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Technical Report

The Effect of Initial and Final Production Volume and MPG Values on Average Fuel Economy

by

Suzanne L. Loos

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U. S. Environmental Protection Agency
Office of Air, Noise and Radiation
Office of Mobile Sources
Emission Control Technology Division
Control Technology Assessment and Characterization Branch
2565 Plymouth Road
Ann Arbor, Michigan 48105

Abstract

The use of manufacturer estimated production can affect the MPG values used to predict fuel consumption, determine CAFE compliance, and generate fuel economy general labels.(1)* By comparing two fuel economy data bases, one containing pre-model year fuel economies and estimated production (General Label Files or "D-files") and one containing final model year fuel economies and actual production (CAFE files or "F-files"), it is possible to identify fuel economy differences and their causes, such as sales shifts.

Comparisons of production and MPG differences will be presented at the fleet level, by manufacturer, and for certain "battleground" car classes, for each model year from 1978 through 1981.** In addition, the "MPG change allocation" program (2) identifies causes of the within-year MPG shifts - weight mix, engine mix, transmission mix, or powertrain optimization.

* Numbers in parentheses indicate references listed at the end of this report.

** A preview of the 1982 model year is also included in Appendix A. While final CAFE data on a car-by-car basis are not yet available for 1982, mid-year estimates submitted to DOT have been acquired and analyzed.

Purpose

This study was done at this time for three reasons:

1) Data of "final CAFE" vintage now exists for four model years -- the data are quite complete for 1978 through 1980, and reasonably complete (most major manufacturers) for 1981. This state of affairs now permits a first look for trends in projected-to-actual production and MPG relationships;

2) Stories are beginning to appear in the media* regarding a growing number of manufacturers whose recent MPG forecasts for model year 1983 are falling short of the MPG standards, and far short of their earlier projections. While of course we cannot yet compare 1983 projections with 1983 actuals, it is pertinent to examine the earlier years' data;

3) The standard procedure for fuel economy trend analysis has been to accept the manufacturers' pre-model year general label data, and to stick with that until final CAFE figures appear two or three years later. If there is any sign of a growing divergence between projections and actuals, it may be necessary to take new approaches, such as (a) closer scrutiny of, and possibly even the application of "judgment factors" to, the projections, and/or (b) acquisition of intermediate updated estimates available before the sometimes-long-delayed CAFE figures are finalized.

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* Wall Street Journal, February 7, 1983, pg. 10; Automotive News, Feburary 21, 1983, pg. 26.

Background

In order to understand how sales shifts can affect fuel economy projections it is neccessary to provide some background on certain aspects of the EPA Fuel Economy Program.

The following sections will concentrate on three areas:

- Uses of Production Volumes
- Production Volume Weighting of Fuel Economy
- How MPG Changes During the Course of a Model Year

Uses of Sales/Production Volumes

Before each model year, manufacturers are required to submit estimates of production volumes for fuel economy labeling purposes. Estimated production volumes are used to calculate sales weighted fuel economy general labels and were used to calculate preliminary CAFE* (Corporate Average Fuel Economy). Estimated production volumes are also used to determine the emission and durability fleets submitted to EPA as a portion of the Application for Certification. After each model year, manufacturers are required to submit their actual production volumes to determine CAFE compliance as required under the Energy Policy and Conservation Act (EPCA).

During the production of vehicles of a given model year, manufacturers label each new vehicle with a model type fuel economy called the general label. The general label is a production volume weighted fuel economy number. These fuel economy values come from two sources: the original emission

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* Preliminary CAFE calculations are no longer required.

certification test fleet and additional fuel economy data vehicles usually projected to be a manufacturer's high seller within a base level. Details of the fuel economy production volume weighting scheme will be presented in the next section.

The preliminary CAFE was used to provide a basis for determining additional testing requirements due to product line changes or additions to a product line.(1) This was done to make the fuel economy data base more representative of a manufacturer's final product line. General label fuel economy data with updated production volumes were also included in the PCAFE data base.

The final CAFE calculated in compliance with EPCA includes all fuel economy data from the sources previously mentioned plus any additional running changes.* The important difference from the earlier estimates is that the CAFE production volume weightings are based on a manufacturer's actual production.

Production Volume Weighting of Fuel Economy

A general label MPG value is defined as a production volume weighted average of base level fuel economies for a particular model type. For a general overview and definition of basic terms of the production volume weighting hierarchy see Table 1. At a glance it may look like numerous tests are required to calculate a single Model-Type fuel economy label. However, this is usually not the case. A minimum of one test (subconfiguration) per base level is all that is needed to meet fuel economy testing requirements, and it is not necessarily the highest seller.

* (Running changes for base level(s) which represent 1% or more of a manufacturers' fleet).

Table 1

Levels of Fuel Economy Sales Weightings (3)

Sales Weighting Level	Definition	FE Uses	Comments
Model Type	A unique combination of car line, basic engine and transmission class.	General Label EPA/DOE GUIDE	--
Base Level	A unique combination of basic engines, inertia weight and transmission.	D-FILES* F-FILES	Usually two "base levels" sales aggregate into a "Modal Type".
Configuration	A unique combination of basic engine, engine code, inertia weight, transmission class and axle ratio within a base level.	Specific Labels	Several "configurations" are sales aggregated within each "base level".
Subconfiguration	A unique combination of basic engine, engine code inertia weight, transmission class axle ratio, estimated test weight and road load horsepower.	Specific Labels	Several "subconfigurations" are sales aggregated within a "configuration". Represents one test vehicle.

* FE Trend Analyses.

In other words, the fuel economy values for one vehicle may represent the fuel economies of several vehicles contained within its configuration and/or base level when production volume weighting is used.

How MPG Changes During the Course of a Model Year

When a manufacturer requests a fuel economy general label it is prior to actual production of the vehicle so a prototype vehicle is used to test for fuel economy. A general label is calculated using this type of data.

Often after a general label is issued, a manufacturer may want to implement a design change (or "running change") to vehicles in their product line. This may result in a fuel economy difference that is not reflected in the general label since no recalculations are required. If the sales attached to that running change are significant it could result in a different MPG value than reflected on that label.

Running changes include, for example, changes in the engine calibration, which could create untested engine codes, and addition or removal of weight.

Projected vs Actual Production Volume Analysis for Model Year 1978-1981

This section will present 55/45 MPG, average inertia weight and average displacement, production volume weighted using both projected and actual figures by various strata for model years 1978-1981. The percent difference (%DIFF) is also given for each within-year comparison. In addition a ratio of projected to actual production volumes is presented as a measure of over- or under-projection of production for each model year.

The Fleet

Table 2 presents percent differences of 55/45 fuel economy, average inertia weight and displacement at the fleet level for model years 1978-1981. It is important to note that the 1981 final CAFE data base used in this study is not the complete fleet (some manufacturers are missing); comparisons were made against a comparable 1981 D-file (with the same manufacturers omitted). Aggregation at the fleet level includes all manufacturers labeled and certified for U.S. sale during any given model year unless otherwise specified.

For most model years presented, sales seemed to shift slightly to favor lighter, more fuel efficient fleets than that projected at the start of the model year.

Individual Manufacturer Fleets

Percent differences of 55/45 MPG, average inertia weight and average displacement are also presented by manufacturer in Table 2 for model years 1978-1981. The domestic manufacturers had a tendency to overproject production but in most cases ended up with lighter more fuel efficient fleets based on actual production. Most foreign manufacturers underprojected production for the years listed. For some manufacturers (Fiat and JRT) there were very large differences between projected and actual production. Most manufacturer's %DIFF values show that when weight and displacement go down, fuel economy goes up and vice versa.

The large changes in fuel economy (1978 Peugeot for example) are attributed in most cases to late model introduction or elimination of a model from a manufacturer's product line altogether. A detailed analysis later in this report helps to pinpoint specific sales shift effects (e.g. weight mix,

Table 2
Percent Differences of Projected vs Actual Sales Comparisons by 55/45 MPG, Inertia Weight, Displacement and Ratio of Projected to Actual Sales

Manufacturer	MODEL YEAR 1978 Projected	%DIFF	Actual	MODEL YEAR 1979 Projected	%DIFF	Actual	MODEL YEAR 1980 Projected	%DIFF	Actual	MODEL YEAR 1981*** Projected	%DIFF	Actual
General Motors	18.83	+0.9	19.00	19.18	-0.3	19.13	21.30	+2.8	21.89	23.36	-0.9	23.15
	3818	-0.6	3794	3777	-0.3	3764	3500	-3.3	3384	3456	-0.2	3449
	296.1	-2.1	289.9	286.2	-0.6	284.6	240.6	-6.4	225.1	225.5	+0.8	227.2
	1.078			0.984			1.209			1.025		
Ford Motor Co.	18.33	+1.3	18.56	18.40	+4.2	19.18	21.71	+3.4	22.45	23.23	+0.5	23.34
	3952	-1.7	3885	3675	-1.5	3621	3406	-6.4	3187	3151	-2.7	3066
	291.3	-4.1	279.4	254.4	-2.4	248.2	229.9	-10.3	206.3	187.4	-1.0	185.5
	0.946			1.072			1.706			1.085		
Chrysler	17.80	+1.2	18.01	19.82	+1.4	20.09	19.99	+8.5	21.69	25.63	+1.6	26.05
	3962	-1.8	3892	3670	-2.6	3576	3498	-8.8	3189	2912	-2.4	2841
	282.4	-2.8	274.5	253.3	-5.8	238.7	231.6	-17.1	192.0	167.1	-5.9	157.3
	1.080			1.174			1.736			1.408		
Toyota	27.12	-1.1	26.82	24.13	-0.5	24.00	26.57	+3.1	27.40	30.30	+1.9	30.89
	2621	+0.0	2622	2713	-0.4	2701	2608	+0.5	2620	2653	-3.6	2557
	111.7	+0.8	112.6	112.8	0.0	112.8	119.6	-3.9	114.9	121.5	-6.3	113.9
	0.723			0.988			0.788			0.823		
Nissan (Datsun)	26.27	+1.9	26.77	26.43	+1.6	26.84	30.45	+2.6	31.23	31.46	-3.1	30.50
	2574	-1.6	2534	2555	-2.4	2494	2507	-1.8	2461	2482	+1.9	2530
	114.7	-3.3	110.9	112.8	-3.5	108.9	110.4	-5.2	104.7	109.2	+3.2	112.7
	0.884			1.068			0.845			0.938		
VW-Audi-Porsche	29.03	-6.4	27.17	30.65	-6.8	28.56	30.53	+2.6	31.32			
	2404	+0.2	2410	2385	+0.2	2389	2403	-0.4	2394	NA	NA	NA
	97.5	+0.3	97.8	97.0	+0.9	97.9	100.9	-1.6	99.3			
	1.289			1.426			0.803					
Honda	33.74	-0.1	33.72	31.22	-7.0	29.03	30.47	-4.2	29.18	30.95	-0.5	30.80
	2113	+0.6	2126	2245	+2.8	2308	2254	+3.4	2330	2303	+1.7	2343
	89.5	+0.9	90.3	95.2	+2.1	97.2	96.6	+3.1	99.6	97.9	+1.8	99.7
	0.813			1.010			1.010			1.009		
Mazda	35.13	+1.1	35.52	27.48	-6.7	25.63	26.89	-3.2	26.02	31.12	-0.2	31.07
	2270	-0.0	2269	2458	+3.9	2554	2455	+4.2	2559	2362	+3.7	2449
	78.0	0.0	78.0	80.7	+3.2	83.3	84.7	+8.3	91.8	92.7	+5.4	97.7
	0.820			0.567			0.704			1.078		
Mitsubishi	30.47	+0.4	30.59	30.15	+7.1	32.29	30.70	+6.0	32.53	31.68	+0.9	31.97
	2627	+0.3	2636	2524	-6.5	2359	2451	-4.1	2351	2358	-0.6	2345
	112.5	+2.2	115.0	113.2	-8.7	103.4	114.3	-7.5	105.7	105.0	+1.4	106.5
	0.660			1.363			0.979			0.969		
Subaru	31.63	-5.4	29.93	29.25	+1.0	29.54	27.81	+1.2	28.13	30.37	+3.0	31.27
	2351	+1.1	2376	2394	+0.4	2404	2382	+0.8	2402	2382	+0.8	2400
	97.0	0.0	97.0	97.0	0.0	97.0	99.0	-0.1	98.9	106.8	+0.2	107.0
	0.639			0.786			0.779			0.748		
American Motors	19.08	-2.6	18.58	19.60	+1.6	19.91	22.00	-2.2	21.51			
	3452	+2.3	3532	3379	0.0	3379	3160	+2.4	3237	NA	NA	NA
	244.8	+2.5	250.9	239.4	-2.9	232.4	208.1	+7.4	223.6			
	1.226			1.092			1.100					
Fiat-Lanc-Ferr	21.56	+0.8	21.74	24.64	+7.0	26.36	27.80	-4.4	26.59	27.46	+0.5	27.60
	2529	+0.3	2537	2514	-0.0	2513	2609	+0.8	2629	2633	-1.6	2591
	96.4	+2.6	98.9	106.1	-1.7	104.3	105.0	+4.2	109.4	110.4	+1.7	112.3
	1.115			0.581			2.205			2.577		
Volvo	21.11	+0.5	21.21	20.68	+1.7	21.04	20.79	+3.6	21.54	23.53	-5.4	22.27
	3347	-0.0	3346	3347	-1.2	3308	3276	+0.5	3294	3390	-0.2	3382
	138.2	-0.2	137.9	138.8	-3.3	134.2	139.3	-0.8	138.2	136.5	-2.5	133.1
	0.916			1.008			0.961			0.905		
Mercedes-Benz	19.16	-2.5	18.68	20.14	+1.7	20.48	24.61	-2.8	23.92	25.15	+1.7	25.59
	3970	+0.0	3971	3967	-0.4	3950	3705	+2.1	3781	3745	+0.1	3747
	203.1	+2.7	208.5	199.5	+2.0	203.4	190.1	+2.8	195.5	184.0	+0.1	184.2
	0.994			0.967			1.673			0.986		
BLMC (JRT)	20.80	+1.7	21.16	20.80	+2.1	21.24	21.58	-0.1	21.55	17.42	+6.4	18.54
	2778	-0.2	2772	2830	-4.2	2712	2817	-1.1	2787	4000	-6.0	3760
	127.2	-4.5	121.5	131.9	-8.1	121.2	133.0	-2.7	129.4	258.0	-8.8	235.3
	2.372			1.536			1.692			0.881		
BMW	19.99	-1.7	19.65	20.25	-0.9	20.07	25.28	+2.4	25.88	26.79	-0.9	26.55
	2929	+2.0	2988	3062	+0.3	3071	3061	-1.8	3005	2924	+0.8	2946
	135.5	+2.5	138.9	140.7	0.0	140.7	132.0	-3.3	127.7	121.4	+1.4	123.1
	0.935			0.989			1.066			1.056		
Renault	29.84	+1.7	30.34	30.06	-0.8	30.31	33.23	+0.2	33.29			
	2079	-1.6	2045	2056	+0.2	2061	2000	0.0	2000	NA	NA	NA
	81.3	-1.2	80.3	80.6	+0.2	80.8	85.0	0.0	85.0			
	0.547			1.777			0.991					
Saab	22.66	+0.4	22.76	22.66	-4.2	21.70	23.23	+0.6	23.36	23.67	-1.8	23.24
	3000	0.0	3000	3000	0.0	3000	2963	-0.1	2961	2971	+0.4	2984
	122.0	0.0	122.0	122.0	-0.8	121.0	121.0	0.0	121.0	121.0	0.0	121.0
	0.912			1.061			1.246			1.852		
Peugeot*	21.24	+16.9	24.83	26.30	-9.4	23.83	27.62			28.36	-1.4	27.95
	3500	0.0	3500	3500	0.0	3500	3500	NA	NA	3500	0.0	3500
	143.5	-3.8	138.0	136.9	+5.1	143.9	137.3			138.8	-0.3	138.4
	0.969			0.820			-			1.082		
Isuzu**	26.79	+0.3	26.86	29.01	+0.3	29.10				29.97	+15.7	34.68
	2500	0.0	2500	2500	0.0	2500	NA	NA	NA	2500	+2.2	2556
	111.0	0.0	111.0	111.0	0.0	111.0				111.0	0.0	111.0
	0.812			1.993						0.525		
Fleet	19.57	+1.6	19.89	20.11	+0.7	20.26	22.37	+5.1	23.51	24.91	+0.1	24.94
	3649	-1.6	3589	3507	-0.6	3485	3283	-5.6	3100	3126	-0.9	3098
	261.9	-3.9	251.6	240.8	-1.1	238.1	210.9	-11.1	187.4	185.3	-0.7	184.0
	1.015			1.034			1.239			1.048		

* 1980 Peugeot final CAFE was never calculated, used estimated data to calculate a final fleet number for Peugeot.
** Isuzu imported no passenger cars in Model Year 1980.
*** The 1981 Final Fleet is not complete at this time, however a truncated Projected Fleet was used for the 81 comparisons

transmission mix, etc.) on fuel economy at the manufacturer and fleet levels.

Leading Car Classes

Percent differences for 55/45 MPG, average displacement and average inertia weight are presented in Table 3 for the leading car classes. The Midsize and Large car classes reveal a tendency to overproject production most years, while Subcompact and Compact car classes show underprojection of production. The actual competition battlegrounds for the years of interest are Subcompact and Midsize with Large and Compact vehicles competing for third place. Actual fuel economy differences within each model year are either slightly higher or lower with no definitive pattern. Note the 1980 production overprojection by a factor of two for Large cars.

Newly-Introduced Model Types

Percent differences for 55/45 MPG, average displacement and average inertia weight are presented in Table 4A for selected model types. These are new models introduced during model year 1978 through 1980; their manufacturers' predictive abilities are tracked from introduction up until 1981. There does not seem to be any substantial MPG gains or losses within a model year due to sales shift even at the specific model type level. The domestics still continue to overproject production more than underproject for new models. The imports generally underprojected production (although Fiat generally has tended to overproject by large amounts as is illustrated by the Brava data).

Table 3

% Difference by Car Class Leaders 1978-1981

Car Class	1978			1979			1980			1981		
	Projected	% Diff	Actual	Projected	% Diff	Actual	Projected	% Diff	Actual	Projected	% Diff	Actual
Subcompact												
55/45 MPG	24.61	+0.0	24.62	24.35	-0.8	24.15	26.21	+3.4	27.11	28.69	+0.5	28.83
Inertia Weight	2870	-0.9	2844	2836	+0.2	2843	2721	-2.9	2643	2664	-1.4	2626
Displacement	163.7	-2.6	159.5	153.5	+0.9	154.9	138.4	-7.7	127.8	127.8	-2.0	125.2
Projected Sales/Actual Sales	0.939		-	1.018		-	0.949		0.969		-	
Compact												
55/45 MPG	19.78	+2.0	20.17	19.07	+1.9	19.44	22.40	+1.8	22.81	27.75	-0.8	27.52
Inertia Weight	3613	-1.7	3550	3663	-1.0	3628	3218	-2.4	3141	2776	-0.6	2758
Displacement	242.1	-2.7	235.6	247.2	-0.8	245.3	191.1	-4.9	181.7	132.1	+1.5	134.1
Projected Sales/Actual Sales	0.945		-	0.943		-	1.052		-	0.901		-
Midsize												
55/45 MPG	18.65	-0.5	18.56	18.90	+1.1	19.11	21.25	+1.7	21.62	23.26	-1.3	22.95
Inertia Weight	3800	+0.5	3820	3734	-0.6	3710	3416	-1.6	3362	3329	+0.5	3346
Displacement	293.1	-0.4	292.0	277.7	-1.9	272.4	239.8	-4.7	228.5	215.4	+2.0	219.8
Projected Sales/Actual Sales	1.109		-	0.999		-	1.279		-	1.167		-
Large												
55/45 MPG	16.77	+0.2	16.80	17.36	+0.1	17.37	18.79	+1.4	19.06	20.66	-1.2	20.41
Inertia Weight	4391	+0.1	4394	4198	+0.3	4210	4158	-0.7	4130	4086	+0.5	4108
Displacement	358.0	-0.3	357.1	336.3	+0.9	339.4	315.7	-0.6	313.8	294.6	+3.3	304.4
Projected Sales/Actual Sales	1.074		-	1.093		-	1.989		-	0.955		-

Table 4A

% Difference by Newly-Introduced Model Types 1978-1981

Model Types	1978			1979			1980			1981		
	Projected	% Diff	Actual	Projected	% Diff	Actual	Projected	% Diff	Actual	Projected	% Diff	Actual
Chrysler Omni/Horizon												
55/45 MPG	26.28	+4.8	27.54	27.52	+0.4	27.62	26.79	+0.9	27.04	31.10	+4.6	32.52
Inertia Weight	2500	0.0	2500	2523	-0.0	2522	2484	-0.6	2469	2448	-1.0	2424
Displacement	105.0	0.0	105.0	105.0	0.0	105.0	105.0	0.0	105.0	105.0	0.0	105.0
Projected Sales/Actual Sales	0.710		-	1.022		-	0.994		-	1.611		-
Ford Fairmont/Zephyr												
55/45 MPG	20.73	-1.0	20.52	19.94	+6.2	21.17	23.46	-1.1	23.20	22.83	-3.6	22.01
Inertia Weight	3212	-0.5	3196	3150	-1.0	3130	3028	-0.0	3027	3114	+0.0	3115
Displacement	226.4	-4.2	216.9	207.1	-4.7	197.3	181.7	+1.8	184.9	184.3	+2.0	188.0
Projected Sales/Actual Sales	1.112		-	1.035		-	1.076		-	1.158		-
General Motors X-Cars												
55/45 MPG							24.80	-1.0	24.54	25.71	-0.6	25.55
Inertia Weight	N/A	N/A	N/A	N/A	N/A	N/A	2886	+0.2	2892	2946	+0.3	2954
Displacement							163.0	-0.1	162.9	156.8	+1.5	159.2
Projected Sales/Actual Sales							0.947		-	1.062		-
Ford Fiesta												
55/45 MPG	37.39	-0.2	37.32	31.85	+0.7	32.07	29.93	-0.4	29.81			
Inertia Weight	2000	0.0	2000	2000	0.0	2000	2000	0.0	2000	N/A	N/A	N/A
Displacement	98.0	0.0	98.0	98.0	0.0	98.0	98.0	0.0	98.0			
Projected Sales/Actual Sales	1.140		-	0.941		-	0.789		-			
Fiat Brava												
55/45 MPG				25.09	+1.2	25.40	24.83	-2.3	24.26	26.67	+2.3	27.27
Inertia Weight	N/A	N/A	N/A	2750	0.0	2750	2964	-1.0	2933	2971	-1.3	2933
Displacement				122.0	0.0	122.0	122.0	0.0	122.0	122.0	0.0	122.0
Projected Sales/Actual Sales				0.814		-	2.345		-	3.659		-
Honda Prelude												
55/45 MPG							27.10	+0.3	27.18	28.36	+1.4	28.76
Inertia Weight	N/A	N/A	N/A	N/A	N/A	N/A	2500	0.0	2500	2500	0.0	2500
Displacement							107.0	0.0	107.0	107.0	0.0	107.0
Projected Sales/Actual Sales							0.813		-	0.905		-
Toyota Tercel												
55/45 MPG							34.36	+0.9	34.68	36.70	-0.1	36.65
Inertia Weight	N/A	N/A	N/A	N/A	N/A	N/A	2184	+0.6	2198	2250	0.0	2250
Displacement							89.0	0.0	89.0	89.0	0.0	89.0
Projected Sales/Actual Sales							0.669		-	0.622		-
Datsun 310												
55/45 MPG							34.58	-1.0	34.22	34.48	+0.5	34.64
Inertia Weight	N/A	N/A	N/A	N/A	N/A	N/A	2250	0.0	2250	2250	0.0	2250
Displacement							85.0	0.0	85.0	91.0	0.0	91.0
Projected Sales/Actual Sales							0.428		-	0.951		-
BMW 528 I												
55/45 MPG				20.00	+0.2	20.04	21.24	+0.4	21.33	21.31	0.0	21.31
Inertia Weight	N/A	N/A	N/A	3500	0.0	3500	3500	0.0	3500	3500	0.0	3500
Displacement				170.0	0.0	170.0	170.0	0.0	170.0	170.0	0.0	170.0
Projected Sales/Actual Sales				1.108		-	1.259		-	0.914		-

Table 4B rearranges the projected-to-actual production volume ratios for the new models to shed some light on the accuracy of projections as a function of time since introduction. Excluding Fiat, an obvious outlier, the average error (unsigned) in predicting production improves significantly in the second year and only marginally in the third year.

Table 4B

Projected/Actual Production Ratio, New Models

	1st Year	2nd Year	3rd Year
Chrysler Omni/Horizon	0.71	1.02	0.99
Ford Fairmont/Zephyr	1.11	1.04	1.08
GM X-Cars	0.95	1.06	-
Ford Fiesta	1.14	0.94	0.79
Fiat Brava	0.81	2.35	3.66
Honda Prelude	0.81	0.91	-
Toyota Tercel	0.67	0.62	-
Datsun 310	0.43	0.95	-
BMW 528I	1.11	1.26	0.91
RMS Error (excluding Fiat)	0.22	0.12	0.10

Analyses using the "Allocation Method"

The allocation program which has been used in the past to identify specific causes of year-to-year fuel economy changes was used here to determine specific causes of within year fuel economy changes. Specific background on the allocation method is available in Appendix B (an excerpt from SAE Paper No. 790225).

The specific areas the allocation method analyzes are listed in Table 5.

Table 5

Total Fuel Economy Change(2)
Divided In To Four Classes

Class Name	Isolates Changes Due to	Example
1. Powertrain Optimization	a) Engine Design changes b) Emission Control System Changes c) Transmission Design Changes d) Change in Test Procedure	1. Change from no-catalyst to oxidation catalyst, recalibration, (a) and (b). 2. Change from A3 transmission to L4 transmission (c). 3. Road load change in 1979, (d).
2. Transmission Mix Shifts	Changing proportion of transmission types.	Change to more manual transmissions.
3. Engine Mix Shifts	a) Changing proportion of different engine displacements b) Change in Gasoline/ Diesel mix	1. More smaller displacement engines, (a). 2. More Diesels, (b).
4. Weight Mix Shifts	a) Changes in sales of different IW classes b) Introduction/Termination of Models	1. More lightweight cars (a). 2. Addition of a new model with a new weight class.

The results for the allocation method will be presented by individual manufacturer and the fleet level in Tables 6 through 9 for model years 1978-1981. Additional results for specific car classes (Subcompact and Midsize) will be presented in Tables 10 through 17 respectively for model years 1978-1981.

Table 6 Allocation of Fuel Economy Changes from 1978D to 1978F for Passenger Car Fleet

Manufacturer	1978D* Car SwMPG	Percent Fuel Economy Change due to: Powertrain Optimization	Transmission Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1978F* Car SwMPG
American Motors	19.1	0.3	-0.3	0.3	-2.9	-2.7	18.6
Chrysler Corp.	17.8	-0.5	0.3	-0.2	1.5	1.1	18.0
Ford Motor Co.	18.3	-0.7	-0.2	0.7	1.4	1.3	18.6
General Motors	18.8	0.0	0.0	0.3	0.6	0.9	19.0
BMW	20.0	0.0	0.2	0.0	-1.8	-1.7	19.7
Mercedes-Benz	19.2	0.0	0.0	-2.5	-0.1	-2.6	18.7
Fiat-Lanc-Frari	21.6	1.3	0.4	-0.2	-0.5	0.8	21.7
Honda	33.7	-0.4	0.0	0.3	0.1	-0.1	33.7
Isuzu	26.8	0.5	-0.1	-0.1	0.0	0.3	26.9
Jag-Rov-Tri	20.8	0.7	0.0	-2.3	3.4	1.7	21.2
Nissan (Datsun)	26.3	-0.6	-0.3	0.3	2.6	1.9	26.8
Peugeot	21.2	-0.4	0.6	16.6	0.0	16.9	24.8
Renault	29.8	-0.1	0.0	0.6	1.2	1.7	30.3
Saab	22.7	-0.3	-0.2	0.9	0.0	0.4	22.8
Mitsubishi	30.5	0.2	0.1	0.8	-0.7	0.4	30.6
Mazda	35.1	-0.4	1.1	0.3	0.1	1.1	35.5
Toyota	27.1	-0.5	-1.0	0.1	0.2	-1.1	26.8
VW-Audi-Porsche	29.0	-0.6	0.1	-5.6	-0.4	-6.4	27.2
Volvo	21.1	-0.5	0.2	0.7	0.0	0.5	21.2
Subaru	31.6	-3.8	-1.0	1.3	-1.9	-5.4	29.9
FLEET	19.6	-0.3	0.0	0.2	1.7	1.6	19.9

* D means projected; F means actual

Table 7 Allocation of Fuel Economy Changes from 1979D to 1979F for Passenger Car Fleet

Manufacturer	1979D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimization	Transmission Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1979F Car SwMPG
American Motors	19.6	0.2	-0.1	1.4	0.2	1.6	19.9
Chrysler Corp.	19.8	-1.0	0.2	-0.2	2.4	1.4	20.1
Ford Motor Co.	18.4	3.0	0.1	-0.1	1.2	4.2	19.2
General Motors	19.2	-0.7	0.1	0.1	0.3	-0.3	19.1
BMW	20.3	0.0	0.0	-0.1	-0.7	-0.9	20.1
Mercedes-Benz	20.1	0.7	-0.6	0.3	1.2	1.6	20.5
Fiat-Lanc-Frari	24.6	1.3	-0.5	5.9	0.2	7.0	26.4
Honda	31.2	-4.6	1.4	-2.4	-1.6	-7.0	29.0
Isuzu	29.0	-0.1	-0.4	0.9	0.0	0.3	29.1
Jag-Rov-Tri	20.8	-1.3	0.0	-1.7	5.2	2.1	21.2
Nissan (Datsun)	26.4	-0.5	0.0	-0.6	2.6	1.6	26.8
Peugeot	26.3	-2.1	0.4	-7.9	0.0	-9.4	23.8
Renault	30.1	0.4	0.0	0.7	-0.2	0.8	30.3
Saab	22.7	-4.5	0.6	-0.4	0.0	-4.2	21.7
Mitsubishi	30.1	-0.1	-0.9	-0.1	8.4	7.1	32.3
Mazda	27.5	-0.5	-0.1	2.6	-8.6	-6.7	25.6
Toyota	24.1	-1.3	0.0	0.2	0.6	-0.5	24.0
VW-Audi-Porsche	30.6	0.0	1.2	-7.3	-0.6	-6.8	28.6
Volvo	20.7	-0.5	0.0	1.8	0.4	1.7	21.0
Subaru	29.3	0.0	1.0	0.5	-0.6	1.0	29.5
FLEET	20.1	0.2	0.0	-0.1	0.6	0.7	20.3

Table 8

Allocation of Fuel Economy Changes from 1980D to 1980F for Passenger Car Fleet

Manufacturer	1980D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimization	Transmission Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1980F Car SwMPG
American Motors	22.0	-0.1	0.1	-0.5	-1.7	-2.3	21.5
Chrysler Corp.	20.0	-0.8	0.0	0.4	9.0	8.5	21.7
Ford Motor Co.	21.7	-1.3	0.1	0.1	4.6	3.5	22.5
General Motors	21.3	-1.1	0.0	1.4	2.4	2.8	21.9
BMW	25.3	0.0	0.1	0.0	2.3	2.4	25.9
Mercedes-Benz	24.6	0.4	0.1	-1.2	-2.2	-2.8	23.9
Fiat-Lanc-Frari	27.8	-2.3	0.9	-1.0	-2.0	-4.4	26.6
Honda	30.5	-1.2	0.3	0.0	-3.4	-4.2	29.2
Jag-Rov-Tri	21.6	-0.5	0.0	-0.4	0.7	-0.2	21.6
Nissan (Datsun)	30.4	-1.6	-0.3	0.6	3.9	2.6	31.2
Renault	33.2	-0.2	0.0	0.4	0.0	0.2	33.3
Saab	23.2	-0.1	0.6	0.0	0.0	0.6	23.4
Mitsubishi	30.7	0.2	0.2	0.2	5.3	5.9	32.5
Mazda	26.9	0.0	0.2	4.0	-7.2	-3.2	26.0
Toyota	26.6	1.3	1.4	2.0	-1.6	3.1	27.4
VW-Audi-Porsche	30.5	-0.6	0.2	1.9	1.1	2.6	31.3
Volvo	20.8	0.0	0.0	3.6	-0.0	3.6	21.5
Subaru	27.8	2.3	0.0	0.3	-1.5	1.2	28.1
FLEET	22.4	-1.0	0.1	0.9	5.0	5.1	23.5

Table 9 Allocation of Fuel Economy Changes from 1981D to 1981F for Passenger Car Fleet

Manufacturer	1981D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimi-zation	Transmis-sion Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1981F Car SwMPG
Chrysler Corp.	25.6	-0.9	-0.1	-0.0	2.7	1.6	26.1
Ford Motor Co.	23.2	-1.9	0.2	-1.3	3.5	0.5	23.3
General Motors	23.4	-0.7	0.0	-0.4	0.2	-0.9	23.1
BMW	26.8	0.0	0.0	0.0	-0.9	-0.9	26.6
Mercedes-Benz	25.1	1.9	-0.0	-0.1	-0.0	1.7	25.6
Fiat-Lanc-Frari	27.5	1.3	0.4	-2.3	1.1	0.5	27.6
Honda	30.9	-0.1	1.2	0.2	-1.7	-0.5	30.8
Isuzu	30.0	-0.6	0.2	15.9	0.2	15.7	34.7
Jag-Rov-Tri	17.4	-0.7	0.0	0.5	6.7	6.4	18.5
Nissan (Datsun)	31.5	-1.2	-0.6	0.5	-1.6	-3.1	30.5
Peugeot	28.4	-0.7	-0.2	-0.5	0.0	-1.4	27.9
Saab	23.7	-1.6	0.6	0.0	-0.9	-1.8	23.2
Mitsubishi	31.7	0.0	0.5	-0.9	1.3	0.9	32.0
Mazda	31.1	-0.4	1.3	1.0	-2.0	-0.2	31.1
Toyota	30.3	-1.0	-0.4	0.2	3.2	1.9	30.9
Volvo	23.5	-0.4	0.0	-5.1	0.1	-5.4	22.3
Subaru	30.4	3.6	0.5	0.1	-1.2	3.0	31.3
FLEET	24.9	-0.8	0.1	-0.5	1.4	0.1	24.9

Table 10

Allocation of Fuel Economy Changes from 1978D to 1978F for Subcompact Passenger Cars

Manufacturer	1978D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimi-zation	Transmis-sion Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1978F Car SwMPG
American Motors	21.4	-0.1	-0.2	1.9	-3.0	-1.5	21.1
Ford Motor Co.	37.4	-0.5	0.0	0.3	0.0	-0.2	37.3
General Motors	20.8	-0.5	-0.0	-0.3	2.0	1.2	21.0
BMW	20.0	0.0	0.2	0.0	-0.4	-0.3	19.9
Mercedes-Benz	0.0	0.0	0.0	0.0	0.0	0.0	14.2
Fiat-Lanc-Frari	20.0	1.1	0.9	0.0	7.6	9.8	22.0
Honda	34.7	-0.8	0.0	0.2	0.0	-0.5	34.5
Isuzu	26.8	0.5	-0.1	-0.1	0.0	0.3	26.9
Jag-Rov-Tri	13.1	8.8	0.0	-2.8	0.0	5.7	13.8
Nissan (Datsun)	24.5	-0.8	-0.1	0.0	8.5	7.6	26.4
Mazda	35.5	-0.5	1.2	0.3	0.4	1.4	36.0
Toyota	27.3	-0.4	-1.0	0.1	0.2	-1.2	27.0
VW-Audi-Porsche	31.9	-0.4	-0.2	-7.1	0.3	-7.3	29.6
FLEET	24.6	-0.4	-0.2	-1.0	1.6	0.0	24.6

Table 11 Allocation of Fuel Economy Changes from 1979D to 1979F for Subcompact Passenger Cars

Manufacturer	1979D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimi-zation	Transmis-sion Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1979F Car SwMPG
American Motors	20.8	0.2	0.0	0.3	0.0	0.6	20.9
Chrysler Corp.	27.5	-1.0	1.0	0.3	0.0	0.3	27.6
Ford Motor Co.	22.8	2.6	-0.2	-1.5	0.7	1.6	23.2
General Motors	21.3	-0.7	0.5	0.7	0.7	1.1	21.6
BMW	21.3	0.0	-0.0	-0.2	-0.0	-0.3	21.2
Mercedes-Benz	0.0	0.0	0.0	0.0	0.0	0.0	14.2
Fiat-Lanc-Frari	24.7	-0.1	-0.3	-1.1	0.4	-1.2	24.4
Honda	30.1	-1.2	0.0	0.6	-7.2	-7.8	27.7
Isuzu	29.0	-0.1	-0.4	0.9	0.0	0.3	29.1
Jag-Rov-Tri	11.0	0.0	0.0	0.5	0.0	0.5	11.1
Nissan (Datsun)	28.2	-1.6	0.2	-0.8	3.8	1.5	28.6
Mitsubishi	31.2	-0.2	-0.2	0.2	9.6	9.4	34.2
Mazda	33.6	-0.4	-0.1	0.0	-5.4	-5.9	31.6
Toyota	24.2	-1.6	0.0	0.3	0.3	-1.0	23.9
VW-Audi-Porsche	33.6	0.2	1.5	-8.7	0.3	-6.9	31.3
FLEET	24.4	-0.2	0.3	-0.5	-0.4	-0.8	24.1

Table 12 Allocation of Fuel Economy Changes from 1980D to 1980F for Subcompact Passenger Cars

Manufacturer	1980D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimi-zation	Transmis-sion Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1980F Car SwMPG
American Motors	22.8	-0.7	0.0	0.1	-0.6	-1.1	22.6
Chrysler Corp.	26.8	1.2	-0.1	0.0	-0.2	0.9	27.0
Ford Motor Co.	25.2	-2.1	0.2	0.6	1.7	0.4	25.3
General Motors	23.5	-0.9	0.1	-0.1	4.0	3.0	24.2
BMW	26.1	0.0	0.1	0.0	1.0	1.1	26.4
Mercedes-Benz	18.3	0.0	0.0	0.0	0.0	0.0	18.3
Fiat-Lanc-Frari	24.8	-1.9	0.6	-2.2	1.3	-2.3	24.3
Honda	26.9	-0.1	0.6	-0.0	0.0	0.5	27.1
Jag-Rov-Tri	15.1	-0.9	0.0	0.0	-4.9	-5.7	14.2
Nissan (Datsun)	32.0	-1.3	-0.5	0.6	1.6	0.4	32.1
Mitsubishi	31.7	0.3	0.1	0.2	4.2	4.7	33.2
Mazda	31.5	0.0	0.3	0.1	-6.3	-6.0	29.6
Toyota	26.6	1.6	1.7	2.0	-2.1	3.2	27.4
VW-Audi-Porsche	32.2	-0.5	0.2	1.1	1.7	2.5	33.0
Subaru	29.1	3.9	0.0	-0.1	-3.2	0.5	29.3
FLEET	26.2	-0.5	0.3	0.4	3.2	3.4	27.1

Table 13 Allocation of Fuel Economy Changes from 1981D to 1981F for Subcompact Passenger Cars

Manufacturer	1981D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimi-zation	Transmis-sion Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1981F Car SwMPG
Chrysler Corp.	30.3	2.5	1.9	-2.5	-1.2	0.6	30.4
Ford Motor Co.	25.0	-1.8	0.3	-2.2	0.5	-3.2	24.2
General Motors	26.3	-1.8	0.1	-0.2	2.3	0.4	26.4
BMW	27.3	0.0	0.0	0.0	-0.5	-0.5	27.1
Mercedes-Benz	19.7	-0.3	0.0	0.0	0.0	-0.3	19.6
Fiat-Lanc-Frari	25.0	4.3	0.3	-5.0	1.1	0.5	25.1
Honda	28.0	-0.1	1.5	0.1	0.0	1.4	28.4
Isuzu	30.0	-0.6	0.2	15.9	0.2	15.7	34.7
Nissan (Datsun)	32.5	-1.1	-0.7	0.5	-1.4	-2.7	31.6
Mitsubishi	31.7	0.0	0.5	-0.9	1.3	0.9	32.0
Mazda	34.5	-0.4	1.3	0.0	-3.2	-2.4	33.7
Toyota	30.0	-1.0	-0.4	0.2	2.5	1.3	30.4
Subaru	31.4	3.2	-0.5	0.1	1.8	4.7	32.8
FLEET	28.7	-0.8	0.2	-0.4	1.6	0.5	28.8

Table 14

Allocation of Fuel Economy Changes from 1978D to 1978F for Midsize Passenger cars

Manufacturer	1978D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimi-zation	Transmis-sion Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1978F Car SwMPG
American Motors	13.6	-0.4	0.0	0.0	0.0	-0.4	13.5
Chrysler Corp.	16.2	-0.7	0.0	-1.2	1.4	-0.5	16.2
Ford Motor Co.	17.9	-0.8	0.1	-0.1	-0.4	-1.2	17.7
General Motors	19.9	-0.1	0.0	0.6	-0.1	0.4	19.9
Mercedes-Benz	13.9	-0.1	0.0	-0.1	0.0	-0.3	13.9
FLEET	18.6	-0.4	0.1	0.1	-0.2	-0.5	18.6

Table 15

Allocation of Fuel Economy Changes from 1979D to 1979F for Midsize Passenger Cars

Manufacturer	1979D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimi-zation	Transmis-sion Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1979F Car SwMPG
Chrysler Corp.	18.4	-0.3	0.0	-0.5	2.2	1.4	18.7
Ford Motor Co.	17.0	3.2	0.1	0.9	0.2	4.3	17.8
General Motors	20.1	-0.5	0.0	-0.3	0.0	-0.8	20.0
Mercedes-Benz	13.9	-0.1	0.0	-2.1	0.0	-2.2	13.6
Saab	0.0	0.0	0.0	0.0	0.0	0.0	21.6
FLEET	18.9	0.6	0.0	0.0	0.5	1.1	19.1

Table 16

Allocation of Fuel Economy Changes from 1980D to 1980F for Midsize Passenger Cars

Manufacturer	1980D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimization	Transmission Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1980F Car SwMPG
Chrysler Corp.	18.8	-1.3	0.0	0.4	3.2	2.3	19.3
Ford Motor Co.	21.9	-1.0	0.1	-0.4	2.2	0.9	22.1
General Motors	21.8	-1.2	0.0	1.4	0.2	0.5	21.9
Mercedes-Benz	18.3	0.0	0.0	0.0	0.0	0.0	18.3
Saab	23.0	-0.1	0.7	0.0	0.0	0.6	23.2
FLEET	21.3	-1.2	0.1	0.9	1.9	1.7	21.6

Table 17

Allocation of Fuel Economy Changes from 1981D to 1981F for Midsize Passenger Cars

Manufacturer	1981D Car SwMPG	Percent Fuel Economy Change due to : Powertrain Optimization	Transmission Mix Shifts	Engine Mix Shifts	Weight Mix Shifts	All Changes Combined	1981F Car SwMPG
Chrysler Corp.	24.3	-1.4	0.2	0.3	0.6	-0.2	24.3
Ford Motor Co.	22.0	-2.0	-0.1	-1.2	1.4	-1.9	21.6
General Motors	23.4	-0.9	-0.0	-0.2	-0.5	-1.6	23.1
Mercedes-Benz	19.5	-0.1	0.0	0.0	0.0	-0.1	19.5
FLEET	23.3	-1.2	0.0	-0.3	0.1	-1.4	22.9

Discussion of Allocation Results

Overall fleet fuel economy changes for all model years confirms the previous finding using % DIFF, with the decrease in weight accounting for most of the positive fuel economy changes. Powertrain optimization is responsible for most of the negative effects on fuel economy for all years but 1979. However, the engine mix and weight mix gains cancel out these negative effects. Shifts in the transmission mix at the fleet level has no impact at all for within year fuel economy changes.

The two most notable within-year fuel economy increases by manufacturer were the 1978 Peugeot fleet and the 1981 Isuzu fleet. In both cases, new Diesel model types present in the actual fleets were not present in these projected fleets, hence are responsible for fuel economy increases of 16.9% and 15.7% respectively. Weight mix shifts, engine mix shifts or a combination of the two were the major factors of within-year fuel economy increases for most manufacturers, although six manufacturers' within-year fuel economy increases were attributed to positive shifts in powertrain optimization. These include the 1978 Fiat and Isuzu fleets, the 1980 Subaru fleet and the 1981 Mercedes-Benz, Fiat and Subaru fleets.

The most notable within year-fuel economy decrease was the 1979 Peugeot fleet, the influencing factor being an engine mix shift. A closer look at sales shifts revealed actual gasoline engine production was higher than projected. Nine manufacturers had within-year fuel economy losses attributed mainly to negative effects of powertrain optimization. These include the 1978 Subaru fleet, the 1979 GM, Honda, Saab and Toyota fleets, the 1980 GM, Saab and Subaru fleets and the 1981 Fiat and JRT fleets.

The only manufacturer fleet where a transmission mix shift was the major contribuing factor was the 1978 Toyota fleet. This is the result of higher actual automatic transmission production than projected.

Allocation analysis results for the Subcompact class (see Tables 10-13) were varied ranging from no within year fuel economy change in 1978, a loss of about 1% in 1979, and fuel economy gains in 1980 and 1981 respectively of 3.4% and 0.5%. Weight mix shifts tend to be a major factor in both fuel economy losses and gains for the Subcompact fleet.

Notable within-year manufacturer fuel economy increases include the 1978 Nissan fleet, the 1979 Mitsubishi fleet and the 1981 Isuzu fleet. The first two increases are attributed to weight mix shifts. The Isuzu fleet increase is due to the presence of a new Diesel model type not included in pre-model year Isuzu forecasts.

Within-year fuel economy decreases include the 1978 and 1979 VW fleets and the 1979 Honda fleet. The VW losses are due to sales shifts favoring gasoline-powered engines. The Honda loss is attributed to a heavier average weight of their Subcompact fleet.

The major factor influencing the Midsize fleet (see Tables 14-17) within-year change for 1978, 1979 and 1981 is powertrain optimization. The 1980 Midsize fleet is most influenced by weight mix shifts. No large fuel economy changes were evident for any Midsize producer for the model years of interest.

Conclusions

1. Neither overprojection nor underprojection of production seem to affect fuel economy significantly at any level of aggregation (the fleet, by manufacturer, car class). If a manufacturer projects overall production incorrectly, the actual production distribution among MPG values within a manufacturer product line seems to stay relatively the same, keeping overall average MPG relatively constant for individual manufacturers. The fleet MPG can still be affected by the projected vs. actual mix among manufacurers, however.

2. Overall fuel economy based on the final fleets was higher than that of the projected fleets for all model years 1978 through 1981. The opposite seems to be true for model year 1982.

Recommendations

1. When the 1982 and 1983 final CAFE's data are available, the allocation program should be run to detect any within year fuel economy changes.

2. The mid-year CAFE estimates received by DOT from the manufacturers should be acquired to provide improved data bases (compared to the pre-model year forecasts) in the long interval awaiting final CAFE data.

References

1. "Fuel Economy Labeling and the Corporate Average Fuel Economy (CAFE) Data Base, Proposed Improvments," Federal Register, Vol. 45, No. 190, Monday, September 29, 1980, pp. 64540-64544.

2. "Refinement of Allocation Program," Memo, Karl H. Hellman to Charles L. Gray, dated January 18, 1983.

3. "Fuel Economy of Motor Vehicles", Manual of Federal Regulations: Title 40 - Part 600.

Appendix A

Quick-look at Model Year 1982: A change in the Projected-to-Actual pattern?

The body of this report concentrated on model years 1978-1981 because Final CAFE data for 1982 are essentially nonexistent. "Midyear" estimates submitted to DOT by the manufacturers in the summer of 1982 have been received and examined, however. Since these updates are very near the end of the model year, it would appear that they should closely resemble the Final CAFE figures.

Figure A-1 illustrates the comparison between Final and Midyear manufacturers' fleet MPG values. It does indeed show that 80 percent of the available manufacturers' Midyear estimates for 1979, 1980 and 1981 were within ± 0.5 MPG of their Final CAFE figures. On an MPG basis, therefore, the Midyear estimates have been a very good approximation of Final CAFE results.

Figure A-2 plots Final production volumes against Midyear estimate volumes. (These are transformations of the actual figures, to conceal manufacturer identities.) The plot shows that 85 percent of the Midyear production estimates have been within ± ten percent of Final production volumes. Clearly then, the Midyear estimates are a good approximation of Final production volumes also.

Having shown that, for all practical purposes, Midyear = Final, it is valid to compare 1982 Midyear results to 1982 projections, in the same way that the earlier years' Final figures were compared to their projections.

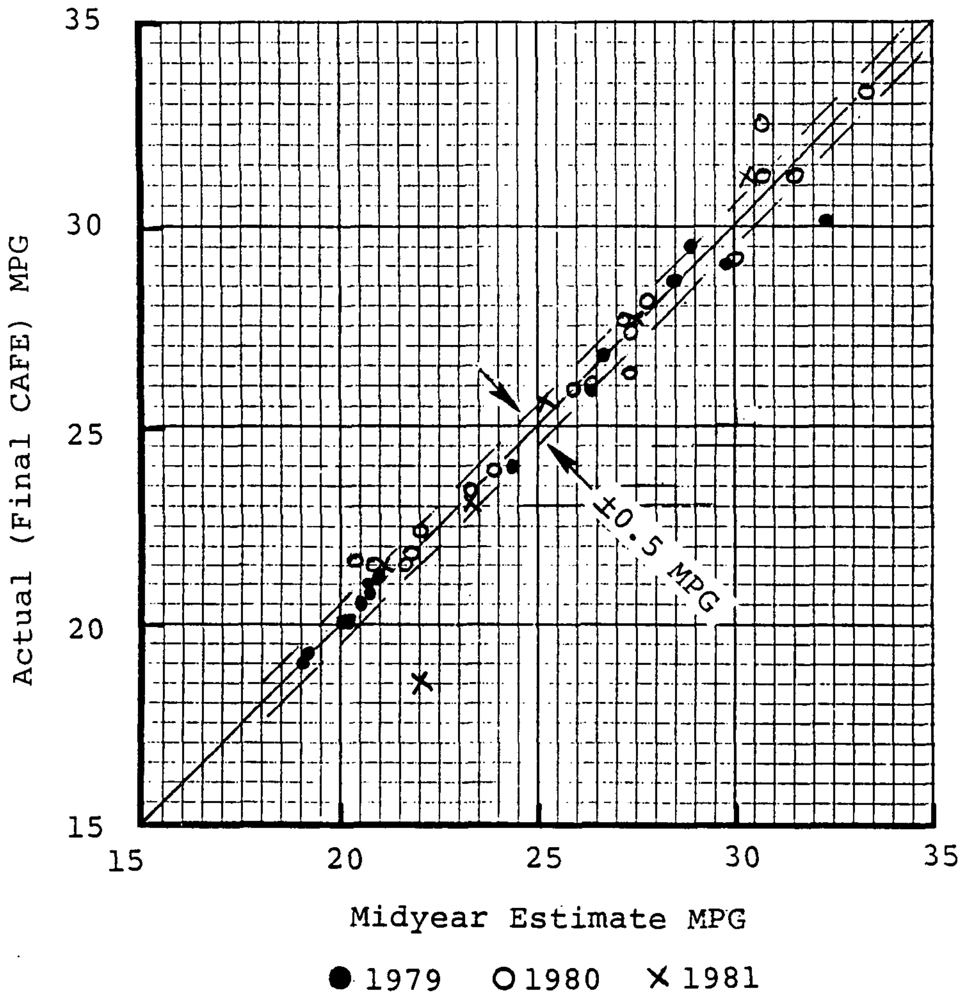

Figure A-1
Final CAFE fuel economy vs. Midyear estimate

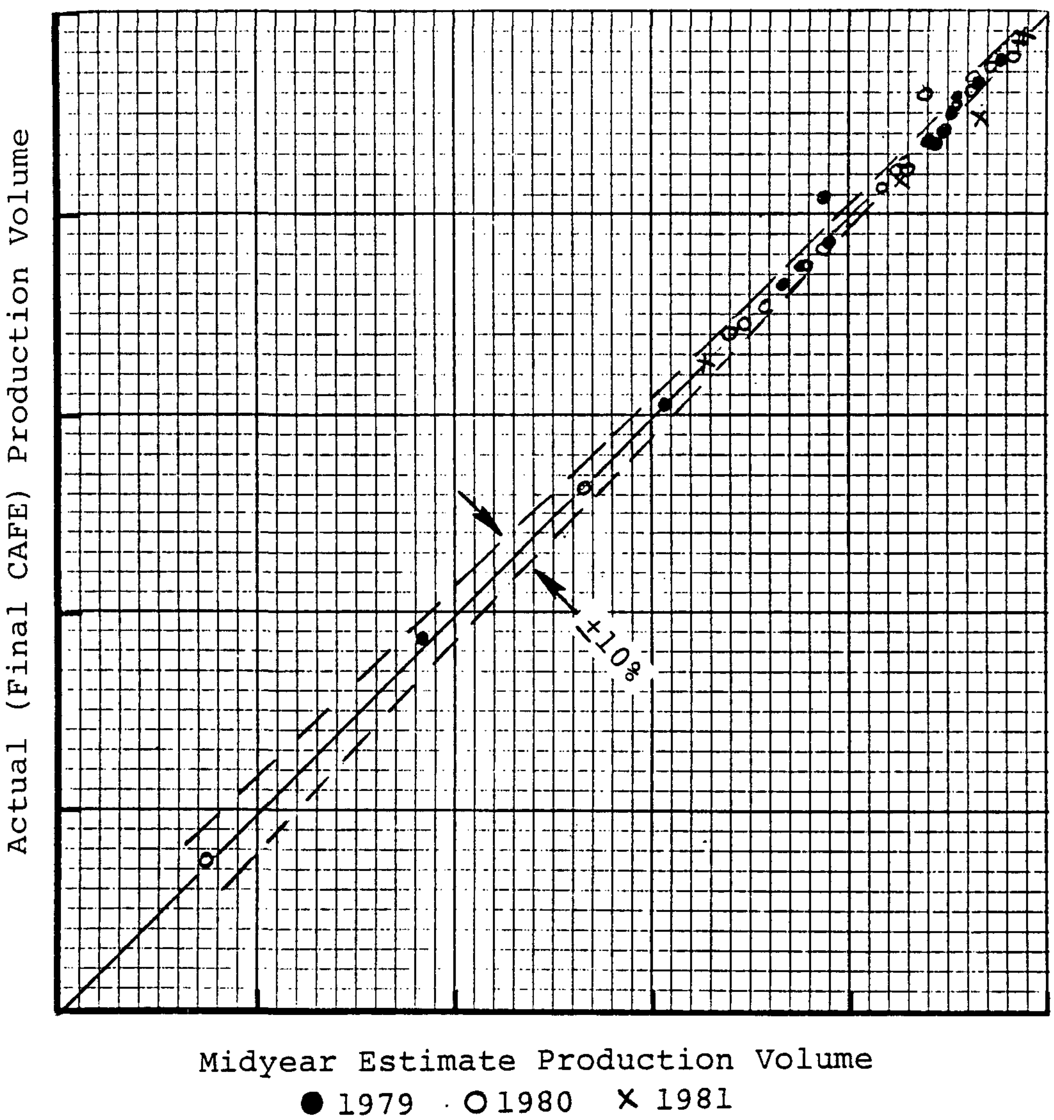

Figure A-2

Final CAFE production volume vs. Midyear estimate

Figure A-3 is the result, using the now extended 1978-1982 data base. Plotting the ratio of actual-to- projected MPG vertically and the ratio of actual-to-projected production volume horizontally, four quadrants are defined as follows:

1. Upper right - MPG and volume were both underestimated;

2. Lower right - MPG overestimated, volume underestimated;

3. Lower left - MPG and volume both overestimated; and

4. Upper left - MPG underestimated, volume overestimated.

In Figure A-3, open circles denote 1978 through 1981 data, and filled circles denote 1982 data. Obviously, something changed in 1982, as illustrated by Table A-1. This is a count, by quadrant of Figure A-3, of the manufacturer forecasting track record. The quadrant that the overall fleet data falls into is also shown in this table, as a darkened box.

Conclusions are:

- For a majority of the manufacturers, and for the fleet, production volumes have been OVERprojected consistently from 1979 through 1982.

- For a majority of the manufacturers, and for the fleet, MPG was UNDERprojected consistently from 1978 through 1981.

- In 1982, however, MPG was OVERprojected for a majority of the manufacturers and for the fleet.

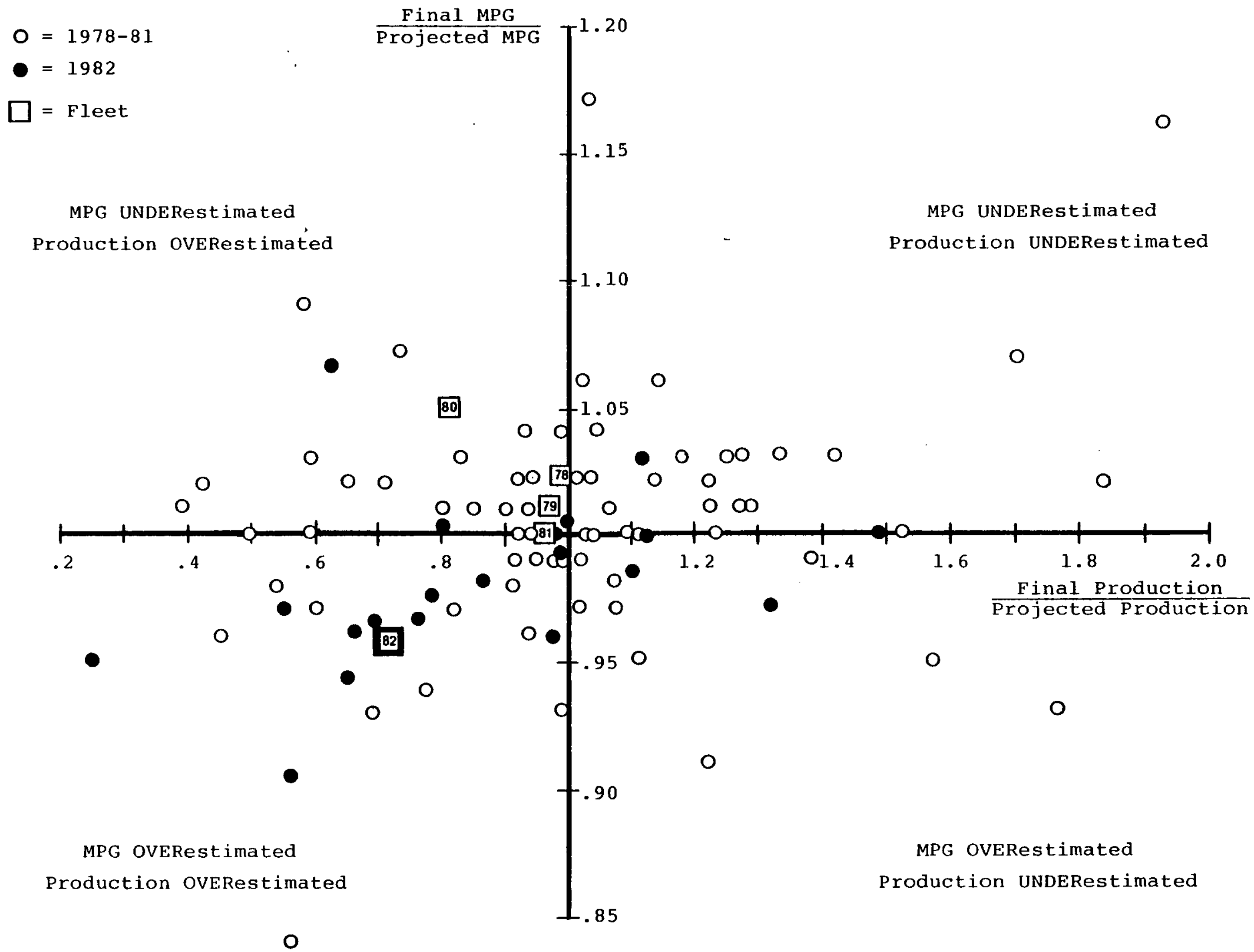

Figure A-3

Projected vs. Actual MPG and Production Volume

Table A-1

Sales and MPG forecasting Track Record, 1978-1982

	Underprojected Sales Underprojected MPG	Underprojected Sales Overprojected MPG	Overprojected Both	Overprojected Sales Underprojected MPG
1978 Manufacturers	45%	25%	10%	20%
Fleet				[redacted]
1979 Manufacturers	15%	25%	20%	40%
Fleet				[redacted]
1980 Manufacturers	39%	6%	28%	28%
Fleet				[redacted]
1981 Manufacturers	35%	12%	35%	18%
Fleet				[redacted]
1982 Manufacturers	20%	10%	60%	10%
Fleet			[redacted]	

APPENDIX B

Calculation Methodology for Fuel Economy Change Allocation

The procedure for computing fleet fuel economy changes due to specific factors, such as system optimization and weight mix shifts, involves the construction of matched sets of data from a base fleet (e.g. 1978) and a new fleet (e.g. 1979), and calculation of intermediate sales-weighted fleet fuel economy values for the matched sets. Depending on the degree of matching, the data sets being compared include only certain known changes between the sets, and hence the calculated intermediate fleet MPG values reflect the fuel economy effects of only those specific changes in fleet makeup.

CALCULATION OF DIFFERENCES DUE TO SYSTEM OPTIMIZATION: To determine the differences in fuel economy between the 1978 and 1979 cars due to system optimization, it was necessary to limit the comparison to nominally identical vehicles. For each manufacturer it was established which 1978 and 1979 models were identical in terms of weight, displacement, and transmission type. When this was established a new set of sales fractions was calculated, based on 1978 sales estimates, using only those combinations which were carried over from 1978 to 1979. Two sales-weighted fuel economy values were calculated using equation (2) [see text]: one calculation using 1978 model MPG values and 1978 carryover sales fractions, and one using the 1978 model MPG values, also with 1978 carryover sales fractions. The difference between the two values reflects the change in fuel economy due to what we have called system optimization. Since the weights, displacements, transmissions - and their sales distributions - are matched, any difference in fuel economy is due to other factors. The main factors which could be contributing to such a system optimization change in fuel economy are:

- Emission control system design changes;
- Engine design and/or calibration changes;
- Changes in transmission efficiency, shift scheduling, or gear ratios;
- Axle ratio changes;
- Changes in test procedure which influence fuel economy.

DIFFERENCES DUE TO TRANSMISSION MIX SHIFTS: In the analysis of fuel economy changes due to system optimization, any IW/CID/transmission combination not common to both years was eliminated from consideration, and the sales distribution of those combinations that were carried over was held at the 1978 mix. If the calculation is repeated using only weight/displacement combinations as the determinants for model year carryover, those IW/CID/transmission combinations that are not common to both sets of data are not "sifted out", but remain in their respective data bases; also, each of the data bases retains its own sales split between automatics and manuals within the carryover IW/CID combinations.

Again, two SWMPG values are calculated using equation 2, wherein the first MPG_i is the harmonic mean sales-weighted fuel economy of each manufacturer's 1978 models in IW/CID class i, and the second MPG_i is the fuel economy of his 1979 models in IW/CID class i. Both of these SWMPG values are based on the same mix of the IW/CID classes (the 1978 mix), so the difference between the two is due to system optimization plus all changes in transmission mix.

DIFFERENCES DUE TO ENGINE MIX SHIFTS: Similarly, by sifting for carryover at only the weight class level, all differences in the IW/CID structures of the fleets are allowed to remain. The difference between the two SWMPG values calculated on this basis is thus due to system optimization, transmission mix shifts, and shifts in the mix of engine displacements*.

DIFFERENCES DUE TO WEIGHT MIX SHIFTS: The bottom-line SWMPG values calculated from the full, unperturbed data bases, each with its own sales mix, includes all of the above effects plus the effect of non-carryover weight classes and the 1979 redistribution of sales among carryover weight classes.

Table B-1 summarizes the above calculation methodology, and Figure B-1 shows a diagram of the relationship between the various calculated SWMPG values. Since the methodology is suitable for a comparison between any two vehicle sets (49-states vs. California, cars vs. trucks, manufacturer X vs. Y, etc.), Table B-1 and Figure B-1 are notated for the general case rather than the year-to-year case.

Table B-2 illustrates the equations for separation of individual factors from the combined effects discussed above.

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* This also includes shifts in the mix of engine standards/systems; Fed vs. Cal. and Spark vs. Diesel.

Table B-1 - Method for Constructing Fuel Economy Comparisons between Two Vehicle Groups

Configuration Determinants	Vehicle Group "A" MPG Base(mpg_i)	Sales Base(f_i)	Fleet SWMPG	Vehicle Group "B" MPG Base(mpg_i)	Sales Base(f_i)	Fleet SWMPG	A-to-B SWMPG Change Attributed To:
IW/CID/Transmission Type	A	A	$FE_{AA}ICT$	B	A	$FE_{BA}ICT$	System optimization in carryover I/C/T combinations
IW/CID	A	A	$FE_{AA}IC$	B	A *	$FE_{BA}IC$	Above plus new/discontinued I/C/T combinations plus shifts in transmission mix within carryover I/C combinations
IW	A	A	$FE_{AA}I$	B	A **	$FE_{BA}I$	Above plus new/discontinued I/C combinations plus shifts in engine mix within carryover IW classes
Open	A	A	FE_{AA}	B	B ***	FE_{BB}	Above plus new/discontinued IW classes plus shifts in IW mix among carryover IW classes

* Includes B mix of transmissions within c/o IC classes.
** Includes B mix of CT combinations within c/o weight classes.
*** Includes B mix of all ICT combinations in group B.

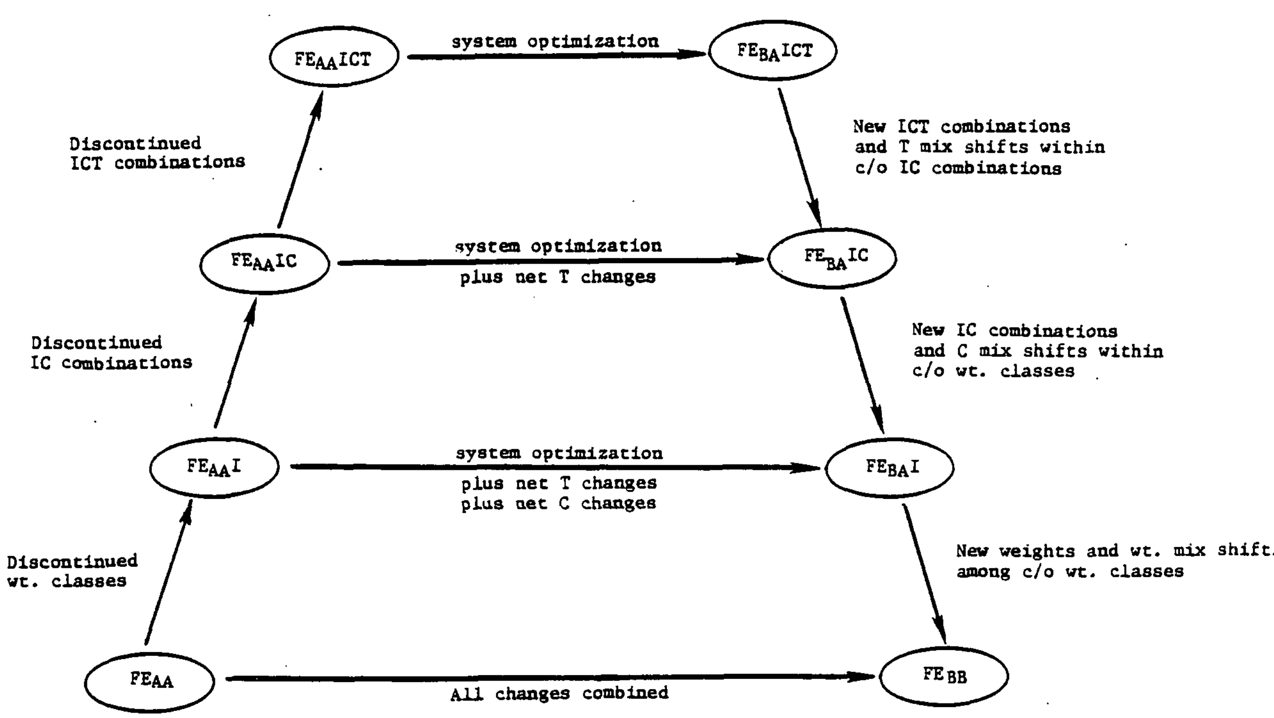

Fig. B-1 - Relationships between SWMPG values from table B-1

Table B-2 - Isolation of Specific Factors Causing Fuel Economy Change

Percent Change in Fuel Economy Due To:	Calculated By:
Systems Optimization	$\left[\left(\frac{FE_{BA}ICT}{FE_{AA}ICT}\right) - 1\right] \times 100$
Transmission Mix Shifts	$\left[\left(\frac{FE_{BA}IC}{FE_{AA}IC} \div \frac{FE_{BA}ICT}{FE_{AA}ICT}\right) - 1\right] \times 100$
Engine Mix Shifts	$\left[\left(\frac{FE_{BA}I}{FE_{AA}I} \div \frac{FE_{BA}IC}{FE_{AA}IC}\right) - 1\right] \times 100$
Weight Mix Shifts	$\left[\left(\frac{FE_{BB}}{FE_{AA}} \div \frac{FE_{BA}I}{FE_{AA}I}\right) - 1\right] \times 100$
All Changes Combined	$\left[\left(\frac{FE_{BB}}{FE_{AA}}\right) - 1\right] \times 100$