3	28.8	24.1	38.8	2655	4214
1994	8414	0.602	28.1	21.1	28.8	24.0	39.1	2638	4237
1995	9396	0.620	28.3	21.2	29.3	24.2	39.6	2676	4315
1996	7890	0.600	28.3	21.2	29.3	24.2	39.8	2671	4342
1997	8335	0.577	28.4	21.3	29.4	24.3	39.9	2674	4341
1998	7964	0.552	28.5	21.3	29.6	24.4	40.5	2683	4401
1999	8375	0.550	28.2	21.1	29.2	24.1	40.6	2656	4441
2000	8853	0.525	28.3	21.2	29.3	24.2	40.8	2687	4493
2001	8988	0.532	28.3	21.2	29.3	24.2	41.2	2719	4558

Table 1, Continued

Fuel Economy Characteristics of 1975 to 2001 Light-Duty Vehicles

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY LAB 55/45	ADJ CITY	ADJ HWY	----> ADJ 55/45	TON -MPG
Trucks							
1975	1987	0.194	13.7	10.9	12.7	11.6	24.2
1976	2612	0.212	14.4	11.5	13.2	12.2	26.0
1977	2823	0.200	15.6	12.6	14.1	13.3	28.0
1978	3273	0.227	15.2	12.4	13.7	12.9	27.5
1979	3088	0.222	14.7	12.1	13.1	12.5	27.3
1980	1863	0.165	18.6	14.8	17.1	15.8	30.9
1981	1821	0.173	20.1	16.0	18.6	17.1	33.0
1982	1914	0.197	20.5	16.3	19.0	17.4	33.7
1983	2300	0.223	20.9	16.5	19.6	17.8	34.0
1984	3345	0.239	20.5	16.1	19.3	17.4	33.5
1985	3669	0.254	20.6	16.2	19.4	17.5	33.7
1986	4350	0.283	21.4	16.9	20.2	18.3	34.4
1987	4134	0.278	21.6	16.9	20.7	18.4	34.5
1988	4559	0.298	21.2	16.5	20.4	18.1	34.9
1989	4435	0.307	20.9	16.3	20.1	17.8	35.2
1990	3805	0.302	20.7	16.1	20.2	17.7	35.6
1991	4049	0.322	21.3	16.4	20.7	18.1	36.0
1992	4064	0.334	20.8	16.1	20.4	17.8	36.2
1993	4754	0.360	21.0	16.1	20.7	17.9	36.6
1994	5572	0.398	20.8	16.0	20.4	17.7	36.7
1995	5749	0.380	20.5	15.8	20.2	17.5	36.9
1996	5254	0.400	20.8	16.0	20.7	17.8	37.8
1997	6117	0.423	20.6	15.8	20.4	17.6	38.3
1998	6477	0.448	20.9	16.0	20.8	17.8	38.3
1999	6839	0.450	20.5	15.7	20.3	17.5	38.6
2000	8012	0.475	20.5	15.7	20.3	17.5	38.6
2001	7902	0.468	20.3	15.6	20.0	17.3	39.2

Table 1, Continued

Fuel Economy Characteristics of 1975 to 2001 Light-Duty Vehicles

MODEL YEAR	SALES (000)	FRAC	<---- FUEL ECONOMY ----> LAB 55/45	ADJ CITY	ADJ HWY	ADJ 55/45	TON -MPG
Both							
1975	10224	1.000	15.3	12.0	14.6	13.1	26.9
1976	12334	1.000	16.7	13.2	15.7	14.2	29.3
1977	14123	1.000	17.7	14.0	16.6	15.1	30.4
1978	14448	1.000	18.6	14.7	17.5	15.8	29.9
1979	13882	1.000	18.7	14.9	17.4	15.9	29.5
1980	11306	1.000	22.5	17.6	21.5	19.2	31.2
1981	10554	1.000	24.1	18.8	23.0	20.5	33.1
1982	9732	1.000	24.7	19.2	23.9	21.1	34.1
1983	10302	1.000	24.6	19.0	23.9	21.0	34.5
1984	14020	1.000	24.6	19.1	24.0	21.0	34.7
1985	14460	1.000	25.0	19.3	24.4	21.3	35.3
1986	15365	1.000	25.7	19.9	25.1	21.9	35.8
1987	14865	1.000	25.9	20.0	25.5	22.1	35.9
1988	15295	1.000	25.9	19.9	25.5	22.1	36.6
1989	14453	1.000	25.4	19.5	25.2	21.7	36.7
1990	12615	1.000	25.2	19.3	25.1	21.5	37.1
1991	12573	1.000	25.4	19.4	25.3	21.7	37.2
1992	12172	1.000	24.9	18.9	25.0	21.3	37.6
1993	13211	1.000	25.1	19.1	25.2	21.4	38.0
1994	13986	1.000	24.6	18.7	24.7	21.0	38.2
1995	15145	1.000	24.7	18.8	25.0	21.1	38.6
1996	13144	1.000	24.8	18.7	25.1	21.2	39.0
1997	14451	1.000	24.5	18.6	24.8	20.9	39.2
1998	14441	1.000	24.5	18.5	24.9	20.9	39.5
1999	15215	1.000	24.1	18.3	24.4	20.6	39.7
2000	16866	1.000	24.0	18.2	24.2	20.5	39.8
2001	16890	1.000	23.9	18.2	24.1	20.4	40.3

Table 2

Vehicle Size and Design Characteristics of 1975 to 2001 Light Duty Vehicles

	<--------- Measured Characteristics							---------->	<-- Percent by -->		
MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	VOL CU-FT	WGHT LB	0-60 TIME	TOP SPD	HP/ WT	VEHICLE SIZE SMALL	MID	LARGE
Cars											
1975	8237	.806	13.5		4057	14.2	111	.0331	55.4	23.3	21.3
1976	9722	.788	14.9		4058	14.4	110	.0324	55.4	25.2	19.4
1977	11300	.800	15.6	110	3943	14.0	111	.0335	51.9	24.5	23.5
1978	11175	.773	16.9	109	3587	13.7	111	.0342	44.7	34.4	21.0
1979	10794	.778	17.2	108	3484	13.8	110	.0338	43.7	34.2	22.1
1980	9443	.835	20.0	104	3101	14.3	107	.0322	54.4	34.4	11.3
1981	8733	.827	21.4	106	3075	14.4	106	.0320	51.5	36.4	12.2
1982	7819	.803	22.2	106	3054	14.4	106	.0320	56.5	31.0	12.5
1983	8002	.777	22.1	108	3111	14.0	108	.0330	53.1	31.8	15.1
1984	10675	.761	22.4	107	3098	13.8	109	.0339	57.4	29.4	13.2
1985	10791	.746	23.0	108	3092	13.3	111	.0355	55.7	28.9	15.4
1986	11015	.717	23.8	107	3040	13.2	111	.0360	59.5	27.9	12.6
1987	10731	.722	24.0	106	3030	13.0	112	.0365	63.5	24.3	12.2
1988	10736	.702	24.4	107	3046	12.8	113	.0375	64.8	22.3	12.8
1989	10018	.693	24.0	107	3099	12.5	115	.0387	58.3	28.2	13.5
1990	8810	.698	23.7	107	3175	12.1	117	.0401	58.6	28.7	12.8
1991	8524	.678	23.9	106	3153	11.8	118	.0413	61.5	26.2	12.3
1992	8108	.666	23.6	108	3239	11.5	120	.0428	56.5	27.8	15.6
1993	8457	.640	24.1	108	3207	11.6	120	.0425	57.2	29.5	13.3
1994	8414	.602	24.0	108	3249	11.4	121	.0432	58.5	26.1	15.4
1995	9396	.620	24.2	108	3262	10.9	125	.0460	57.3	28.6	14.0
1996	7890	.600	24.2	108	3281	10.8	125	.0464	54.3	32.0	13.6
1997	8335	.577	24.3	108	3274	10.7	126	.0469	55.1	30.6	14.3
1998	7964	.552	24.4	108	3306	10.6	127	.0475	49.4	39.2	11.5
1999	8375	.550	24.1	109	3364	10.5	128	.0481	47.7	39.7	12.6
2000	8853	.525	24.2	109	3367	10.4	129	.0490	46.5	34.3	19.2
2001	8988	.532	24.2	110	3380	10.3	130	.0494	46.7	35.2	18.2

Table 2, Continued

Vehicle Size and Design Characteristics of 1975 to 2001 Light Duty Vehicles

	<------ Measured Characteristics					------->		<---------- Percent by					---------->
MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	WGHT LB	0-60 TIME	TOP SPD	HP/ WT	VEHICLE SIZE SMALL	MID	LARGE	VEHICLE TYPE PICKUP	VAN	SUV
Trucks													
1975	1987	.194	11.6	4072	13.6	114	.0349	10.9	24.2	64.9	67.6	23.0	9.4
1976	2612	.212	12.2	4154	13.8	113	.0340	9.0	20.3	70.7	71.4	19.2	9.3
1977	2823	.200	13.3	4135	13.3	115	.0356	11.1	20.3	68.5	71.8	18.2	10.0
1978	3273	.227	12.9	4151	13.4	114	.0351	10.9	22.7	66.3	69.3	19.1	11.6
1979	3088	.222	12.5	4251	14.3	111	.0325	15.2	19.5	65.3	71.5	15.6	13.0
1980	1863	.165	15.8	3868	14.5	108	.0313	28.4	17.6	54.0	77.1	13.0	9.9
1981	1821	.173	17.1	3805	14.6	108	.0311	23.2	19.1	57.7	79.1	13.5	7.5
1982	1914	.197	17.4	3805	14.5	109	.0317	21.1	31.0	47.9	75.3	16.2	8.5
1983	2300	.223	17.8	3763	14.5	108	.0313	16.6	45.9	37.6	70.8	16.6	12.6
1984	3345	.239	17.4	3782	14.7	108	.0310	19.5	46.4	34.1	61.1	20.2	18.7
1985	3669	.254	17.5	3795	14.1	110	.0326	19.2	48.5	32.3	56.6	23.3	20.0
1986	4350	.283	18.3	3737	14.0	110	.0330	23.5	48.5	28.0	58.2	24.0	17.8
1987	4134	.278	18.4	3712	13.3	113	.0351	19.9	59.6	20.6	51.9	26.9	21.1
1988	4559	.298	18.1	3841	12.9	115	.0366	15.0	57.2	27.8	53.9	24.8	21.2
1989	4435	.307	17.8	3921	12.8	116	.0372	13.9	58.9	27.2	50.3	28.8	20.9
1990	3805	.302	17.7	4005	12.6	117	.0377	13.4	57.1	29.6	48.2	33.2	18.6
1991	4049	.322	18.1	3948	12.6	117	.0379	11.4	67.2	21.4	47.4	25.5	27.0
1992	4064	.334	17.8	4055	12.5	118	.0382	10.4	64.0	25.6	45.3	30.0	24.7
1993	4754	.360	17.9	4073	12.1	120	.0398	8.8	65.3	25.9	42.1	30.3	27.6
1994	5572	.398	17.7	4129	12.0	121	.0402	9.8	62.5	27.7	46.5	25.0	28.5
1995	5749	.380	17.5	4184	12.0	121	.0401	8.6	63.5	27.9	39.5	28.9	31.6
1996	5254	.400	17.8	4224	11.5	124	.0423	6.5	67.1	26.4	37.2	26.8	36.0
1997	6117	.423	17.6	4344	11.4	126	.0429	10.1	52.5	37.3	39.3	20.7	40.0
1998	6477	.448	17.8	4282	11.2	126	.0435	8.9	58.7	32.4	37.3	23.0	39.8
1999	6839	.450	17.5	4412	11.0	128	.0446	7.7	55.8	36.5	37.2	21.4	41.4
2000	8012	.475	17.5	4397	11.0	128	.0448	11.1	51.9	37.0	36.2	20.9	42.9
2001	7902	.468	17.3	4510	10.6	131	.0465	7.0	52.3	40.7	35.7	19.9	44.3

Table 2, Continued

Vehicle Size and Design Characteristics of 1975 to 2001 Light Duty Vehicles

				<------- Measured Characteristics ------->				<-- Percent by -->		
MODEL YEAR	SALES (000)	FRAC	ADJ 55/45 MPG	WGHT LB	0-60 TIME	TOP SPD	HP/ WT	VEHICLE SIZE SMALL	MID	LARGE
Both Cars and Trucks										
1975	10224	1.000	13.1	4060	14.1	112	.0335	46.8	23.5	29.8
1976	12334	1.000	14.2	4079	14.3	111	.0328	45.6	24.2	30.3
1977	14123	1.000	15.1	3981	13.8	112	.0339	43.8	23.7	32.5
1978	14448	1.000	15.8	3715	13.6	112	.0344	37.0	31.7	31.2
1979	13882	1.000	15.9	3655	13.9	110	.0335	37.3	30.9	31.7
1980	11306	1.000	19.2	3227	14.3	107	.0320	50.1	31.6	18.3
1981	10554	1.000	20.5	3201	14.4	107	.0318	46.6	33.4	20.0
1982	9732	1.000	21.1	3201	14.4	107	.0320	49.6	31.0	19.5
1983	10302	1.000	21.0	3257	14.1	108	.0327	44.9	34.9	20.1
1984	14020	1.000	21.0	3261	14.0	109	.0332	48.4	33.4	18.2
1985	14460	1.000	21.3	3271	13.5	110	.0347	46.5	33.9	19.7
1986	15365	1.000	21.9	3237	13.4	111	.0351	49.3	33.7	17.0
1987	14865	1.000	22.1	3220	13.1	112	.0361	51.4	34.1	14.5
1988	15295	1.000	22.1	3283	12.8	114	.0372	50.0	32.7	17.3
1989	14453	1.000	21.7	3351	12.5	115	.0382	44.7	37.6	17.7
1990	12615	1.000	21.5	3426	12.2	117	.0394	44.9	37.2	17.8
1991	12573	1.000	21.7	3409	12.1	118	.0402	45.3	39.4	15.2
1992	12172	1.000	21.3	3512	11.8	120	.0413	41.1	39.9	19.0
1993	13211	1.000	21.4	3518	11.8	120	.0416	39.8	42.4	17.8
1994	13986	1.000	21.0	3600	11.7	121	.0420	39.1	40.6	20.3
1995	15145	1.000	21.1	3612	11.3	123	.0438	38.8	41.9	19.3
1996	13144	1.000	21.2	3658	11.1	125	.0447	35.2	46.0	18.7
1997	14451	1.000	20.9	3727	11.0	126	.0452	36.1	39.9	24.1
1998	14441	1.000	20.9	3744	10.9	126	.0457	31.2	47.9	20.8
1999	15215	1.000	20.6	3835	10.7	128	.0465	29.7	46.9	23.4
2000	16866	1.000	20.5	3856	10.7	129	.0470	29.7	42.7	27.6
2001	16890	1.000	20.4	3909	10.5	130	.0481	28.1	43.2	28.7

The distribution of MPG in any model year is of interest. In Figure 3, highlights of the distribution of MPG is shown since 1975. Since 1975, the distribution has both narrowed and widened. Now, 50% of the cars are within 4 MPG of each other, but the range of the best to the worst has increased from about 3:1 in 1975 to about 6:1 today. The range of light-truck MPG is narrower, as seen in Figure 4.

In absolute terms, the fuel economy difference between the least efficient and most efficient car increased from about 20 MPG in 1975 to nearly 40 MPG a decade later in 1985 and is now, with the introduction for sale of the Honda Insight gasoline-electric hybrid vehicle, more than 50 MPG.

The overall MPG distribution trend for trucks is very similar to that for cars, except that there is a peak in the efficiency of the most efficient truck in the early 1980s when small pickup trucks equipped with Diesel engines were being sold. As a result, the fuel economy range between the most efficient and least efficient truck has narrowed from about 30 MPG in 1983 to about 15 MPG this year. Half of the trucks built each year since 1991 have been within about 4 MPG of each year's average fuel economy value.

Considering the trends in the fuel economy of cars, light trucks, and the combined fleet, it is usually the case that the combined 55/45 MPG value is considered. In addition to the city fraction, the relationship between the highway MPG and the city MPG influences the result of the calculation. The trend in the ratio of highway MPG to city MPG is shown on Figure 5. In the mid 1970s, the value was about 1.4. Currently, it is about 1.7 for light trucks and 1.9 for cars using laboratory data, with the trend line for each being relatively flat for the past 6 or 7 years. The overall influence since 1975 has tended toward improved 55/45 MPG, since the highway MPG values have gone up slightly or remained about the same.

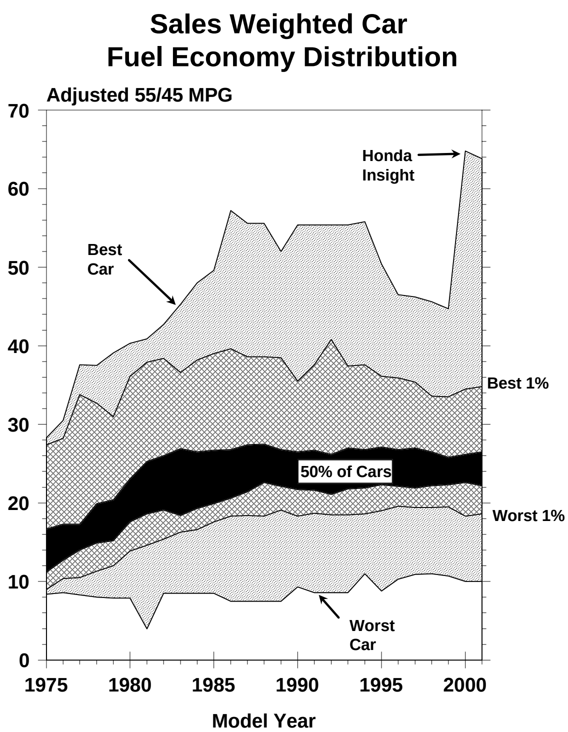


Figure 3

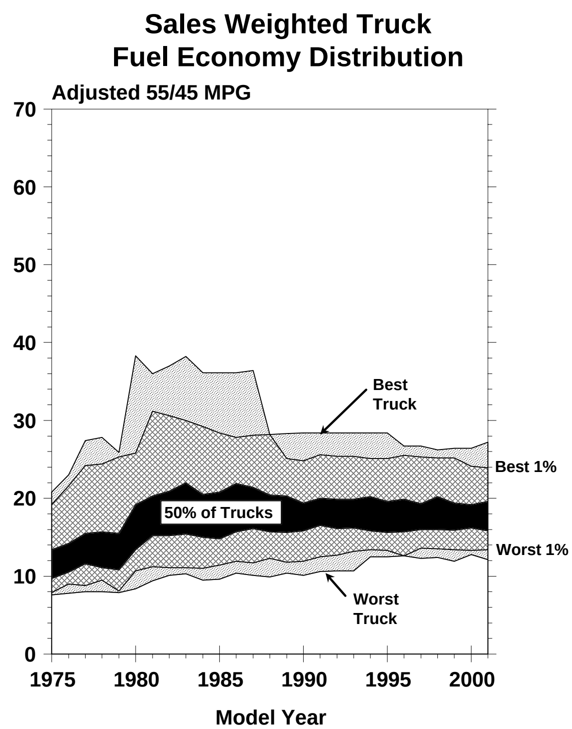


Figure 4

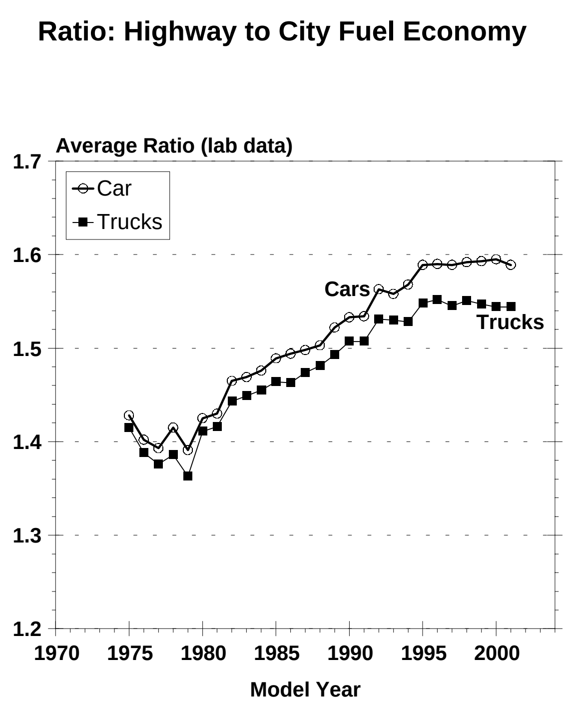


Figure 5

III. Trends by Vehicle Type and Size Class

Figure 1 and Table 1 show that trucks are expected to account for over 46% of the light-duty vehicles produced during model year 2001. In the next series of figures and tables, cars and light trucks are classified into five vehicle types: cars (i.e., coupes, sedans, and hatchbacks), station wagons, vans, sports utility vehicles (SUVs), and pickup trucks; and three vehicle sizes: small, midsize, and large. Note that vehicles have not been produced recently in the Small Van and Large Wagon classes. Appendixes F and G contains a series of tables describing light-duty vehicles at the vehicle size/type level of stratification.

In some of the tables and figures, only four classes are used. In these cases, the wagons are merged with the cars. This is because the wagon class for some instances is so small that the information is better represented by combining the car and the wagon classes.

Table 3 compares sales fractions by vehicle type and size for model years 1975, 1988, and 2001. Since 1975, the largest increases in sales fraction on this basis have been for midsize SUVs and midsize vans. These two truck-size classes are expected to account for almost 20% of the vehicles built this year, compared to a combined total of about 4% and 10% in 1975 and 1988, respectively. Conversely, the largest sales fraction decrease has occurred for small cars which accounted for 40% of all light-duty vehicles produced in both 1975 and nearly 44% in 1988. While their sales fraction has consistently remained the largest of the 15 vehicle sizes and types, it has since decreased to about 24% and thus is a little more than half what it was in 1975.

An overall decrease has occurred for large cars which accounted for about 15% of total light-duty sales in 1975 when they ranked third. Between then and 1988, their sales fraction dropped almost in half but has increased this year.

Considering the five classes: cars, wagons, SUVs, vans, and pickups, since 1975 the biggest increase has been for SUVs, up from less than 2% of the market to over 20%, and the biggest decrease for cars, down from over 70% to less than 50%. Cars and wagons together have lost roughly the same market share that vans and SUVs together have gained.

Table 3

Sales Fractions of MY1975, MY1988 and MY2001
Light-Duty Vehicles by Vehicle Size and Type

Vehicle Type	Size	Sales Fraction 1975	Sales Fraction 1988	Sales Fraction 2001	Difference in Sales Fraction From 1975 To 2001	Difference in Sales Fraction From 1975 To 1988	Difference in Sales Fraction From 1988 To 2001
Car	Small	40.0%	43.8%	23.8%	-16.2%	3.9%	-20.1%
	Midsize	16.0%	13.8%	15.9%	-0.1%	-2.1%	2.1%
	Large	15.2%	8.5%	9.7%	-5.5%	-6.7%	1.1%
	All	71.2%	66.2%	49.3%	-21.8%	-5.0%	-16.9%
Wagon	Small	4.7%	1.7%	1.1%	-3.6%	-3.0%	-0.6%
	Midsize	2.8%	1.9%	2.8%	-0.0%	-1.0%	1.0%
	Large	1.9%	0.5%	0.0%	-1.9%	-1.4%	-0.5%
	All	9.4%	4.0%	3.9%	-5.5%	-5.4%	-0.1%
Van	Small	0.0%	0.4%	0.0%	-0.0%	0.3%	-0.4%
	Midsize	3.0%	6.2%	8.1%	5.2%	3.2%	2.0%
	Large	1.5%	0.9%	1.2%	-0.3%	-0.6%	0.3%
	All	4.5%	7.4%	9.3%	4.9%	2.9%	1.9%
SUV	Small	0.5%	1.9%	2.0%	1.5%	1.4%	0.2%
	Midsize	1.2%	4.0%	11.6%	10.4%	2.8%	7.6%
	Large	0.1%	0.5%	7.1%	7.0%	0.3%	6.6%
	All	1.8%	6.3%	20.7%	18.9%	4.5%	14.4%
Pickup	Small	1.6%	2.2%	1.2%	-0.3%	0.7%	-1.0%
	Midsize	0.5%	6.9%	4.7%	4.2%	6.4%	-2.2%
	Large	11.0%	7.0%	10.7%	-0.3%	-4.1%	3.8%
	All	13.1%	16.1%	16.7%	3.6%	3.0%	0.6%
All Trucks		19.4%	29.8%	46.8%	27.4%	10.4%	17.0%

Table 4

Worst, Average, and Best Fuel Adjusted Economy by Vehicle Type and Size

Vehicle Type	Size	1975 Worst	1975 Avg.	1975 Best	1988 Worst	1988 Avg.	1988 Best	2001 Worst	2001 Avg.	2001 Best
Car	Small	8.6	15.6	28.3	7.5	26.0	55.6	10.0	26.3	63.8
	Midsize	8.6	11.6	18.4	10.6	22.8	28.0	12.8	23.3	28.5
	Large	8.4	11.2	14.6	10.1	20.7	26.3	12.8	21.7	25.1
	All	8.4	13.4	28.3	7.5	24.5	55.6	10.0	24.3	63.8
Wagon	Small	11.8	19.1	24.1	17.3	26.6	33.7	17.5	22.7	30.9
	Midsize	8.4	11.3	25.0	17.7	22.4	28.0	15.8	24.4	31.3
	Large	8.4	10.2	12.8	19.4	19.5	19.6	---	---	---
	All	8.4	13.8	25.0	17.3	23.6	33.7	15.8	23.9	31.3
Van	Small	16.2	17.5	18.5	15.7	20.8	25.3	---	---	---
	Midsize	8.2	11.3	18.4	11.4	18.6	23.7	16.3	20.1	21.7
	Large	8.9	10.7	14.5	10.0	14.4	17.0	12.8	15.5	17.5
	All	8.2	11.1	18.5	10.0	18.0	25.3	12.8	19.3	21.7
SUV	Small	10.2	13.7	16.3	15.8	20.6	28.2	16.0	20.5	27.2
	Midsize	8.2	10.2	18.4	10.3	16.6	23.9	12.1	18.1	25.4
	Large	7.9	10.3	13.7	12.3	14.2	19.0	13.1	15.2	18.5
	All	7.9	11.0	18.4	10.3	17.4	28.2	12.1	17.2	27.2
Pickup	Small	13.0	19.2	20.8	13.5	21.2	24.9	16.0	19.3	23.9
	Midsize	17.8	17.9	18.0	15.5	21.5	26.2	13.8	17.4	23.6
	Large	7.6	11.1	18.5	9.9	15.4	21.2	12.3	15.9	18.7
	All	7.6	11.9	20.8	9.9	18.3	26.2	12.3	16.5	23.9
All	Cars	8.4	13.5	28.3	7.5	24.4	55.6	10.0	24.2	63.8
All	Trucks	7.6	11.6	20.8	9.9	18.1	28.2	12.1	17.3	27.2
All	Vehicles	7.6	13.1	28.3	7.5	22.1	55.6	10.0	20.4	63.8

Table 4 shows the average, worst, and best adjusted MPG performance in the five classes for the three selected years. Improvements in nearly every class are seen from 1975 to 1988. For 2001, the MPG performance is such that the large vehicles in some categories have better fuel economy than the corresponding entry for small vehicles in 1975.

In Table 5, the percentage changes obtainable from the entries in Table 4 are presented. Midsize cars and wagons have improved over 100%. Overall, the across-the-board improvements in MPG seen in Table 4 are reproduced here.

Table 5

Percent Change in Worst, Average, and Best Adjusted Fuel Economy by Vehicle Type and Size

Vehicle Type	Size	From 1975 to 2001			From 1975 to 1988			From 1988 to 2001		
		Worst	Avg.	Best	Worst	Avg.	Best	Worst	Avg.	Best
Car	Small	16%	69%	125%	-13%	67%	96%	33%	1%	15%
	Midsize	49%	101%	55%	23%	97%	106%	21%	2%	2%
	Large	52%	94%	72%	20%	85%	101%	27%	5%	-5%
	All	19%	81%	125%	-11%	83%	96%	33%	-1%	15%
Wagon	Small	48%	19%	28%	47%	39%	40%	1%	-15%	-8%
	Midsize	88%	116%	25%	111%	98%	12%	-11%	9%	12%
	Large	---	---	---	131%	91%	53%	---	---	---
	All	88%	73%	25%	106%	71%	35%	-9%	1%	-7%
Van	Small	---	---	---	-3%	19%	37%	---	---	---
	Midsize	99%	78%	18%	39%	65%	29%	43%	8%	-8%
	Large	44%	45%	21%	12%	35%	17%	28%	8%	3%
	All	56%	74%	17%	22%	62%	37%	28%	7%	-14%
SUV	Small	57%	50%	67%	55%	50%	73%	1%	-0%	-4%
	Midsize	48%	77%	38%	26%	63%	30%	17%	9%	6%
	Large	66%	48%	35%	56%	38%	39%	7%	7%	-3%
	All	53%	56%	48%	30%	58%	53%	17%	-1%	-4%
Pickup	Small	23%	1%	15%	4%	10%	20%	19%	-9%	-4%
	Midsize	-22%	-3%	31%	-13%	20%	46%	-11%	-19%	-10%
	Large	62%	43%	1%	30%	39%	15%	24%	3%	-12%
	All	62%	39%	15%	30%	54%	26%	24%	-10%	-9%
All	Cars	19%	79%	125%	-11%	81%	96%	33%	-1%	15%
All	Trucks	59%	49%	31%	30%	56%	36%	22%	-4%	-4%
All	Vehicles	32%	56%	125%	-1%	69%	96%	33%	-8%	15%

Figure 6 depicts the sales fraction trends shown in the previous tables. The rise in the sales fraction of the SUV and van classes is clearly shown as is the decline in the car class and the nearly constant market share of the pickup class.

Figures 7 through 10 show trends in performance, weight, and adjusted fuel economy for cars, vans, SUVs, and pickups. All show increasing weight and increased performance over roughly the last two decades. The fuel economy picture is mixed, vans increasing, cars and SUVs about constant, and pickups decreasing during the same time period.

Figure 11 shows the four classes compared on a ton-MPG basis. In this measure of efficiency, cars and vans are about the same and better than SUVs which are like pickups.

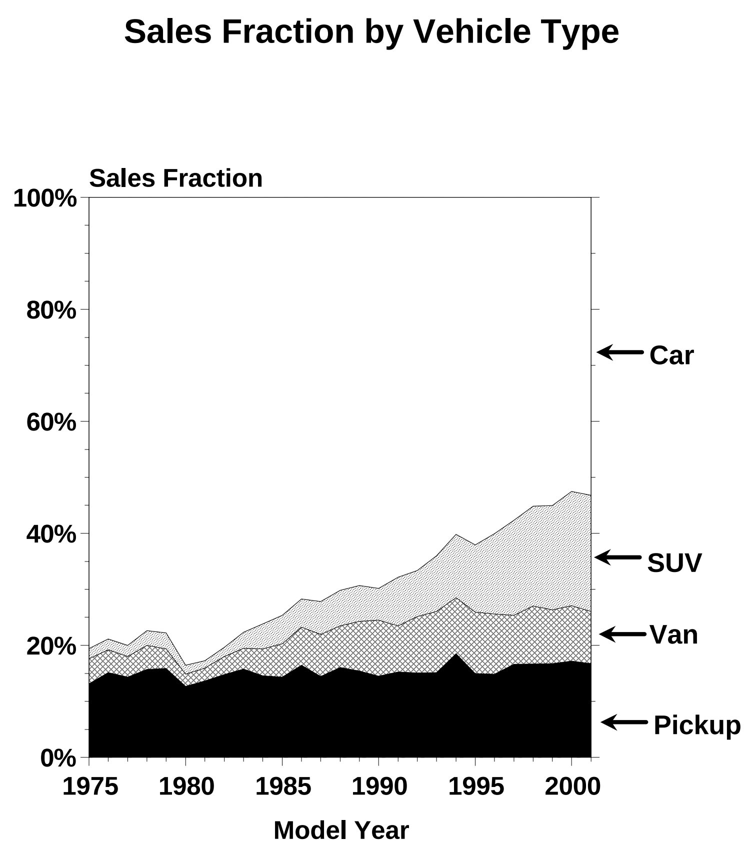


Figure 6

Fuel Economy and Performance
Cars

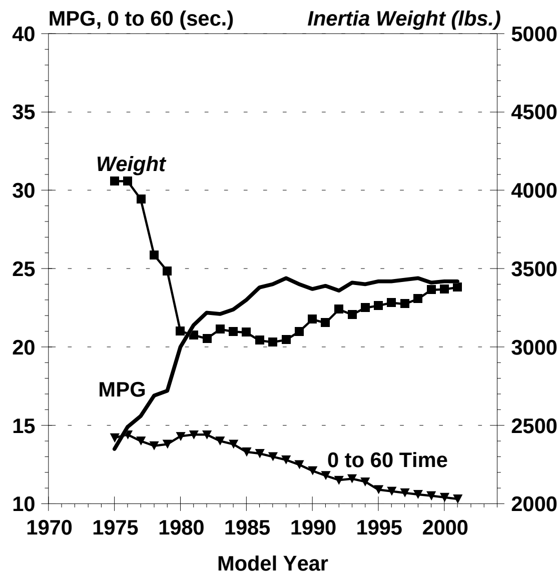


Figure 7

Fuel Economy and Performance
Vans

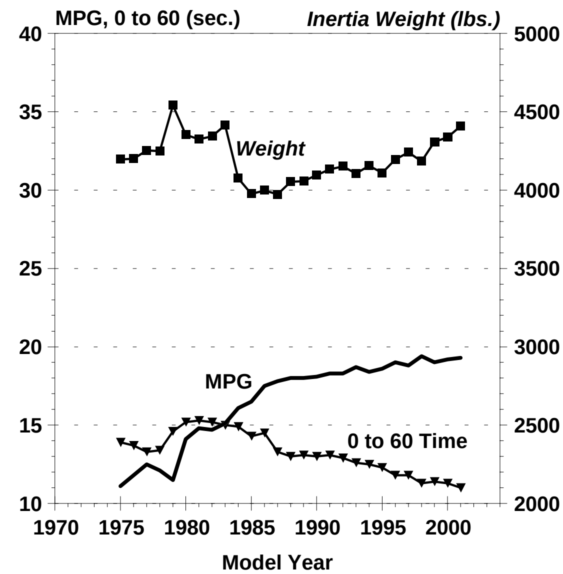


Figure 8

Fuel Economy and Performance
SUVs

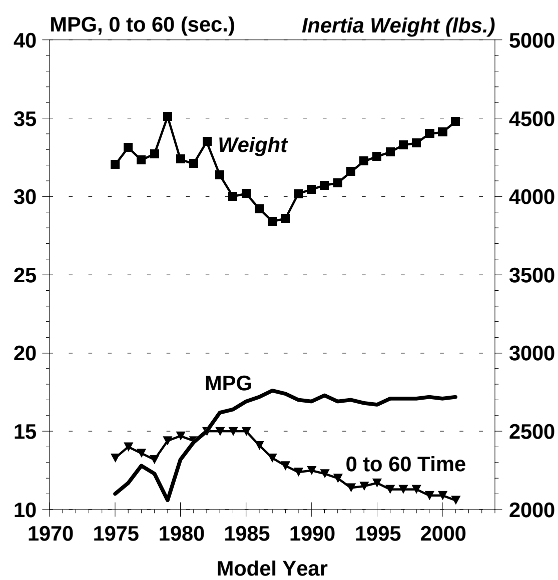


Figure 9

MPG and Performance
Pickups

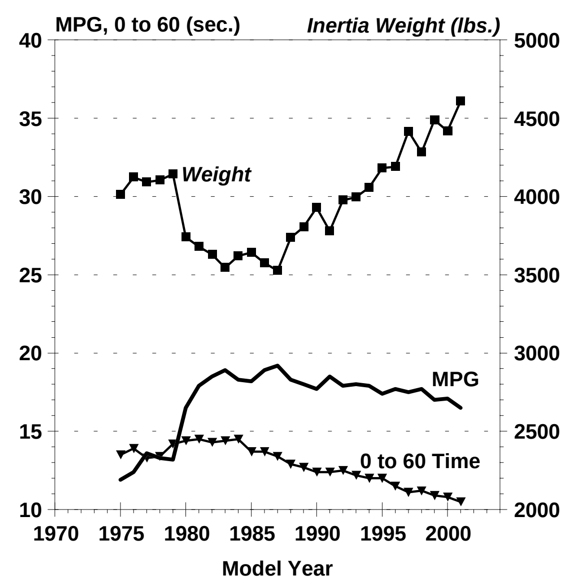


Figure 10

Ton-MPG by Model Year

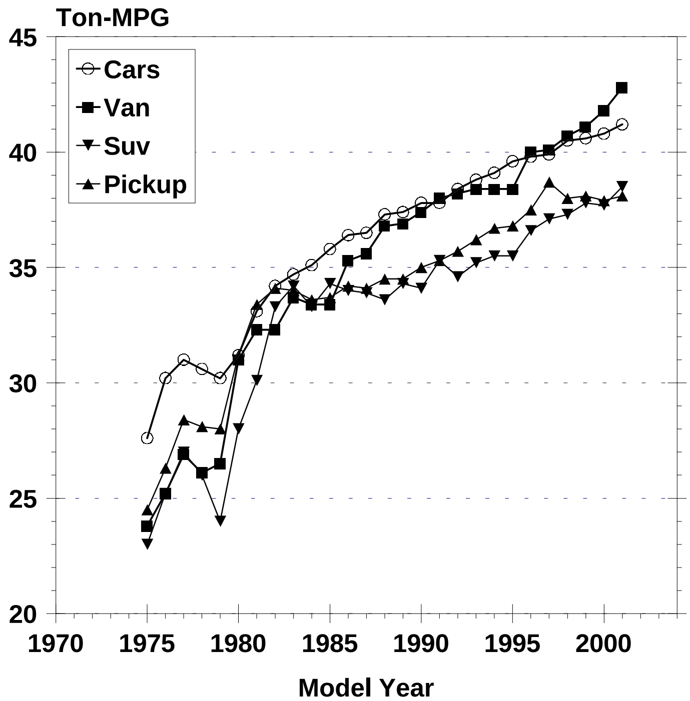


Figure 11

Another way to look at the performance of different types of vehicles is by a classification other than size: weight, for example. In Figures 12 through 15, the four classes of vehicles are shown by weight class. Model years 1975 and 2001 are shown. The graphs all show the same trends with weight—that as weight increases, MPG tends to decrease. Some of the trends may look flat because the scales for all four graphs are the same and are influenced by the high MPG of the 2000-lb weight class for 2001.

Figures 16 through 19 provide an indication of the market share of different weight vehicles within the different classes. Trends within classes are shown which underlie the increasing weight shown by the classes as a whole.

MPG vs Inertia Weight Class
Cars

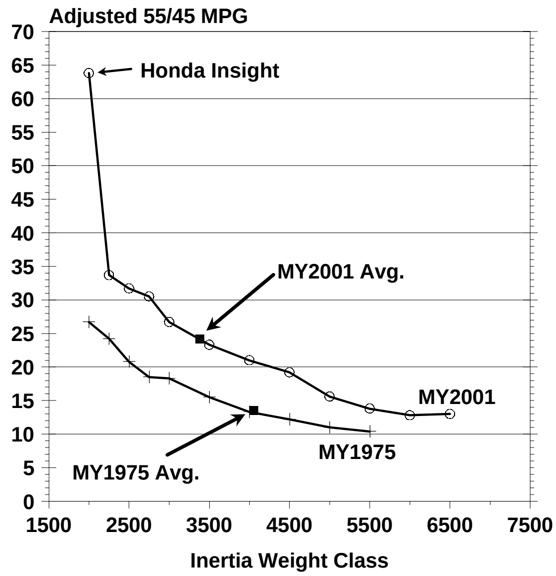


Figure 12

Fuel Economy vs Inertia Weight Class
Vans

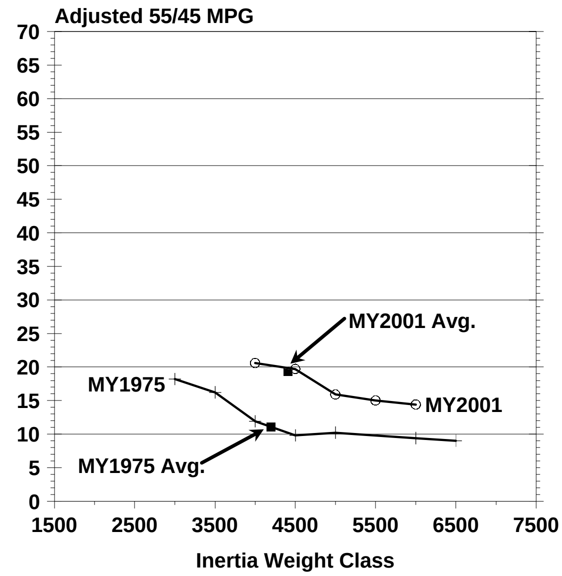


Figure 13

Fuel Economy vs Inertia Weight Class
SUVs

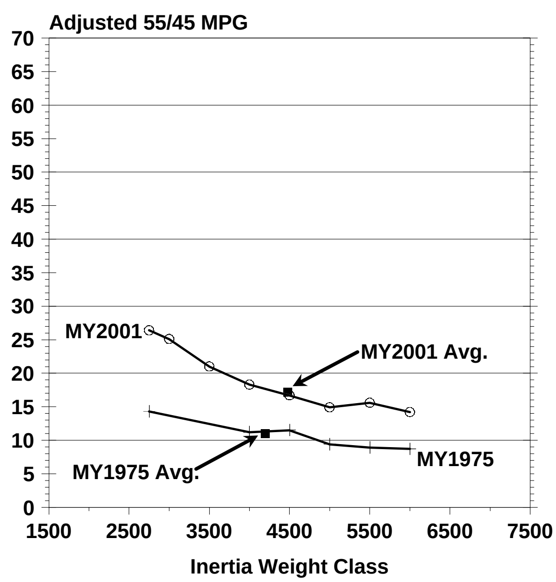


Figure 14

Fuel Economy vs Inertia Weight Class
Pickups

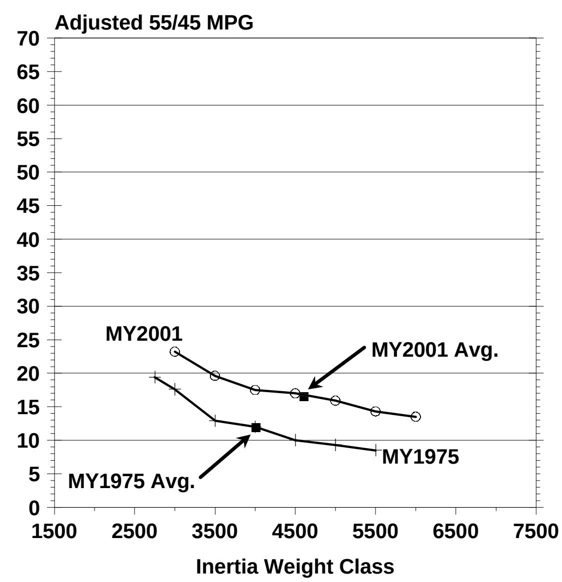


Figure 15

Sales Fraction by Inertia Weight Class
Cars

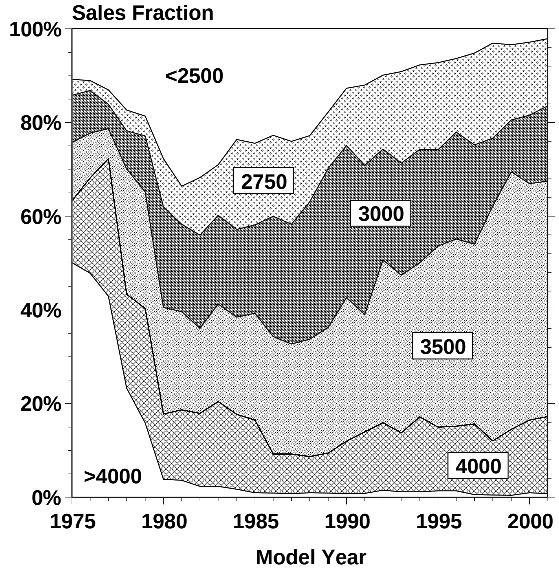


Figure 16

Sales Fraction by Inertia Weight Class
Vans

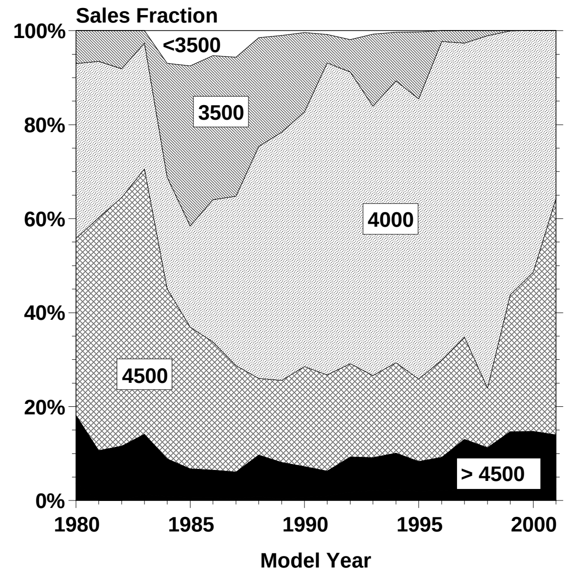


Figure 17

Sales Fraction by Inertia Weight Class
SUVs

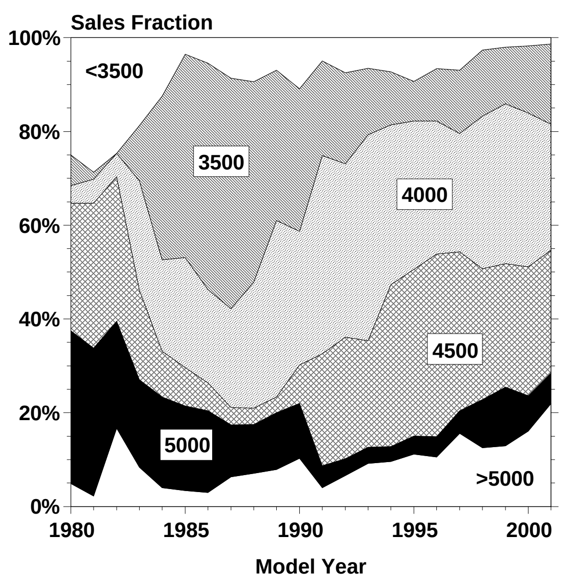


Figure 18

Sales Fraction by Inertia Weight Class
Pickups

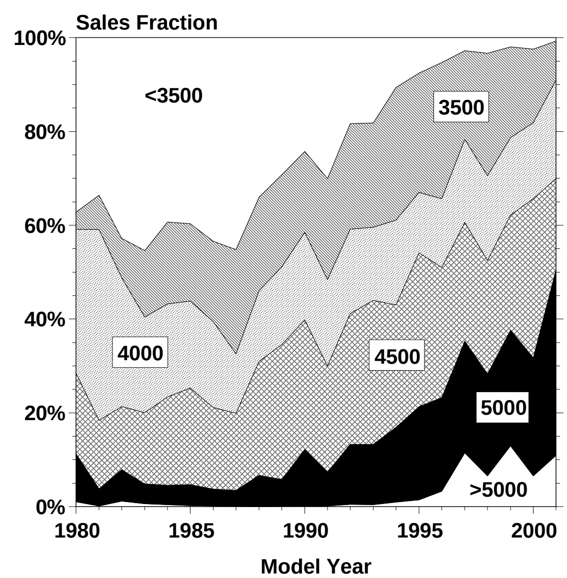


Figure 19

IV. Marketing Groups

Past reports in this series have reported on fuel economy trends in terms of the whole fleet of cars and light trucks and in various subcategories of interest, e.g., by weight class, by size class, etc. In addition, there has been a treatment of trends by groups of manufacturers. Initially, these groups were derived from the "Domestic" and "Import" categories which are part of the automobile fuel economy standards categories. This classification approach evolved into a market segment approach in which vehicles were apportioned to a "Domestic," "European," and "Asian" category.

In this report, the trends by groups of manufacturers have been changed to reflect the transnational and transregional nature of the automobile industry. As the industry transitions to one in which there are a smaller number of independent companies, we begin to reflect trends by "Marketing Group." The General Motors Group (GMG) includes GM (which has always included Opel), Suzuki, Saab, Isuzu, and Subaru. The Ford Motor Group (FMG) includes Ford, Jaguar, Volvo, Land Rover, and Mazda. The Daimler Chrysler Group (DCG) includes Chrysler, Mercedes Benz, and Mitsubishi.

The balance of the fleet is comprised of Toyota/Lexus and Honda/Acura, with the rest of the market comprised of all others: "Other." Table 6 and Table 7 provide fuel economy values for the marketing groups described above for model years 2000 and 2001. The "Other" group totals about 10% to 11% of the market.

Table 8 and Table 9 show fuel economy values by marketing group and vehicle class for model year 2000 using the Adjusted MPG (Table 8) and Laboratory MPG (Table 9). Table 10 and Table 11 present the same information for model year 2001.*

The data in tables for 2000 and 2001 can be used to investigate year-to-year changes in fuel economy between different classes and marketing groups.

As we discussed in last year's report, Ford has announced that they intend to improve the fuel economy of all their SUVs by 25% in five years. Considering the data in Table 8 through Table 11, it can be seen that the fuel economy for the FMG SUV class has improved between 2000 and 2001, although it should be noted that the +25% commitment by Ford may include vehicles heavier than the heaviest SUVs contained in the data base that was used to prepare this report.

*As explained in Appendix A, the laboratory fuel economy values in this report are lower than those reported by the Department of Transportation.

Table 6

Model Year 2000 Unadjusted (Laboratory) 55/45 Fuel Economy by Marketing Group

Group	Group Member Added	Cars	Trucks	Both
GM	GM	28.1	20.6	24.3
	Above plus Subaru	28.1	20.8	24.4
	Above plus Isuzu	----	20.7	24.3
	Above plus Suzuki	28.1	20.8	24.3
	Above plus Saab	28.1	----	24.3
	Entire GM Group	28.1	20.8	24.3
Ford	Ford	26.8	19.9	22.2
	Above plus Mazda	27.1	20.0	22.5
	Above plus Volvo	27.0	----	22.6
	Above plus Jaguar	26.9	----	22.6
	Above plus Land Rover	----	20.0	22.5
	Entire Ford Group	26.9	20.0	22.5
DC	Chrysler	27.3	19.8	21.2
	Above plus Mitsubishi	27.7	19.8	21.6
	Above plus Mercedes	27.2	19.8	21.8
	Entire DC Group	27.2	19.8	21.8
Toyota	Toyota	30.8	22.3	26.8
Honda	Honda	31.1	25.0	29.4
Others	Ten Others	28.4	21.0	26.2
All	Fleet Average	28.3	20.5	24.0

Table 7

Model Year 2001 Unadjusted (Laboratory) 55/45 Fuel Economy by Marketing Group

Group	Group Member Added	Cars	Trucks	Both
GM	GM	28.1	19.9	23.6
	Above plus Subaru	28.1	20.1	23.7
	Above plus Isuzu	----	20.1	23.6
	Above plus Suzuki	28.1	20.1	23.7
	Above plus Saab	28.1	----	23.7
	Entire GM Group	28.1	20.1	23.7
Ford	Ford	26.7	19.8	22.2
	Above plus Mazda	27.0	19.9	22.5
	Above plus Volvo	27.0	----	22.6
	Above plus Jaguar	26.9	----	22.6
	Above plus Land Rover	----	19.9	22.5
	Entire Ford Group	26.9	19.9	22.5
DC	Chrysler	26.7	19.6	21.4
	Above plus Mitsubishi	27.3	19.6	21.9
	Above plus Mercedes	27.0	19.7	22.1
	Entire DC Group	27.0	19.7	22.1
Toyota	Toyota	31.4	21.9	26.5
Honda	Honda	31.8	24.7	29.7
Others	Ten Others	28.3	21.3	26.4
All	Fleet Average	28.3	20.3	23.9

Table 8

Model Year 2000 In-Use Adjusted 55/45 Fuel Economy by Marketing Group

VEHICLE TYPE	SIZE	GM GROUP	Ford GROUP	DC GROUP	Toyota	Honda	Others	All
Cars	Small	25.7	25.3	25.0	29.0	30.3	25.2	26.1
Cars	Midsize	23.2	21.8	22.7	24.5	24.2	22.6	23.3
Cars	Large	22.5	21.2	21.8	24.1	---	19.1	21.8
Cars	All	24.0	22.9	23.3	26.3	26.5	24.4	24.2
Wagons	Small	27.6	23.9	---	---	---	22.9	24.7
Wagons	Midsize	23.7	24.1	22.4	---	---	21.7	23.7
Wagons	Large	---	---	---	---	---	---	---
Wagons	All	24.7	24.1	22.4	---	---	22.5	23.9
All Cars	Small	25.8	25.3	25.0	29.0	30.3	25.1	26.1
All Cars	Midsize	23.2	22.5	22.7	24.5	24.2	22.5	23.3
All Cars	Large	22.5	21.2	21.8	24.1	---	19.1	21.8
All Cars	All	24.0	23.0	23.3	26.3	26.5	24.3	24.2
Vans	Small	---	---	---	---	---	---	---
Vans	Midsize	19.7	19.3	20.6	20.5	20.6	19.5	20.1
Vans	Large	15.6	15.8	14.8	---	---	16.7	15.5
Vans	All	18.6	18.3	19.9	20.5	20.6	19.4	19.2
SUVs	Small	22.3	---	17.0	24.6	---	18.3	18.8
SUVs	Midsize	17.4	17.1	17.5	19.2	22.1	16.5	17.8
SUVs	Large	14.6	14.8	15.2	14.6	---	15.0	14.9
SUVs	All	17.0	16.1	16.8	19.1	22.1	17.4	17.1
Pickups	Small	---	---	---	20.5	---	18.5	19.5
Pickups	Midsize	20.5	19.0	16.6	---	---	---	18.9
Pickups	Large	17.1	16.6	14.4	15.9	---	---	16.2
Pickups	All	18.2	17.3	15.0	18.4	---	18.5	17.1
Trucks	All	17.7	17.0	16.9	19.1	21.4	17.9	17.5
All	All	20.8	19.3	18.6	22.9	25.1	22.4	20.5

Table 9

Model Year 2000 Laboratory 55/45 Fuel Economy by Marketing Group

VEHICLE TYPE/SIZE		GM GROUP	Ford GROUP	DC GROUP	Toyota	Honda	Others	All
Cars	Small	30.1	29.6	29.2	34.0	35.6	29.5	30.6
Cars	Midsize	27.0	25.5	26.6	28.7	28.4	26.4	27.2
Cars	Large	26.2	24.7	25.5	28.1	---	22.3	25.5
Cars	All	28.0	26.8	27.2	30.8	31.1	28.5	28.3
Wagons	Small	32.3	28.0	---	---	---	26.8	28.8
Wagons	Midsize	27.8	28.2	26.2	---	---	25.3	27.7
Wagons	Large	---	---	---	---	---	---	---
Wagons	All	28.9	28.2	26.2	---	---	26.2	28.0
All Cars	Small	30.1	29.6	29.2	34.0	35.6	29.4	30.5
All Cars	Midsize	27.1	26.3	26.6	28.7	28.4	26.3	27.2
All Cars	Large	26.2	24.7	25.5	28.1	---	22.3	25.5
All Cars	All	28.1	26.9	27.2	30.8	31.1	28.4	28.3
Vans	Small	---	---	---	---	---	---	---
Vans	Midsize	23.1	22.6	24.1	24.0	24.0	22.8	23.5
Vans	Large	18.3	18.5	17.4	---	---	19.6	18.2
Vans	All	21.8	21.4	23.2	24.0	24.0	22.7	22.5
SUVs	Small	26.3	---	20.0	28.9	---	21.5	22.1
SUVs	Midsize	20.4	20.0	20.5	22.6	26.0	19.4	20.9
SUVs	Large	17.2	17.4	17.8	17.1	---	17.5	17.4
SUVs	All	20.0	18.9	19.7	22.5	26.0	20.5	20.0
Pickups	Small	---	---	---	24.1	---	21.7	23.0
Pickups	Midsize	24.0	22.3	19.4	---	---	---	22.2
Pickups	Large	20.0	19.5	16.8	18.7	---	---	18.9
Pickups	All	21.3	20.3	17.5	21.6	---	21.7	20.1
Trucks	All	20.8	20.0	19.8	22.4	25.0	21.0	20.5
All	All	24.3	22.5	21.8	26.8	29.4	26.2	24.0

Table 10

Model Year 2001 In-use Adjusted 55/45 Fuel Economy by Marketing Group

VEHICLE TYPE/SIZE		GM GROUP	Ford GROUP	DC GROUP	Toyota	Honda	Others	All
Cars	Small	26.0	25.1	24.5	29.5	31.7	25.3	26.3
Cars	Midsize	23.1	21.7	23.1	25.2	24.3	22.0	23.3
Cars	Large	22.6	20.8	21.7	23.3	---	19.2	21.7
Cars	All	24.1	22.6	23.2	26.8	27.2	24.3	24.3
Wagons	Small	27.5	25.7	21.9	---	---	22.3	22.7
Wagons	Midsize	23.5	24.9	22.3	---	---	21.4	24.4
Wagons	Large	---	---	---	---	---	---	---
Wagons	All	24.3	24.9	21.9	---	---	21.8	23.9
All Cars	Small	26.0	25.1	23.9	29.5	31.7	25.2	26.1
All Cars	Midsize	23.1	23.5	23.0	25.2	24.3	22.0	23.4
All Cars	Large	22.6	20.8	21.7	23.3	---	19.2	21.7
All Cars	All	24.1	23.0	23.1	26.8	27.2	24.2	24.2
Vans	Small	---	---	---	---	---	---	---
Vans	Midsize	20.0	19.8	20.1	21.1	20.5	19.1	20.1
Vans	Large	15.4	16.2	14.9	---	---	---	15.5
Vans	All	18.9	19.0	19.5	21.1	20.5	19.1	19.3
SUVs	Small	21.7	---	17.0	25.2	---	19.9	20.5
SUVs	Midsize	17.7	18.1	17.2	19.0	21.4	17.7	18.1
SUVs	Large	15.0	15.4	15.3	14.6	---	16.6	15.2
SUVs	All	16.9	16.5	16.6	18.5	21.4	18.0	17.2
Pickups	Small	---	---	---	19.7	---	18.3	19.3
Pickups	Midsize	17.6	17.9	16.3	---	---	---	17.4
Pickups	Large	16.4	16.3	14.4	15.7	---	---	15.9
Pickups	All	16.7	16.8	15.0	17.9	---	18.3	16.5
Trucks	All	17.2	17.0	16.8	18.6	21.0	18.2	17.3
All	All	20.2	19.2	18.8	22.6	25.3	22.5	20.4

Table 11

Model Year 2001 Laboratory 55/45 Fuel Economy by Marketing Group

VEHICLE TYPE/SIZE		GM GROUP	Ford GROUP	DC GROUP	Toyota	Honda	Others	All
Cars	Small	30.3	29.3	28.7	34.6	37.2	29.6	30.8
Cars	Midsize	27.0	25.4	26.9	29.4	28.4	25.8	27.2
Cars	Large	26.3	24.3	25.3	27.3	---	22.5	25.3
Cars	All	28.1	26.4	27.1	31.4	31.8	28.4	28.4
Wagons	Small	32.2	30.0	25.6	---	---	26.0	26.6
Wagons	Midsize	27.5	29.1	26.1	---	---	25.0	28.5
Wagons	Large	---	---	---	---	---	---	---
Wagons	All	28.5	29.1	25.6	---	---	25.5	28.0
All Cars	Small	30.4	29.3	28.0	34.6	37.2	29.5	30.6
All Cars	Midsize	27.0	27.5	26.9	29.4	28.4	25.7	27.4
All Cars	Large	26.3	24.3	25.3	27.3	---	22.5	25.3
All Cars	All	28.1	26.9	27.0	31.4	31.8	28.3	28.3
Vans	Small	---	---	---	---	---	---	---
Vans	Midsize	23.4	23.2	23.5	24.7	23.9	22.4	23.5
Vans	Large	18.1	18.9	17.4	---	---	---	18.2
Vans	All	22.1	22.2	22.8	24.7	23.9	22.4	22.6
SUVs	Small	25.5	---	20.0	29.6	---	23.4	24.1
SUVs	Midsize	20.8	21.2	20.2	22.3	25.2	20.8	21.2
SUVs	Large	17.6	18.1	17.9	17.1	---	19.5	17.8
SUVs	All	19.8	19.4	19.5	21.7	25.2	21.2	20.1
Pickups	Small	---	---	---	23.2	---	21.5	22.6
Pickups	Midsize	20.6	21.0	19.0	---	---	---	20.4
Pickups	Large	19.2	19.1	16.8	18.4	----	---	18.7
Pickups	All	19.6	19.7	17.5	21.0	---	21.5	19.4
Trucks	All	20.1	19.9	19.7	21.8	24.7	21.3	20.3
All	All	23.7	22.5	22.1	26.5	29.7	26.4	23.9

V. Technology Trends

Table 12 compares technology usage for MY2001 by vehicle type and size. For this table, the car classes remain 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 small vans and large wagons are not represented in this table, because none have been produced since 1996.

Front-wheel drive is used heavily in all of the car and wagon size classes, and nearly 90% of midsize vans now use it. By comparison, none of this year's pickups will have front-wheel drive, and very little use of it is found in large vans or any of the SUVs. Conversely, four-wheel drive is used heavily in SUVs, pickups, and wagons, but very little use of it is made in vans and cars.

Large vehicles make greater use of automatic/lockup transmissions than their midsize or small counterparts. The opposite holds for usage of four-valve engines, with small and midsize vehicles making greater use of this technology than large ones.

Additional tabulations of different technology types can be found in the Appendixes.

Table 12

MY2001 Technology Usage by Vehicle Type and Size
(Percent of Vehicle Type/Size Strata)

	Vehicle	Vehicle Type				
Variable	Size	Car	Wagon	Van	SUV	Pickup
Front Wheel Drive	Small	85	82	--	8	0
	Midsize	93	76	88	11	0
	Large	79	--	0	0	0
Four Wheel Drive	Small	1	14	--	77	45
	Midsize	1	23	4	68	42
	Large	0	--	0	63	52
Manual Transmission	Small	26	20	--	36	42
	Midsize	5	12	0	7	18
	Large	0	--	0	0	7
Four Valves Per Cylinder	Small	66	91	--	77	79
	Midsize	66	68	21	47	0
	Large	39	--	0	9	6

Figures 20 through 23 show trends in drive use for the four classes. Cars used to be all rear-wheel drive (RWD), now they are 80% front-wheel drive (FWD) with a small four-wheel drive (4WD) fraction, and the trend is flat. Vans are roughly the same, although the trends at the introduction of FWD are sharper than they were for cars. SUVs are mostly 4WD; with the beginning of a trend toward FWD just showing up recently. Pickups remain the bastion of RWD with the increasing amount of 4WD the only other drive option.

Two important changes in transmission design have occurred: the addition of a gear for both automatic and manual transmissions and, for the automatics, conversion to lockup (L3, L4, or L5) torque converter transmissions. Figures 24 to 27 indicate that the L4 transmission is currently the predominant transmission type for cars, vans, SUVs, and pickup trucks. Where manual transmissions are used, the 5-speed (M5) transmission now predominates. The increasing trend in ton-MPG discussed earlier can be attributed to better vehicle design, including more efficient engines, better transmission design, and better matching of the engine and transmission.

Front, Rear and Four Wheel Drive Usage
Cars

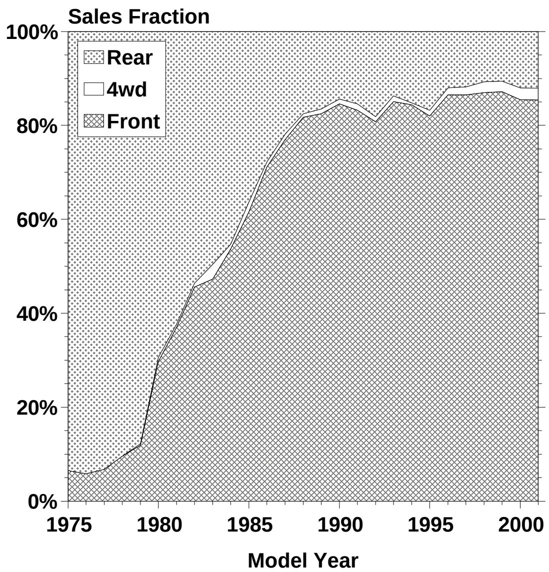


Figure 20

Front, Rear and Four Wheel Drive Usage
Vans

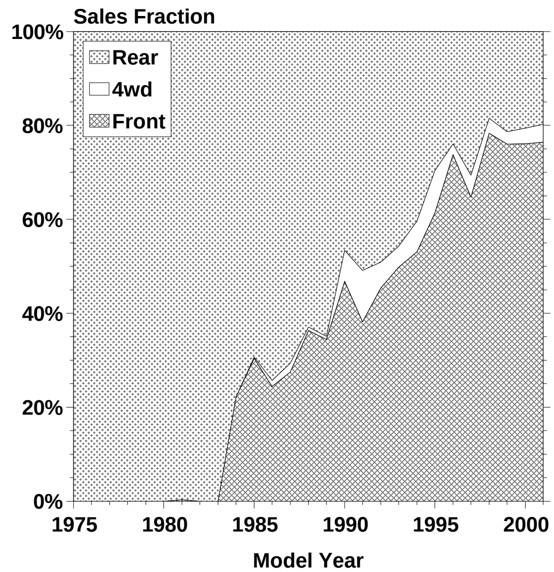


Figure 21

Front, Rear and Four Wheel Drive Usage
SUVs

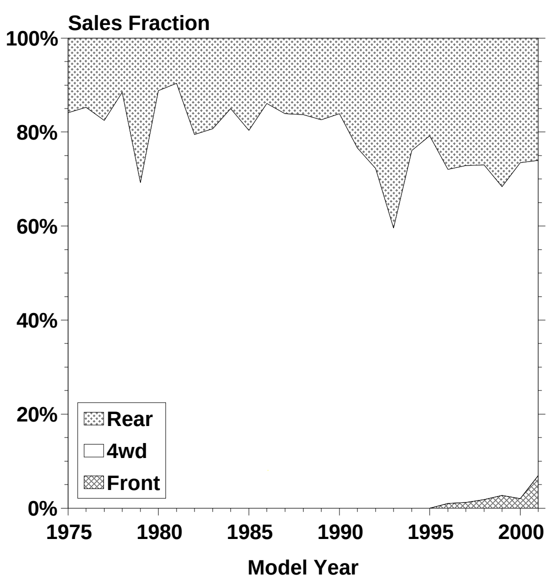


Figure 22

Front, Rear and Four Wheel Drive Usage
Pickups

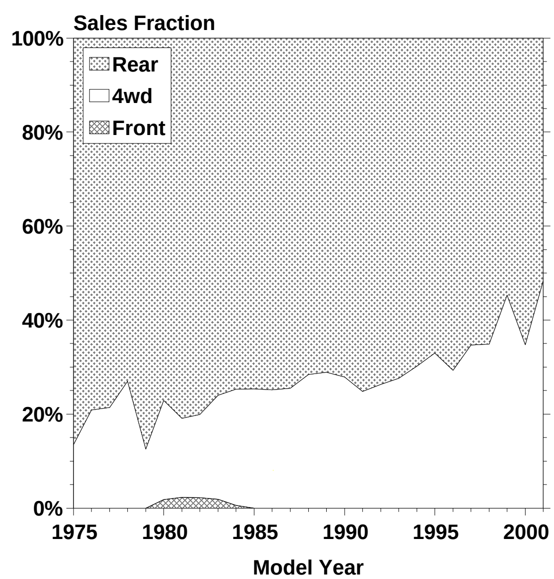


Figure 23

Transmission Sales Fraction
Cars

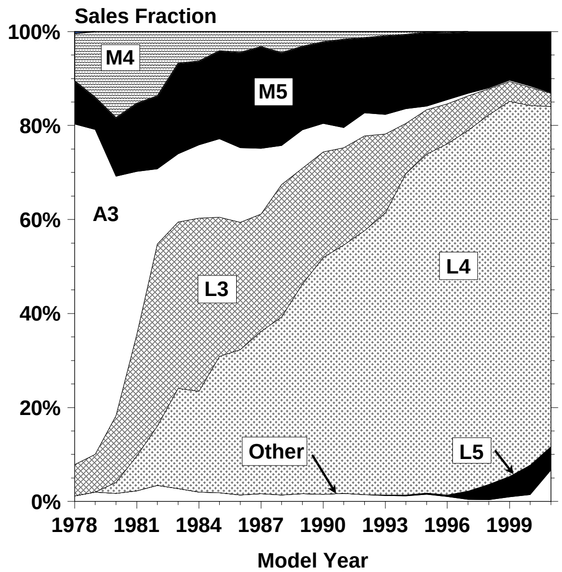


Figure 24

Transmission Sales Fraction
Vans

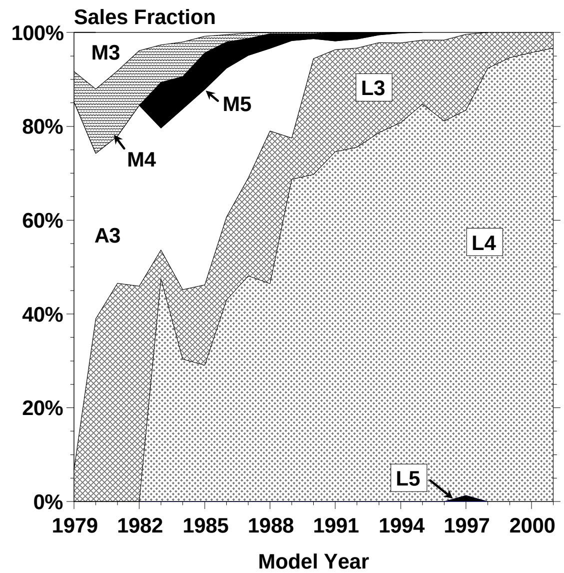


Figure 25

Transmission Sales Fraction
SUVs

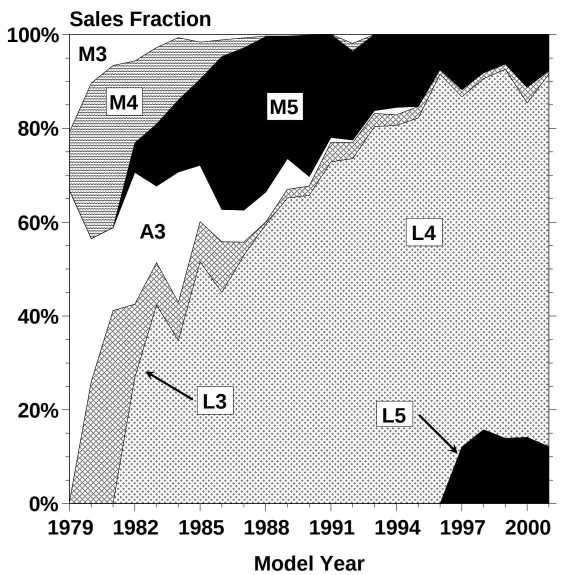


Figure 26

Transmission Sales Fraction
Pickups

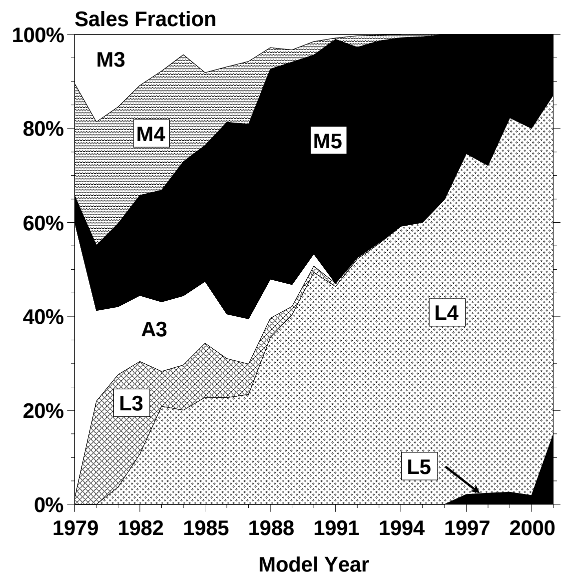


Figure 27

Powertrains are matched to the load better when the engine operates closer to its best efficiency point more of the time. For many conventional engines, this point is approximately 2000 RPM and 2/3 of the maximum torque at that speed. One way to make the engine operate more closely to its best efficiency point is to increase the number of gears in the transmission and, for automatic transmissions, using a lockup torque converter.

Table 13 compares ton-MPG by transmission and vehicle type between 1988, the peak year for passenger car fuel economy, and this year. For every strata for which the equivalent vehicle type used the same transmission type in both years shown in the table, ton-MPG will be higher this year, than it was in 1988. For model year 2001, cars and SUVs equipped with L5 transmissions will achieve about the same ton-MPG as their M5-equipped counterparts. Similarly, for all four vehicle types, MY2001 vehicles with L4 transmissions achieve the same or better ton-MPG this year than any of the corresponding vehicles did in 1988.

Table 13

Ton-MPG by Transmission and Vehicle Type

	Car		Van		SUV		Pickup	
Trans	2001	1988	2001	1988	2001	1988	2001	1988
M3	--	--	--	--	--	34	--	34
M4	--	38	--	34	--	39	--	33
M5	42	38	--	38	38	34	37	36
A3	36	34	--	35	--	30	--	32
A4	38	34	--	--	--	35	36	33
L3	41	37	41	37	32	34	--	32
L4	41	38	43	37	39	34	39	34
L5	41	--	--	--	38	--	36	--

Figures 28 through 31 compare the trends since 1975 for horsepower (HP), displacement (CID), and specific power or horsepower per cubic inch (HP/CID) for passenger cars, vans, SUVs, and pickups. In all four cases, significant CID reductions occurred in the late 1970s and early 1980s. Since 1985, however, engine displacement has been flat for cars and vans but for SUVs and pickups has increased. For all four vehicle types, average horsepower has increased substantially (i.e., 40% to 80%) since 1981. Light-duty vehicle engines, thus, have also improved in HP/CID, with engines used in passenger cars improving at a faster rate than truck engines. In fact, for the past two years, car engines have averaged at least 1.0 HP/CID, compared to 0.85, 0.91, and 0.80, respectively, for vans, SUVs, and pickups.

Car Horsepower, CID and Horsepower per CID

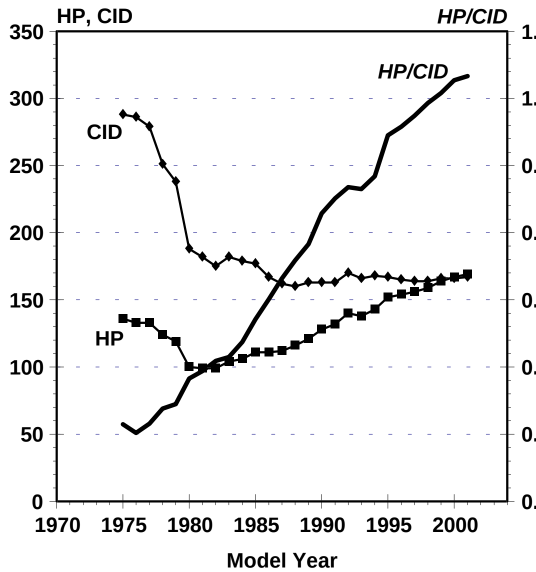


Figure 28

Van Horsepower, CID and Horsepower per CID

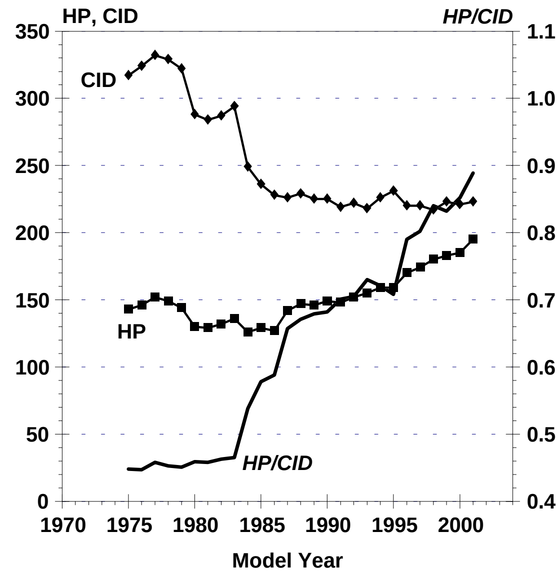


Figure 29

SUV Horsepower, CID and Horsepower per CID

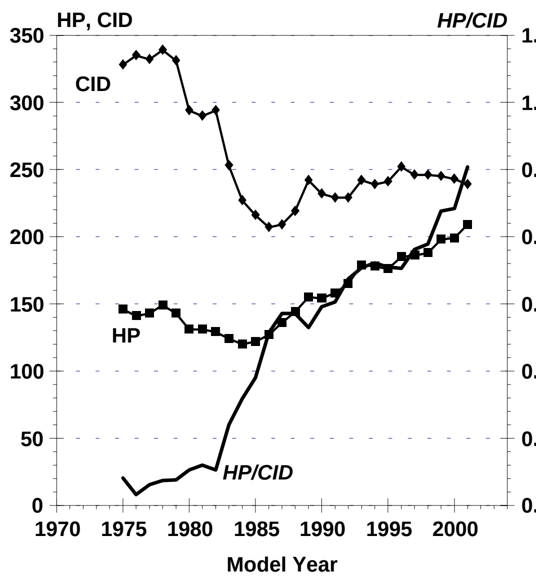


Figure 30

Pickup Horsepower, CID and Horsepower per CID

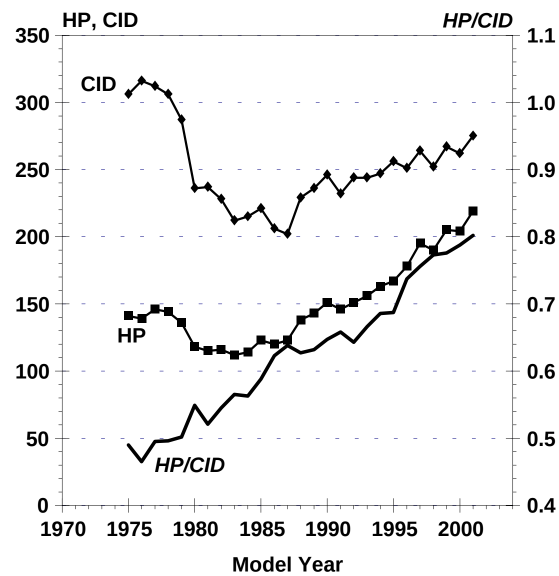


Figure 31

As shown in Table 14, for model year 2001 depending on the vehicle type, truck engines average about 15% to 30% more horsepower but require 33% to 65% greater displacement, compared to the average passenger car engine because of the differences in specific power.

Table 14

MY2001 Engine Characteristics by Vehicle Type

Vehicle Type	HP	CID	HP/ CID	Percent 4 Valve
Car	169	167	1.03	62%
Van	195	223	.89	19%
SUV	209	239	.90	37%
Pickup	219	275	.80	9%

Table 15 compares CID, HP, and HP/CID by vehicle type and number of cylinders for model years 1988 and 2001. Since 1988, changes in engine size have been relatively small for all strata shown in the table, particularly when compared to the changes in horsepower that have taken place with specific power improvements related to the use of multivalve engines likely accounting for the difference. Four-cylinder engines used in cars, vans, and SUVs have exceeded the one HP-per-CID level, but the same cannot be said of pickup trucks.

At the number-of-cylinders level of stratification, model year 2001 cars achieve higher specific power than SUVs, vans, and pickup trucks with one minor exception: four-cylinder SUVs. Similarly, this year’s pickup truck engines achieve lower specific power than their counterparts used in vans, SUVs, and cars.

Table 15

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

Vehicle Type	Cyl.	CID 1988	CID 2001	Percent Change	HP 1988	HP 2001	Percent Change	HP/CID 1988	HP/CID 2001	Percent Change
Car	4	118	123	4%	95	130	37%	.81	1.060	32%
	6	193	193	0%	142	196	38%	.74	1.023	38%
	8	301	282	-6%	164	255	55%	.54	.905	66%
Van	4	145	143	-1%	98	150	53%	.68	1.049	55%
	6	213	216	1%	149	192	29%	.72	.898	24%
	8	322	322	0%	168	242	44%	.52	.752	45%
SUV	4	122	128	5%	94	142	51%	.77	1.111	44%
	6	211	220	4%	147	197	34%	.71	.915	30%
	8	338	311	-8%	183	252	38%	.54	.812	50%
Pickup	4	142	155	9%	97	140	44%	.69	.903	32%
	6	229	233	2%	142	184	30%	.64	.792	23%
	8	329	317	-4%	180	252	40%	.54	.800	47%

The difference in HP and HP-per-CID is because the different classes use different technologies. Figures 32 through 39 show that engines with more valves per cylinder deliver higher values of HP per CID and that many cars are equipped with 4-valve engines, but the other classes aren’t.

HP/CID by Number of Valves Per Cylinder

Cars

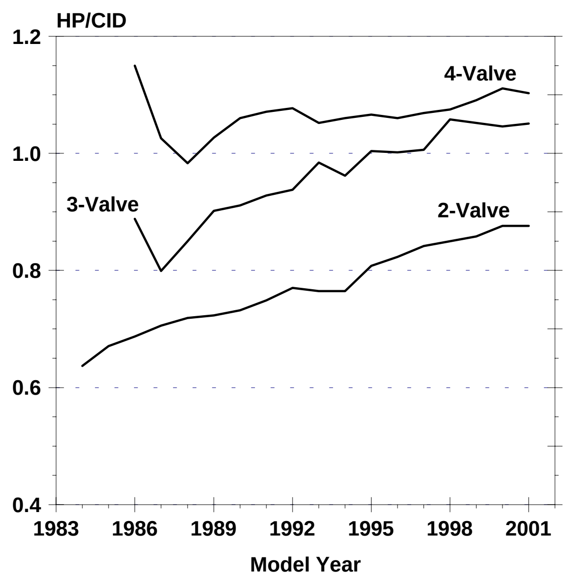


Figure 32

HP/CID by Number of Valves Per Cylinder

Vans

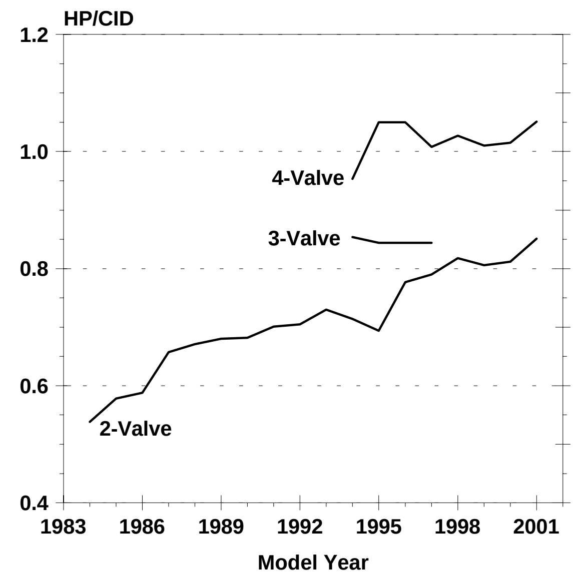


Figure 33

HP/CID by Number of Valves Per Cylinder

SUVs

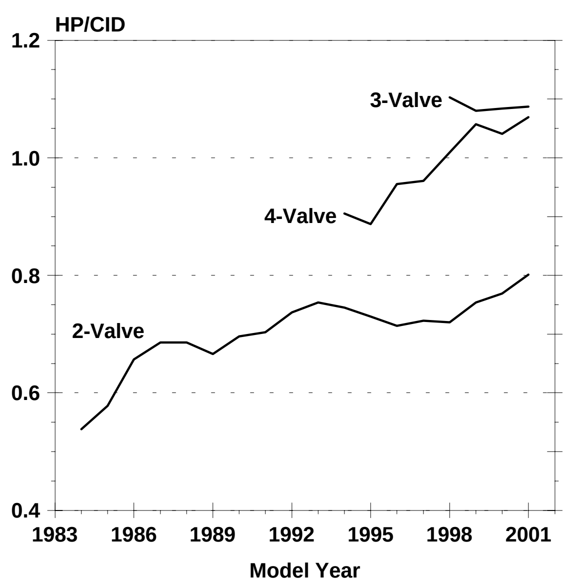


Figure 34

HP/CID by Number of Valves Per Cylinder

Pickups

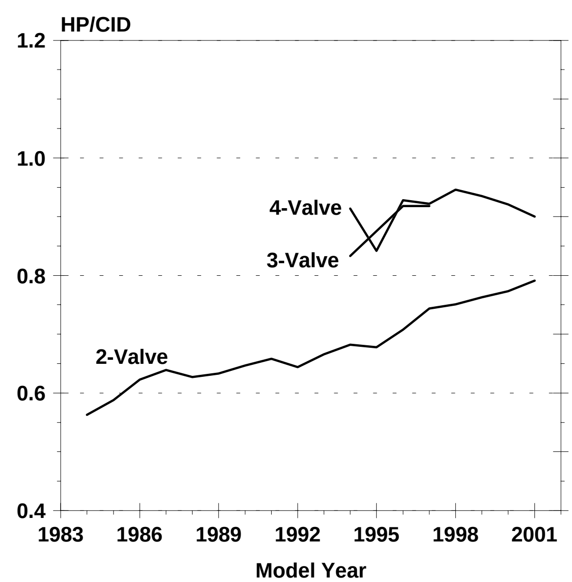


Figure 35

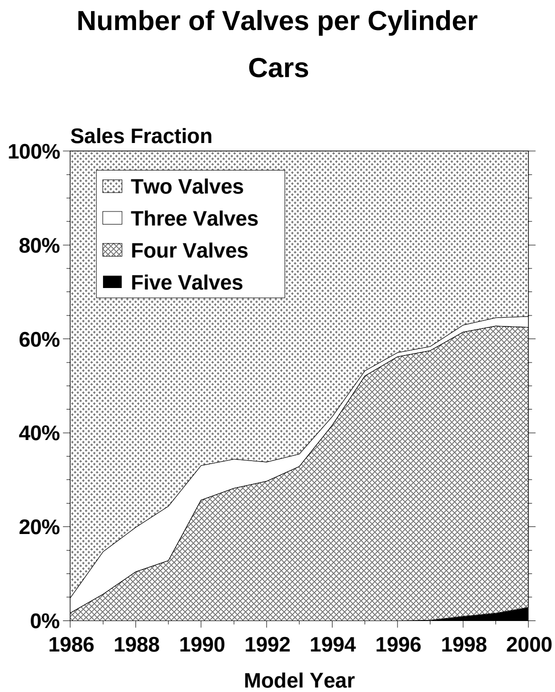


Figure 36

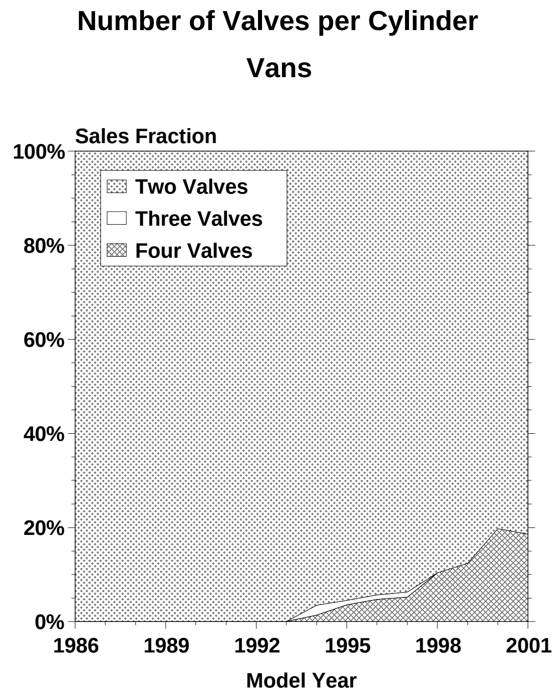


Figure 37

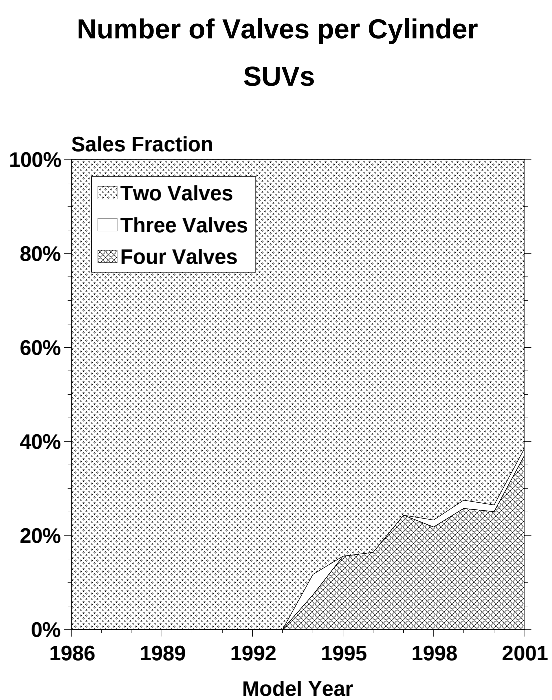


Figure 38

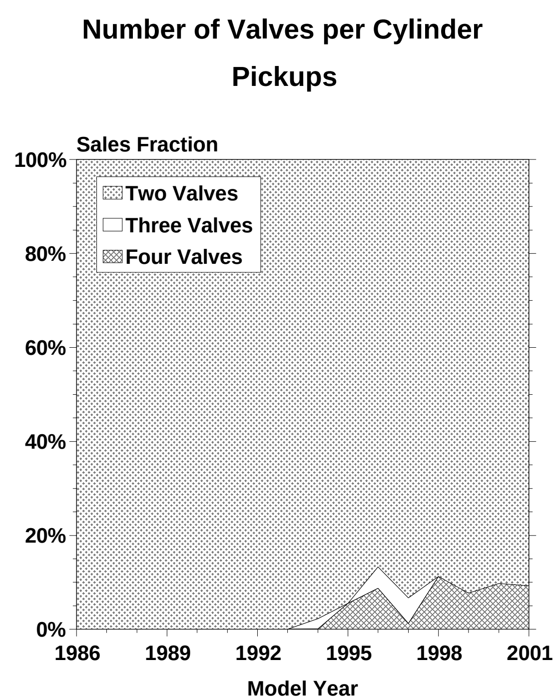


Figure 39

Figure 40 compares penetration rates for five passenger car technologies, namely port fuel injection (Port FI), front-wheel drive (FWD), four valves per cylinder (4-Valve) and four- and five-speed lockup transmissions (L4 and L5). This figure indicates that it may take a decade for a technology to prove itself and attain a sales fraction of 40% to 50% and as long as another five or ten years to reach maximum market penetration. With the recent introduction of the L5 transmission type, the sales fraction of L4 transmissions reached its maximum and now has started a declining trend. It thus takes some time after the introduction of a new technology for it to penetrate the market. A saturation time of about 15 years can be inferred from Figure 40.

A similar comparison of three technologies whose sales fraction peaked out at about 40% or less is shown in Figure 41. This figure shows that it may also take a number of years for technologies such as 3-valve-per-cylinder engines (3-valve) throttle body fuel injection (TBI), and lockup 3-speed (L3) transmissions to reach their maximum sales fraction, and even then use of these technologies may continue for a decade or longer.

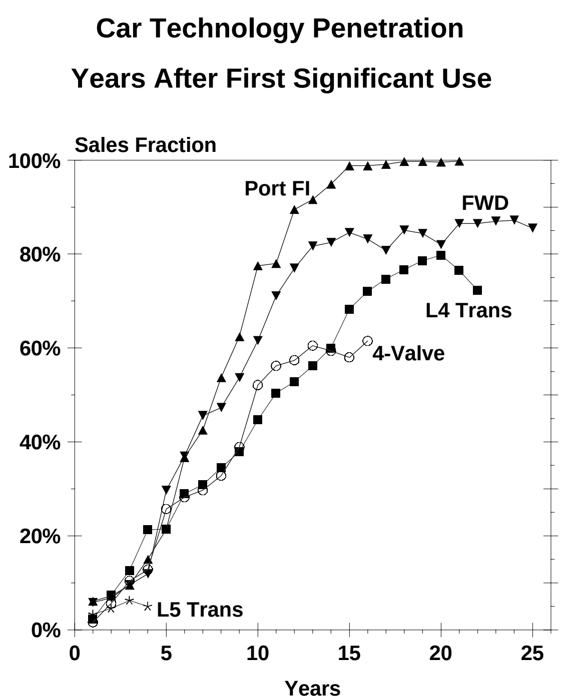


Figure 40

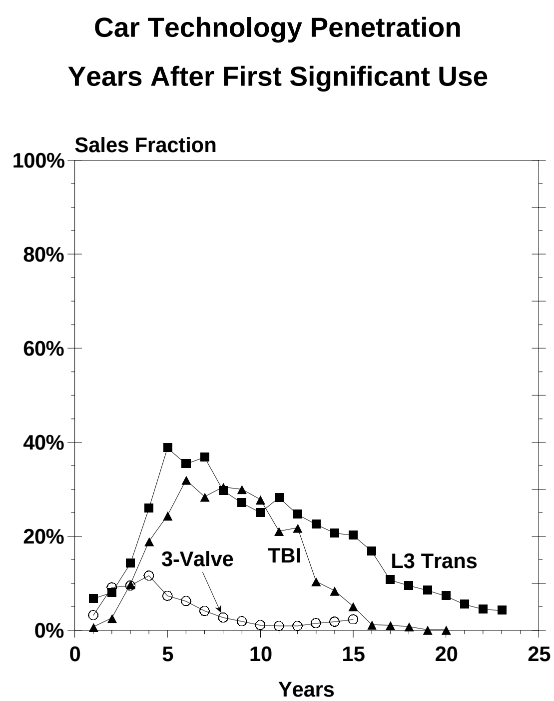


Figure 41

In terms of fuel economy technologies that are of importance in the U.S. market, the most significant in the past quarter century may be the introduction of vehicles equipped with hybrid propulsion systems. In model year 2001, two hybrids are in the fleet: the Honda Insight and the Toyota Prius. Both are hybrids that use gasoline-fueled engines, batteries, and motor/generators as key parts of their propulsion systems.

Even though these vehicles are not yet sales significant (comprising less than .25% of the market), their technology may be. How different the MPG performance of these vehicles is compared to other vehicles can be used to determine the significance of the new technology they represent.

The comparison can be made to vehicles of the same size class or the same weight class. For the Honda Insight, weight class comparisons are not useful, since it is the only 2000-lb inertia weight entry. Comparing the Honda Insight to other two-seater cars makes a comparison to a (somewhat) catchall category that contains some high-performance and low-fuel economy cars.

In Table 16, the two hybrids are compared to other cars chosen for their high MPG. The comparison is based on adjusted MPG for this Table.

Table 16

Characteristics of Cars with Relatively High Fuel Economy

Manufacturer Model	Honda Insight	Toyota Prius	VW Diesels	Honda Civic HX	Suzuki Swift	MY1986 Geo Sprint	Average MY2001 Small Car
Drive	Front	Front	Front	Front	Front	Front	----
Trans	M5	CVT	M5	M5	M5	M5	----
Weight	2000	3000	3000	2750	2250	1750	3096
CID	61	91	116	102	79	61	142
HP	67	70	90	117	79	46	149
Adj City MPG	60.6	51.6	41.8	36.1	36.4	55.4	23.3
Adj Hwy MPG	68.2	45.2	49.1	43.7	42.3	59.6	31.2
Adj 55/45 MPG	63.8	48.5	44.8	39.2	38.8	57.2	26.3
Hwy/City Ratio	1.12	0.88	1.17	1.21	1.16	1.08	1.34

Another way to look at the MPG performance of the hybrids is on a distribution of MPG values with other vehicles in the same EPA car class. The Toyota Prius is compared on this basis in Figure 42. Unadjusted MPG is used here to provide another way to compare MPGs and also as a reminder that hybrid technology was not being used when the MPG adjustment factors were determined. The Toyota Prius stands out as being exceptionally efficient. The same comparison is made in Figure 43 but with vehicles in the Toyota Prius's 3000-lb inertia weight class. The same relationship prevails.

The small car class used for this report includes four EPA car classes: two seaters, mini-compacts, subcompacts, and compacts. When the Toyota Prius and the Honda Insight are compared to all small cars in Figure 44, they both stand out as being exceptionally high in fuel economy.

Both vehicles can be compared to the average of other vehicles depending on the class it is compared to and whether or not the class average contains the hybrids. The Honda Insight is 2.5 to 2.9 times better in MPG than the average, and the Toyota Prius is 1.8 to 1.9 times better than the average. These factors are based on unadjusted 55/45 MPG. If they were to be based on adjusted 55/45 MPG, the ratios would be higher. Roughly speaking, then, vehicles equipped with hybrid propulsion systems can deliver two to three times better MPG than the average of conventionally powered vehicles. Hybrid technology, therefore represents a new kind of MPG technology, not just another increment of conventional technology.

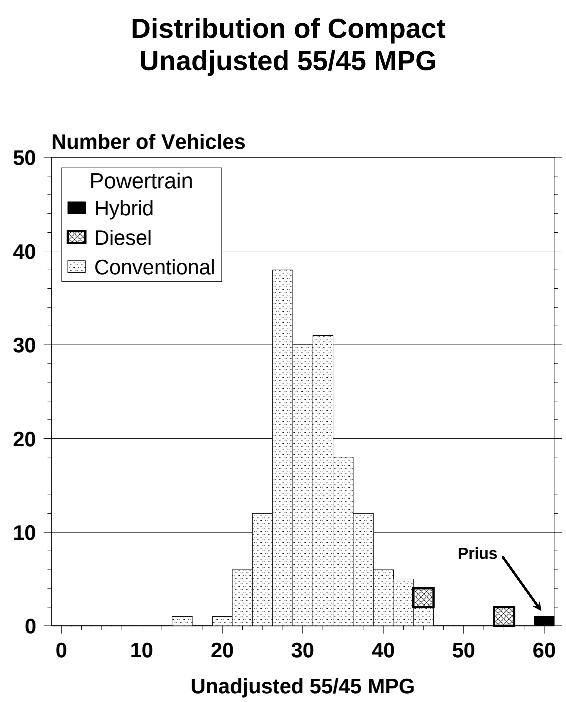


Figure 42

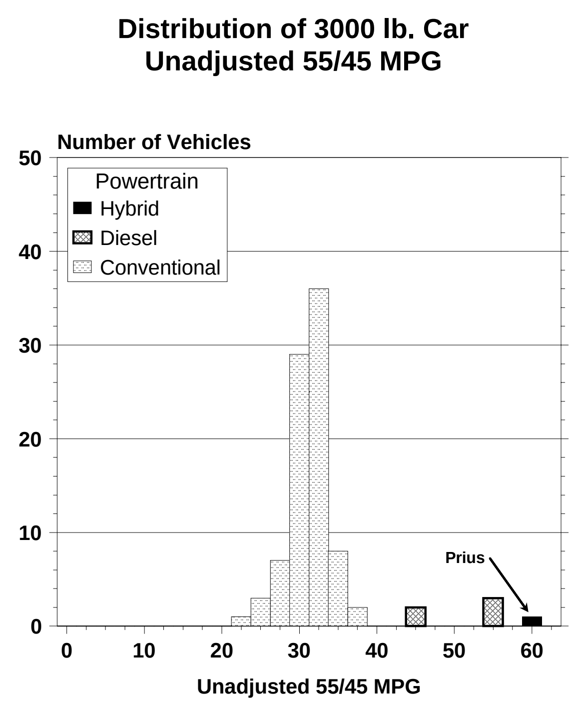


Figure 43

Distribution of Small Car Unadjusted 55/45 MPG

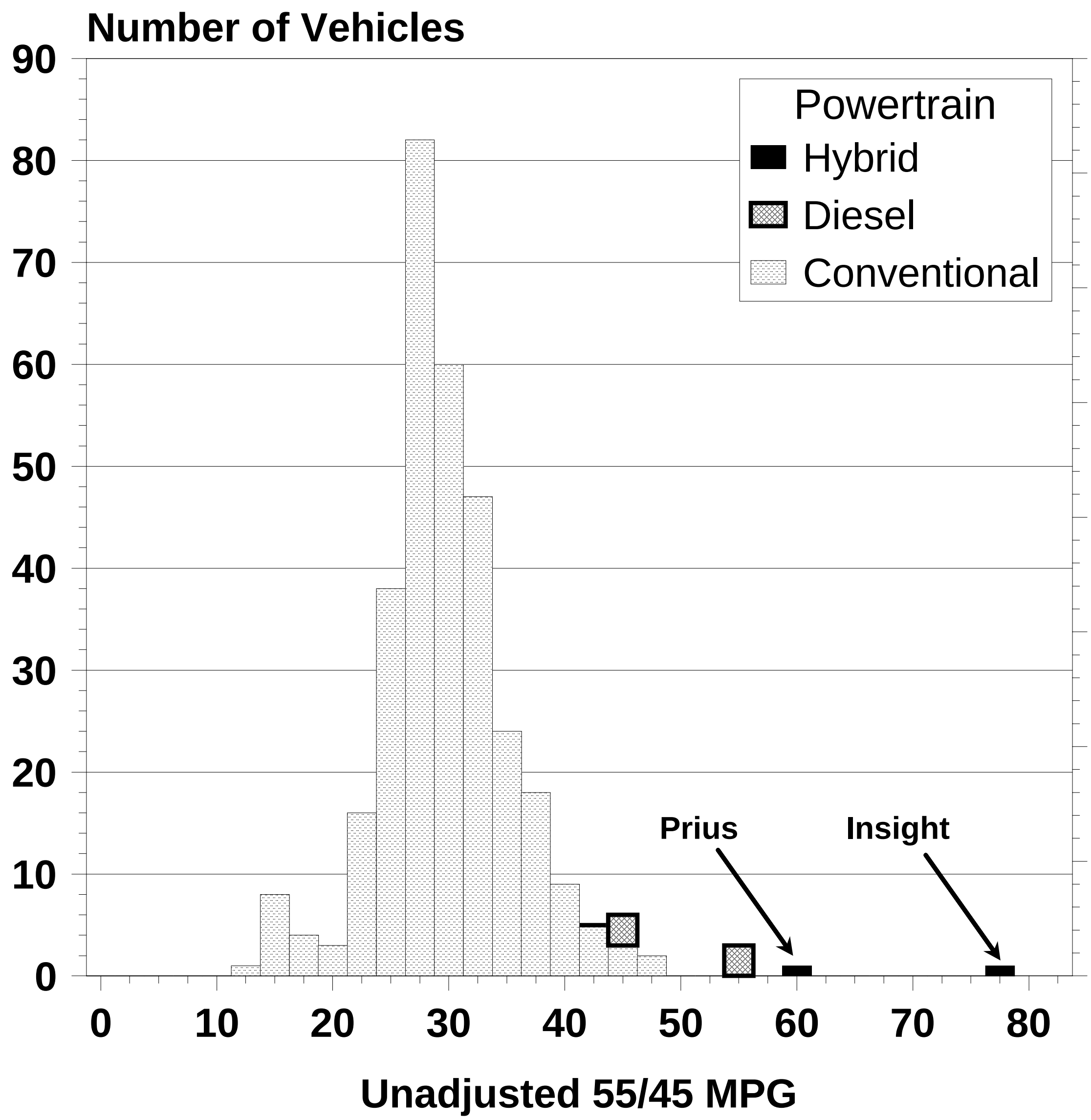


Figure 44

VI. <u>Fuel Economy Improvement Potential</u>

In any treatment of trends in fleet fuel economy, some discussion of the reasons for the trends is necessary. This leads to treatments of the technical reasons for trends in fuel economy, regardless of whether the trends show increases or decreases in fuel economy.

When the subject turns to consideration of what might be possible for the future, however, there has never been any interest in any discussion of approaches that would lead to worse fleet fuel economy. The emphasis always has been on “what if” considerations that might lead to improved fleet fuel economy—hence the title of this section of the report.

Most past projections of fuel economy improvements in this report series have been made on the basis of technologies already in the fleet, with estimates made of what the fuel economy effects would be due to presumed changes in the relative proportions of different kinds of vehicles in the fleet.

Now that hybrid vehicles are in the fleet, it is of interest to consider what increased penetration of hybrid vehicles might mean for fleet fuel economy. The efficiency potential of hybrids is so great that projections of future fleet fuel economy may come down to estimating the market penetration rates of different hybrids with different fuel efficiency improvement factors instead of estimating what MPG the fleet could get by when. Given the uncertainty in the degree of improvement due to hybrids and their penetration rates into the market, it is probably better to say what can’t happen rather than what can happen. This can be done using information previously discussed in this report.

Earlier in the report, it was seen that new technologies take roughly 15 years to penetrate the fleet. The technologies that the 15-year estimate was based on are not as much of a change as hybrids represent, so it seems appropriate to conclude that we can’t have an all-hybrid fleet before 15 years from now, i.e., before model year 2016.

The MPG improvement that is associated with hybrids in the market now is from a factor of two to a factor of three, as discussed earlier. It is probably the case that all hybrids introduced won’t be a factor of three better in fuel economy, so the current 23.9 MPG value for unadjusted 55/45 car and light-truck fleet probably will not be tripled to 71.7 MPG, if and when the fleet is initially hybridized. Therefore, it can be concluded that a fuel economy value for the combined car and light-truck fleet of 71.7 MPG cannot be obtained before 2016. The lower boundary for fleet fuel economy for the future would appear to be the “all truck” scenario, in which the fuel economy would asymptote to a value close to the average value that light trucks deliver, i.e., a little more than 20 MPG.

Increasing the market share of vehicles which utilize fuel efficient hybrid technology offers the greatest degree of fuel economy potential currently available.

Another approach for determining what potential exists for improving fuel economy is “best in class” analysis which involves dividing the fleet of vehicles into classes, selecting a set of representative “role model” vehicles from each class, and then calculating the average characteristics of the resultant fleet using the same relative sales proportions as in the baseline fleet.

In the discussion which follows, three best-in-class analyses are made using three different procedures to select the role models. Two of these selection procedures use the EPA Car Size Classes (which for cars are the same as those used for the EPA/DOE Fuel Economy Guide) and the truck type/size classes described previously in this report. Note that this classification system includes nine car and nine truck classes and, for model year 2000, two of these eighteen classes are not represented (Large Wagons and Small Vans). The third best-in-class role model selection procedure is based on using the vehicle inertia weight classes used for EPA’s emission certification process.

The advantage of using and analyzing data from the best-in-size class methods is that if the sales proportions of each class are held constant, the sales distribution of the resultant fleet by *vehicle type and size* does not change. Similarly, there also is an advantage in using the inertia weight classes to determine the role models, since if the sales proportions in each inertia weight class are held constant, the sales distribution of the resultant fleet by *weight* does not change.

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. Under this procedure, all vehicles in a class with the same nameplate are included as role models regardless of vehicle configuration. Each role model nameplate from each class was assigned the same sales weighting factor, but the original sales weighting distribution for different vehicle configurations within a given nameplate (e.g., transmission type, engine size, and/or drive type) was retained. The resulting values were used to recalculate the fleet average values using the same relative proportions in each of the size classes that constitute the fleet.

In cases where two identical vehicles differ by only one characteristic, but have slightly different nameplates (such as the two-wheel drive Chevrolet C1500 and the four-wheel drive K1500 pickups), both are considered to have the same nameplate. Conversely, in the cases where technically identical vehicles with different nameplates are used (e.g., the Chevrolet S10 Pickup, GMC Sonoma, and Isuzu Hombre or the Suzuki Swift and Chevrolet Metro), only one representative vehicle nameplate was used.

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

The third best-in-class procedure involves selecting as role models the best dozen vehicles in each weight class. As with the previous method, each vehicle configuration was considered separately. (See tables in the Appendix of the MY2001 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 vehicles with different nameplates are used, only one representative vehicle was included. As with the two best-in-size class methods, the sales data for each role model vehicle in each class was assigned the same value, and the resulting values were used to recalculate the fleet values again using the same relative proportions in each of the size classes that constitute the fleet.

Tables 17 and 18 compare, for cars and trucks respectively, the results of the best-in-class (BIC) analysis with actual average data for model year 2001. 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. Despite the fact that 55% of the cars in the BIC weight class data set are classified as "Small," compared to 45% in the entire fleet, average interior volume for cars in the BIC weight class analysis is about the same as the overall average (110 vs. 111 cu. ft.). The small differences in interior volume between the Size Class scenarios and the actual fleet can be attributed to the fact that, within a size class, there is considerable variation in interior volume (i.e., not all vehicles in each size class have the same interior volume.)

Under all of the best-in-class (BIC) scenarios, the vehicles used for the BIC analysis have less powerful engines, have slower 0-to-60 acceleration times and are more likely to be equipped with manual transmissions than the entire fleet as a whole. Usage of front- and four-wheel drive is about the same for cars in the BIC weight class analysis but not in the size class where there is greater use of front-wheel drive than in the actual fleet. For trucks, however, the BIC data set vehicles make greater use of front-wheel drive. When the best 12 vehicles in size or weight were used as the role model selection criteria, the truck BIC data sets also make less use of four-wheel drive than the actual fleet.

For both cars and trucks, the “Best 12 Vehicles” in Size Class scenario results in significantly higher fuel economy than the actual fleet, but the vehicles in these BIC sets are lighter than their counterparts from the other scenarios. Depending on the scenario chosen, for model year 2001, cars could have achieved from 17% to 20% better fuel economy than they did. Similarly, trucks could have achieved from 10% to 13% better fuel economy

One of the characteristics of the best-in-class analysis is that it typically results in a hypothetical fleet of vehicles which has a larger fraction of manual transmissions than today’s fleet does. This is a consequence of the methodology. There has been some discussion of the practicality of such a fleet of vehicles, especially for the U.S. market, where automatic transmissions dominate. The issue is moot if one considers the potential of the automatically shifted manual transmission (ASM)—a manual transmission in terms of design (and efficiency) which is shifted automatically [33]. These more efficient transmissions could replace conventional torque converter-based automatic transmissions, provide the fuel economy benefits implied by the best in class analysis, and also allow for shiftless driving.

A third approach for determining potential fuel economy improvement is to study the relationships between vehicle technology improvements, vehicle acceleration times, vehicle size and vehicle weight.

The MPG/performance interdependence was quantified by means of a regression analysis performed on the EPA databases as described in reference 20. This yielded sensitivity coefficients on the order of 0.4, i.e., a 10% increase in 0-to-60 time corresponds to a 4% increase in fuel economy. Using these sensitivities, average MPG data at one 0-to-60 level can be adjusted to what it would have at a different one.

Similarly, by normalizing either the weight or size distribution, a comparison can be made of what the fuel economy of each year’s fleet would have been if it had the same weight or size distribution as in a given base year. For comparison purposes, two base years were analyzed: 1981 and 1991. Table 19 shows that this year’s cars get better fuel economy than their counterparts from both baseline years but are significantly heavier and have faster 0-to-60 acceleration time. This year’s trucks get about the same fuel economy as the base line years and are also heavier and have faster 0-to-60 times.

Table 17

Best in Class Results: Model Year 2001 Cars

Vehicle Characteristic	Selection Basis / Selection Criteria	Actual Data / All Cars	Size Class / Best 4 Nameplates	Size Class / Best 12 Vehicles	Weight Class / Best 12 Vehicles
Fuel Economy	LAB 55/45	28.3	33.3	33.9	33.0
	ADJ City	21.2	25.3	25.8	25.0
	ADJ Highway	29.3	33.5	34.1	33.2
	ADJ 55/45	24.2	28.4	29.0	28.2
Vehicle Size	Weight Lb.	3380	3135	3141	3380
	Volume Cu-Ft.	111	109	109	110
Engine	CID	167	140	133	128
	HP	169	145	139	140
	HP/CID	1.033	1.049	1.052	1.094
	HP/WT	.0494	.0456	.0438	.0411
	Four Valve Usage	61.5%	72.4%	63.8%	71.3%
Performance	0-60 Time (Sec)	10.3	11.1	11.4	11.8
	Top Speed (mph)	130	123	121	119
	Ton-MPG	41.2	45.8	46.6	48.3
	CU-FT-MPG	2719	3204	3251	3173
	CU-FT-TON-MPG	4558	4963	5040	5296
Drivetrain	Front Wheel	85.4%	96.5%	96.4%	91.0%
	Four Wheel	2.5%	2.1%	2.1%	4.2%
Transmission	Manual	13.9%	16.0%	47.7%	48.3%
	Lockup	80.1%	72.3%	44.7%	49.0%
Fuel Metering	Port FI	99.8%	100.0%	90.1%	90.5%
	Diesel	.2%	0.0%	9.9%	9.5%
Hybrid Vehicle		<.25%	8.8%	2.9%	1.3%

Table 18

Best in Class Results: Model Year 2001 Trucks

	Selection Basis	Actual Data	Size Class	Size Class	Weight Class
Vehicle Characteristic	Selection Criteria	All Cars	Best 4 Nameplates	Best 12 Vehicles	Best 12 Vehicles
Fuel Economy	LAB 55/45	20.3	21.9	23.0	22.4
	ADJ City	15.6	16.9	17.8	17.2
	ADJ Highway	20.0	21.5	22.5	22.1
	ADJ 55/45	17.3	18.7	19.6	19.1
Size	Weight Lb.	4511	4324	4138	4511
Engine	CID	249	221	202	216
	HP	210	203	184	197
	HP/CID	.864	.947	.938	.936
	HP/WT	.0465	.0467	.0442	.0434
	Four Valve Usage	23.4	43.2	43.8	42.1
Performance	0-60 Time (sec.)	10.6	10.6	11.1	11.3
	Top Speed (mph)	131	131	126	127
	Ton-MPG	39.2	40.5	40.8	43.2
Drivetrain	Front	18.3%	31.2%	31.1%	32.3%
	4WD	47.8%	38.8%	21.3%	37.1%
Transmission	Manual	8.0%	9.0%	37.1%	20.8%
	Lockup	91.2%	87.8%	62.4%	74.4%
Fuel Metering	Port	100.0%	100.0%	100.0%	100.0%
	Diesel	0.0%	0.0%	0.0%	0.0%

Table 19

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

Vehicle Type	Model Year	55/45 MPG	Inertia Weight	0 to 60 Time
Cars	1981	25.1	3076	14.4
	1991	28.0	3154	11.8
	2001	28.3	3380	10.3
Trucks	1981	20.1	3806	14.6
	1991	21.3	3948	12.6
	2001	20.3	4511	10.6

Figures 45 through 48 provide estimates of what the MPG of the car and truck fleet would have been each model year if:

(1) the weight mix had been kept the same as in each of the two base years,

(2) the average acceleration time was kept at the base year's acceleration time, and

(3) both the weight distribution and average acceleration time were the same as in the base year.

A similar comparison on the basis of vehicle size and type is presented in Figures 49 through 52. For those cases, i.e., Small Vans and Large Wagons, values from the last year for which these vehicles were produced were substituted in the analysis as necessary.

Effect of Vehicle Weight and Acceleration on Car Fuel Economy

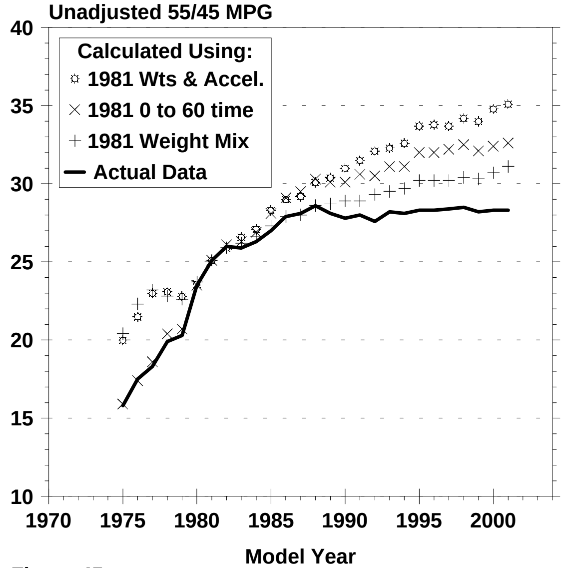


Figure 45

Effect of Vehicle Weight and Acceleration on Truck Fuel Economy

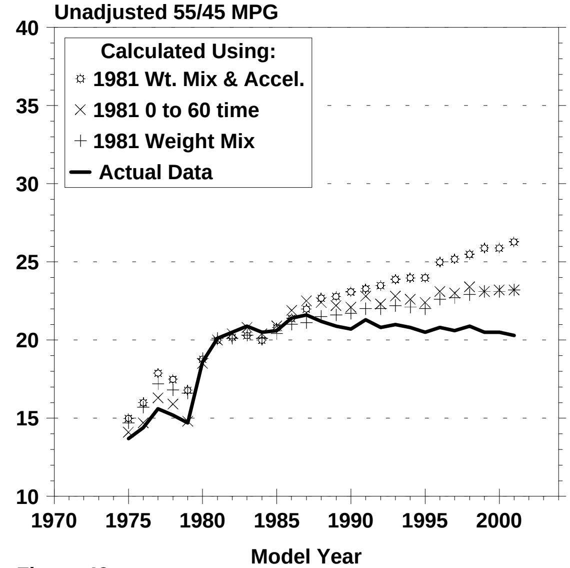


Figure 46

Effect of Vehicle Weight and Acceleration on Car Fuel Economy

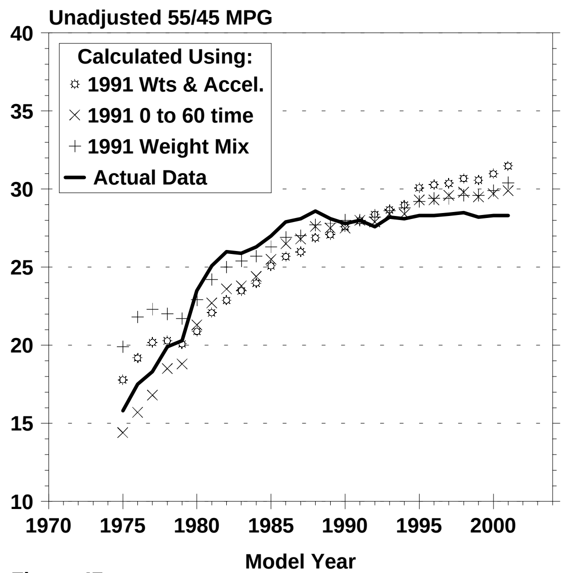


Figure 47

Effect of Vehicle Weight and Acceleration on Truck Fuel Economy

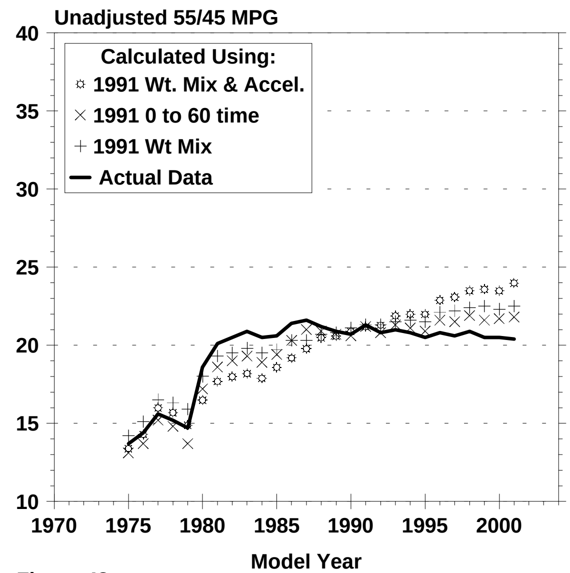


Figure 48

Effect of Vehicle Size, Type & Acceleration on Car MPG

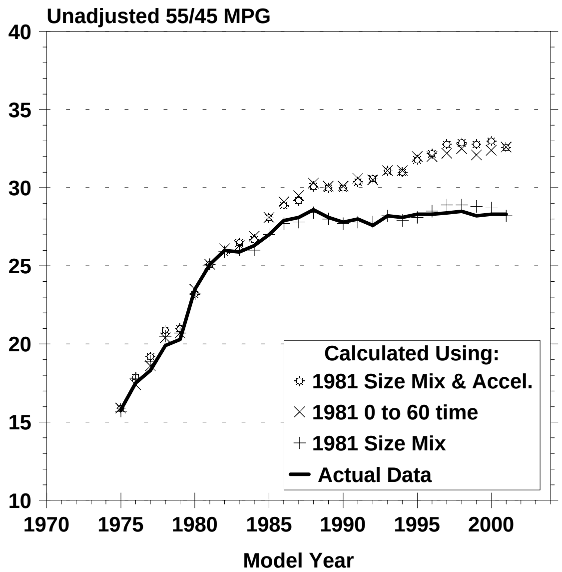


Figure 49

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

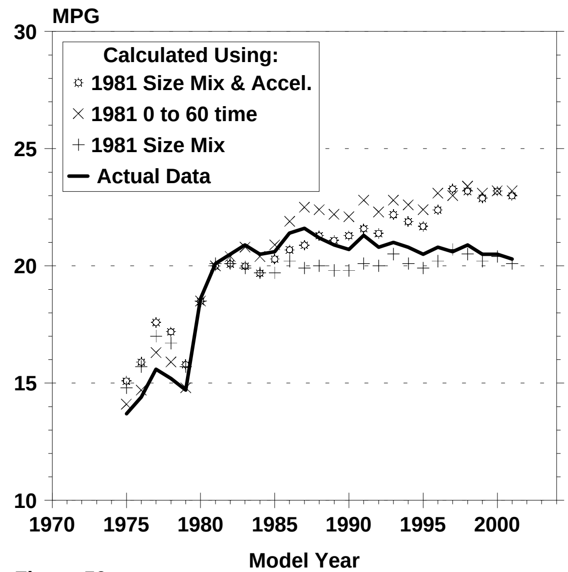


Figure 50

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

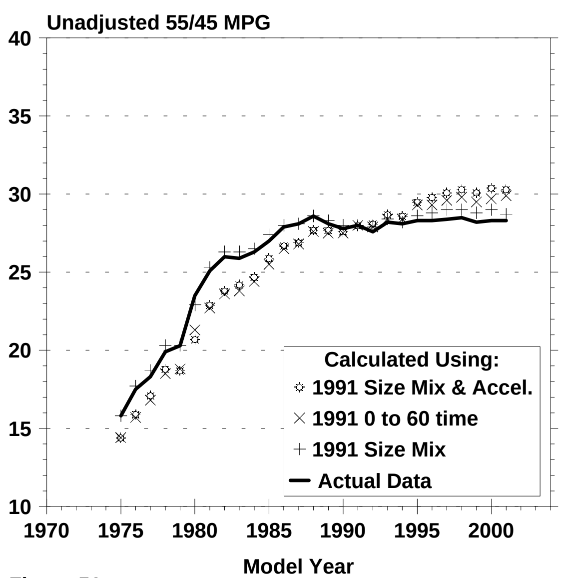


Figure 51

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

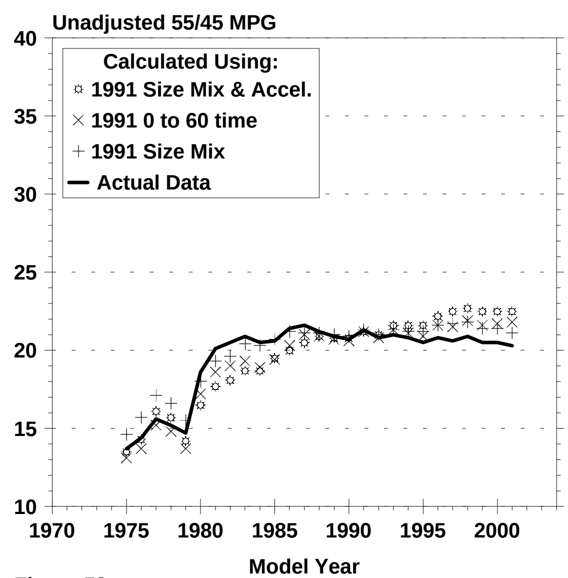


Figure 52

A summary of the different approaches is presented in Table 20. Considering the seven different ways in which fuel economy improvements for the fleet can be estimated, based on the characteristics of the existing fleet, the range of improvements for the fleet is from 9% to 27%. The average is 15%. Different methods and different base years, of course, yield different results, and as discussed earlier, the hypothetical fleets that have higher fuel economy tend to be different from today's fleet: higher fuel economy but slower and lighter.

Table 20

Summary of Fuel Economy Improvement Potential

Scenario		Unadjusted Fuel Economy Cars	Trucks	Both
1.	Model Year 2001 Actual Average	28.3	20.3	23.9
2.	1981 Weight Mix and 0 to 60 Time	35.1	26.3	30.3
3.	1991 Weight Mix and 0 to 60 Time	31.5	23.8	27.4
4.	1981 Size Mix and 0 to 60 Time	32.6	23.0	27.3
5.	1991 Size Mix and 0 to 60 Time	30.3	22.5	26.1
6.	Best 4 Nameplates in Size Class	33.3	21.9	26.8
7.	Best 12 Vehicles in Size Class	33.9	23.0	27.7
8.	Best 12 Vehicles in Weight Class	33.0	22.4	27.0

	Percent Improvement over Model Year 2001 Actual Fuel Economy			
1.	Model Year 2001 Actual Average	0.0%	0.0%	0.0%
2.	1981 Weight Mix and 0 to 60 Time	24.0%	29.6%	27.0%
3.	1991 Weight Mix and 0 to 60 Time	11.3%	17.2%	14.5%
4.	1981 Size Mix and 0 to 60 Time	15.2%	13.3%	14.1%
5.	1991 Size Mix and 0 to 60 Time	7.1%	10.8%	9.1%
6.	Best 4 Nameplates in Size Class	17.7%	7.9%	12.0%
7.	Best 12 Vehicles in Size Class	19.8%	13.3%	16.1%
8 .	Best 12 Vehicles in Weight Class	16.6%	10.3%	13.0%

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