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COMMISSION AUTHORIZED

BEFORE THE
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
Washington, D.C.

Intent to Prepare an Environmental Impact Statement for the Corporate Average Fuel Economy Program	)	49 CFR Part 531 [Docket No. FR-89-19, #1]

COMMENTS OF THE STAFF OF THE BUREAU OF ECONOMICS OF THE FEDERAL TRADE COMMISSION*

Washington, D.C. 20580
November 13, 1989

* These comments are the views of the staff of the Bureau of Economics of the Federal Trade Commission. They are not necessarily the views of the Commission or of any individual Commissioner.

I. Introduction and Summary

On September 12, 1989, the National Highway Traffic Safety Administration (NHTSA) issued a Notice of Intent asking for comments about the potential environmental impacts of Corporate Average Fuel Economy (CAFE) standards on automobiles.[1] Comments are requested to aid NHTSA in the preparation of an Environmental Impact Statement (EIS) for the CAFE program. A major environmental effect of the CAFE program comes from changes in gasoline consumption due to the enforcement of the standards. In response to NHTSA's request, the staff of the Bureau of Economics of the Federal Trade Commission ("the staff") submits the following conceptual and quantitative analysis of the consequences of higher CAFE standards for gasoline consumption.[2] For standards set for years close at hand, these comments present both conceptual analysis and quantitative estimates of possible changes in gasoline consumption. While we do not present quantitative estimates of the effects of standards set for years farther in the future, we present conceptual analysis concerning these effects.

Economic theory suggests that a binding CAFE standard can have several effects on gasoline consumption. Firms may choose to meet the standard either by engaging in technological innovation or by selling relatively

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[1] 54 Federal Register 37702 (September 12, 1989). There is a similar program in place for light trucks which we will not discuss in these comments.

[2] These comments are the views of the staff of the Bureau of Economics of the Federal Trade Commission. They are not necessarily the views of the Commission or of any individual Commissioner. Inquiries regarding these comments should be directed to staff economist Andrew N. Kleit, Bureau of Economics, Federal Trade Commission, Washington, D.C., 20580, (202) 326-3481.

more fuel-efficient and fewer fuel-intensive vehicles. Through these means, CAFE standards can push consumers into more fuel-efficient vehicles than they otherwise might use. This, by itself, would serve to decrease gasoline consumption. There are, however, other effects of a binding CAFE standard that may serve to affect fuel consumption. These comments discuss four such effects and factor them into estimates of gasoline savings provided by various CAFE standards. First, by changing the price of new cars, CAFE standards can change the scrappage rate of used cars. Second, by increasing the fuel-efficiency of newer vehicles, CAFE standards can lower the cost of driving additional miles, which may increase the number of miles travelled. Third, by altering the relative prices of automobiles, CAFE standards can change the number of vehicles on the road. Finally, by constraining the sales of less fuel-efficient vehicles by companies that face a binding CAFE constraint, CAFE standards can indirectly decrease the fuel-efficiency of the vehicles sold by firms that do not face a binding CAFE constraint.[3]

The current NHTSA model may mis-estimate the consumption savings from higher CAFE standards, if, as appears to be the case, it does not take account of the factors noted above. We will present estimates that indicate that consideration of such factors can significantly change the expected gasoline savings from the CAFE program. Therefore, we urge that NHTSA take these factors into account in any EIS that attempts to measure the conservation effect of CAFE standards.

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[3] In the body of the comments we refer to these effects as the "scrappage effect," the "mileage effect," the "market elasticity effect," and the "market substitution effect," respectively.

II. Experience of the Staff of the Federal Trade Commission

The Federal Trade Commission (FTC) is an independent regulatory agency responsible for fostering competition and safeguarding the interests of consumers.[4] Upon request by federal, state, and local government bodies, the staff of the FTC frequently analyze regulatory proposals to identify provisions that may impair competition or increase costs to consumers without offering compensatory benefits. The FTC also has a statutory responsibility to review complaints that the CAFE standards harm competition.[5]

The FTC staff has accumulated significant experience in examining the effects of CAFE standards over the past few years. In 1986, the FTC staff submitted comments when NHTSA was considering modifying CAFE standards for Model Years (MY) 1987 and 1988.[6] In 1988 the staff of the FTC's Bureau of Economics submitted comments when NHTSA was considering modifying CAFE

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[4] 15 U.S.C. Section 41 *et seq.*

[5] The Secretary of the Department of Transportation may modify or waive CAFE civil penalties under certain limited circumstances, one of which is certification by the FTC that waiver or modification is necessary to prevent harm to competition. 15 U.S.C. § 2008 (b)(3)(C). The statute provides that a manufacturer may petition the FTC for a certification that modification of the civil penalty "is necessary to prevent a substantial lessening of competition in that segment of the automobile industry subject to the standard with respect to which such penalty was assessed." 15 U.S.C § 2008 (b)(4).

[6] Comments of the Bureaus of Competition, Consumer Protection, and Economics of the Federal Trade Commission, *Passenger Automobile Average Fuel Economy Standards Model Year 1987-88*, National Highway Traffic Safety Administration, Docket No. FE-85-01, March 26, 1986. (Hereinafter cited as FTC Staff Comments (1986).)

standards for MYs 1989 and 1990.[7] In addition, members of the FTC staff have conducted a series of studies of the effects of the CAFE law.[8]

III. Description of the CAFE Program

The CAFE program, as enacted in 1975, calls for all auto manufacturers producing more than 10,000 automobiles per year to satisfy the mandated CAFE levels. The program establishes average MPG standards that apply to a manufacturer's entire fleet, rather than to the fuel-efficiency of individual models. CAFE levels were scheduled to rise from 18.0 MPG in 1978 to 27.5 MPG in Model Year (MY) 1985 and all subsequent years. Failure to satisfy the MPG standard can result in the imposition of civil penalties.[9]

The CAFE legislation divided each manufacturer's fleet into two distinct groups -- foreign and domestic. Average MPG for a manufacturer's

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[7] Comments of the Staff of the Bureau of Economics of the Federal Trade Commission to the National Highway Traffic Safety Administration, "Passenger Automobile Average Fuel Economy Standards for Model Years 1989 and 1990," September 15, 1988. (Hereinafter cited as FTC Staff Comments (1988).)

[8] See A. Kleit, "The Economics of Automobile Fuel Economy Standards," Ph.D. dissertation, Yale University, 1987. Also see Kleit, "The Impact of Auto Fuel Standards," FTC Working Paper No. 160, February 1988, and "Enforcing Time Inconsistent Government Regulations," FTC Working Paper No. 161, March 1988; R. Rogers, "The Short-Run Impact of Changes in the Corporate Average Fuel Economy Standards," Bureau of Economics Staff Manuscript, March 1986.

[9] The fine for a firm out of compliance is equal to $50 times the number of cars made by the producer in a given model year times the amount (in miles per gallon) that the producer is out of compliance (Public Law 46:15-2008). So far, however, no domestic manufacturers, and only a few small European firms, have actually paid fines.

domestic cars and foreign cars[10] are each calculated separately.[11] The provision was designed to induce domestic firms to produce high-MPG cars in the U.S.[12]

Although the CAFE standards are set by statute,[13] NHTSA is empowered to adjust through rulemakings the CAFE standard for MY 1985 and any subsequent year to the "maximum feasible average fuel economy level." In determining this maximum feasible level, NHTSA is required to consider four factors: (1) technological feasibility, (2) economic practicability, (3) the effect of other federal motor vehicle standards on fuel economy, and (4) the need of the nation to conserve energy.[14] NHTSA acted to lower the required MPG standard from 27.5 MPG to 26.0 MPG for MYs 1986 through 1988 and from 27.5 MPG to 26.5 MPG for MY 1989. The standard for MY 1990 remains at the original statutory level of 27.5 MPG.

During the time that CAFE standards have been in force, average automobile fuel efficiency has risen significantly. The limited available quantitative evidence indicates, however, that a significant reason for this rise has been the increase in gasoline prices rather than the imposition of standards. Research by Crandall and Graham[15] indicates that

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[10] A foreign car is defined as one having less than 75% of its value added produced in the United States.

[11] 53 Federal Register 33080 (August 29, 1988).

[12] NHTSA Annual Report on Fuel Economy, 1982, 9.

[13] Title V of the Motor Vehicle Information and Cost Savings Act, 15 U.S.C. 2001 *et seq.*

[14] 53 Federal Register 33081 (August 29, 1988).

[15] Robert W. Crandall and John D. Graham, "The Effect of Fuel Economy Standards on Automobile Safety," *Journal of Law and Economics* 32:2 (April, 1989), 97-118.

only a small part of the increase in fuel-efficiency can be attributed to CAFE standards forcing firms to change the mix of the fleet of cars sold. Crandall and Graham also find no significant technological innovations in automobile fuel efficiency introduced as a result of CAFE standards between 1978 and 1986.

IV. Economic Effects of CAFE Standards That May Affect Gasoline Conservation

Domestic automotive gasoline consumption is determined by three factors: (1) the average number of gallons of gasoline required to drive a mile, (2) the average number of miles driven per vehicle, and (3) the total number of vehicles owned by American consumers. By establishing standards for newly produced cars, CAFE regulations directly address only the first of these factors. If the latter two factors do not change subsequent to the imposition of CAFE standards, and if the rate of replacement of existing large cars is not reduced in response to the standards, then the program may fulfill its objective of reducing total fuel consumption. It may be unlikely, however, that these factors would remain constant. Changes in these factors can be expected to influence actual gasoline savings.

When CAFE standards become binding[16] on a particular firm, that firm

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[16] A "binding" CAFE standard is one that changes the average fuel-efficiency of the automobiles produced compared to the average fuel-efficiency that would have resulted if no CAFE standard existed. Thus, for example, if a firm's fleet averages 35 MPG and a CAFE standard of 27.5 MPG were established, the standard would not be binding on that firm. If the firm's fleet averages 25 MPG, the standard would be binding on that firm.

has two methods by which it can raise its CAFE rating. First, it can engage in "technology forcing" by changing the technology in its vehicles so that they become more fuel-efficient. Second, in both the short and the long run, the firm can engage in what may best be termed as "mix-shifting."[17]

Technology forcing is a long-run phenomenon because it generally requires engineering modifications that could take several years to implement. Thus, such actions are more likely to occur if firms are told of the relevant CAFE standard several years in advance. Further, for technology-forcing to occur, firms must have reason to believe that the standard is likely to be upheld once the date for its enforcement is reached. Otherwise, they may not have sufficient incentives to increase the fuel-efficiency of their vehicles to the mandated standard. Such innovation may, while lowering the per-mile costs of driving, generate substantial production costs which may be passed on to consumers.

If technology forcing is used to meet a particular CAFE standard, gasoline savings will be influenced by the "scrappage effect." While technological progress may increase new car average fuel-efficiency over time, the improvements may lead to an increase in the price of new vehicles that may be greater than the savings to consumers in reduced fuel operating costs. To the extent that this is true, the scrappage rates of used cars, which are likely to be less fuel-efficient than new cars, will

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[17] In the long run a firm has the choice of meeting a standard either by "technology-forcing" or "mix-shifting." It can be expected to use both in a manner such that the marginal cost to the firm of using either method is equal. See Kleit (1988b), supra note 8.

be reduced (and the price of used cars will rise).[18] Of course, the relative fuel efficiency of new cars versus used cars depends on the rate of technological innovation, which in turn depends on such factors as gasoline prices and the level of relevant CAFE standards.[19]

Gasoline savings generated by technology forcing may also be influenced by the "mileage effect." A binding CAFE standard may induce consumers to buy more fuel-efficient vehicles than they otherwise would. Since the gasoline cost of driving additional miles for these consumers is reduced, they likely will be induced to drive more miles than they otherwise would. It has been estimated that a 10 percent increase in fuel-efficiency of particular vehicles leads to an increase in miles driven of approximately 3 percent.[20] Thus, a 10 percent increase in fuel-efficiency can be expected to decrease fuel consumption slightly less than 7 percent for those consumers who are induced to buy more fuel-efficient vehicles than they otherwise would.

Firms also may meet binding standards set in years close at hand and those set to take effect several years in the future by mix-shifting.

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[18] This phenomenon has been observed in other regulatory contexts. For example, it has been shown that increasing the stringency of pollution controls can actually increase pollution (in net present value terms) by delaying the replacement of older, more pollution-intensive automobiles. See Howard K. Gruenspecht, "Differentiated Regulation: A Theory with Applications to Automobile Emission Controls," Yale University Ph.D. dissertation, 1982, and Gruenspecht, "Differential Regulation: The Case of Auto Emissions Standards," *American Economic Review* 72:3 (1982), 328-331.

[19] If technological progress does generally increase fuel-efficiency over time, it implies that for CAFE standards to be remain binding they will have to rise over time.

[20] See Roger D. Blair, David L. Kaserman, and Richard C. Tepel, "The Impact of Improved Gasoline Mileage on Gasoline Consumption," *Economic Inquiry* (1984) 209-217.

Mix-shifting means that a manufacturer will raise the price, and reduce the quantity sold (relative to the prices and quantities otherwise dictated by market forces), of cars having low-MPG ratings, and reduce the price, and raise the quantity sold, of cars offering high-MPG ratings. In effect, mix-shifting implies that the automaker has established an internal system of quasi-taxes and subsidies for its autos.[21] The change in price of each type of car depends primarily on the relation of that car's fuel-efficiency to the CAFE standard (the less fuel efficient a particular model, the greater the internal tax).

Like technology forcing, mix-shifting will contribute to the "scrappage effect" and the "mileage effect." Mix-shifting may cause two additional effects. First, mix-shifting can generate what we refer to as the "market elasticity effect." CAFE standards implicitly act as a tax on new large cars and as a subsidy on new small cars.[22] Depending on demand and supply conditions, the increase in the number of small cars produced (and subsequently purchased by consumers) could more than offset the decline in large cars produced (and subsequently purchased by consumers).[23] In general, this would tend to diminish the extent to which fuel consumption would decline if large car production fell by as much as small car production rose. On the other hand, if the increase in small car

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[21] By artificially decreasing large car production, and increasing small car production, a higher CAFE standard is conceptually similar to placing a tax on large cars, and a subsidy on small cars. See John E. Kwoka Jr., "The Limits of Market Oriented Regulatory Techniques: The Case of Automotive Fuel Economy Standards," *Quarterly Journal of Economics* (1983), 695-704, and Kleit (1987) and (1988).

[22] See the discussions in Kleit (1988) and FTC Staff Comments (1988).

[23] See Kwoka, supra at 702.

production were more than offset by the decrease in large car production, CAFE standards could certainly decrease the number of new cars on the road. This would tend to increase the decline in gasoline consumption as a result of CAFE standards.

Second, mix-shifting also may generate what we have termed the "market substitution effect." In general, some firms (those with fleet MPGs above the relevant level) may not be constrained by a particular CAFE standard. Manufacturers unconstrained by CAFE standards will have incentives to sell larger, less fuel-efficient vehicles. This is because their rivals will not be able to meet the demand for these types of automobiles and thus the prices of these automobiles will rise. Thus, while CAFE standards can be expected to raise the average fuel efficiency of those firms bound by the standards, CAFE standards may also lower the fuel efficiency of those firms not bound by the standards, depending upon those firms' competitive strategies and distance from the CAFE standard.

For example, currently General Motors and Ford appear to be constrained in large car production by CAFE standards while Chrysler is not. Chrysler would thus appear to have a comparative advantage over GM and Ford in the production of new fuel-efficient vehicles. Consequently, if newly binding CAFE standards cause the prices for large new cars produced by GM and Ford (e.g., Cadillacs and Lincolns) to rise, Chrysler might be able to increase its profits by producing more of its large models (e.g., the New Yorker) without jeopardizing its compliance with the standard. Thus, Chrysler's average fleet MPG could decline if CAFE standards required a rise in the fleet MPGs of GM and Ford. (This example also applies to several foreign manufacturers who are not bound by CAFE standards.)

Mix-shifting may also have important impacts on the scrappage effect. CAFE standards may act to raise the price of new large cars, which implies that consumers will hold used large cars longer, and therefore will scrap them later. This implies that in the near term used large cars, which can be expected to be less fuel-efficient than new large cars, will stay on the road longer and consume more gasoline. Mix-shifting also implies, however, that the price of new small cars relative to the price of large cars may be reduced, which implies that owners of used small or large cars may replace them with new small cars, which can be expected to be more fuel-efficient. First-time purchasers accordingly may be more inclined to buy a small car than they otherwise would be.

There are factors other than the four effects enumerated above that may also affect the estimates of changes in gasoline consumption due to CAFE standards. For instance, CAFE standards on automobiles, which raise the price of relatively fuel-inefficient automobiles, may increase the demand for light-duty trucks. If more light-duty trucks were purchased, gasoline consumption would likely increase because light-duty trucks presently have less stringent CAFE standards than automobiles (around 20.5 MPG as opposed to 27.5 MPG).[24] Unfortunately, we are currently unaware of any empirical estimates that would aid in determining the potential magnitude of such switching. Nor can we say how long the differential in CAFE standards between light trucks and automobiles will continue. We

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[24] Light truck MPG standards have been set in the range 20.0 to 20.5 MPG for MYs 1986 through 1991. 54 Federal Register 37703 (September 12, 1989).

therefore do not include this effect in any of the estimates that we present in Section V.

The factors discussed in this section may have important impacts on any estimates of gasoline consumption savings due to CAFE standards. It appears that these factors are not currently taken account of in NHTSA's model of gasoline savings due to CAFE standards.[25]

V. Simulation Results of CAFE Standards on Gasoline Conservation

In this section, we generate quantitative estimates of the magnitude of the four effects discussed in Section IV (the scrappage effect, the mileage effect, the market elasticity effect, and the market substitution effect). The model we presented in FTC Staff Comments (1988) uses various assumptions to generate estimates of the gasoline savings that would have occurred had NHTSA chosen CAFE standards above 26.6 MPG for MY 1989. (26.6 MPG is the highest level at which a CAFE standard would have been nonbinding for major producers in MY 1989.) A description of this model is contained in the technical appendix to these comments.

We note that this model is designed to calculate the "short run" effects of higher CAFE standards.[26] It was devised to address whether to

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[25] Our knowledge of NHTSA's method for estimating gasoline savings due to CAFE standards comes from "Final Regulatory Impact Analysis: Average Fuel Economy Standard for Model Year 1989 Passenger Automobiles," Plans and Policy Office of Regulatory Analysis, National Highway Traffic Safety Administration, September 28, 1989 ("RIA").

[26] By "short run" we mean that the model is designed to measure the effects of NHTSA's lowering or raising the CAFE standard under its administrative discretion immediately prior to a particular model year or for a year close at hand. Under such conditions, we assume that manufacturers do not have the opportunity to engage in "technology forcing". It therefore must meet the higher CAFE standard solely by "mix-shifting".

change the CAFE standard for a model year close at hand, a question NHTSA has addressed several times since 1985. It is assumed in the model that firms reach the higher CAFE standards entirely through mix-shifting. The model is not directly applicable to estimating the long term effects of raising a CAFE standard today on automobiles to be produced several years from now, although the qualitative effects discussed in Section IV would still apply. It is presented here to give some examples of how these effects may influence an estimate of gasoline savings.[27] We note that it may be expected that CAFE standards effectively set for several years in the future may have a larger impact on gasoline savings than the same standards set for years close at hand if technology forcing is a part of firms' compliance strategies for future years.

Our model first estimates the changes in the composition of the fleet of MY 1989 cars produced under various CAFE standards. It then estimates the changes in gasoline consumed by this fleet and the stock of used cars over the next 15 years. Future gasoline savings are discounted at an annual rate of four percent. The model abstracts from possible exogenous shocks in such areas as gasoline prices and regulatory policy that may occur to the fleets of cars sold after MY 1989.

Figure 1 traces the gasoline consumption savings from progressively higher CAFE standards, assuming these standards had been put into effect for MY 1989. The dotted "No Effects" line traces the estimated savings under the assumption that the sole effect of a CAFE standard is to raise the average MPG of MY 1989 cars produced by firms for which the standard

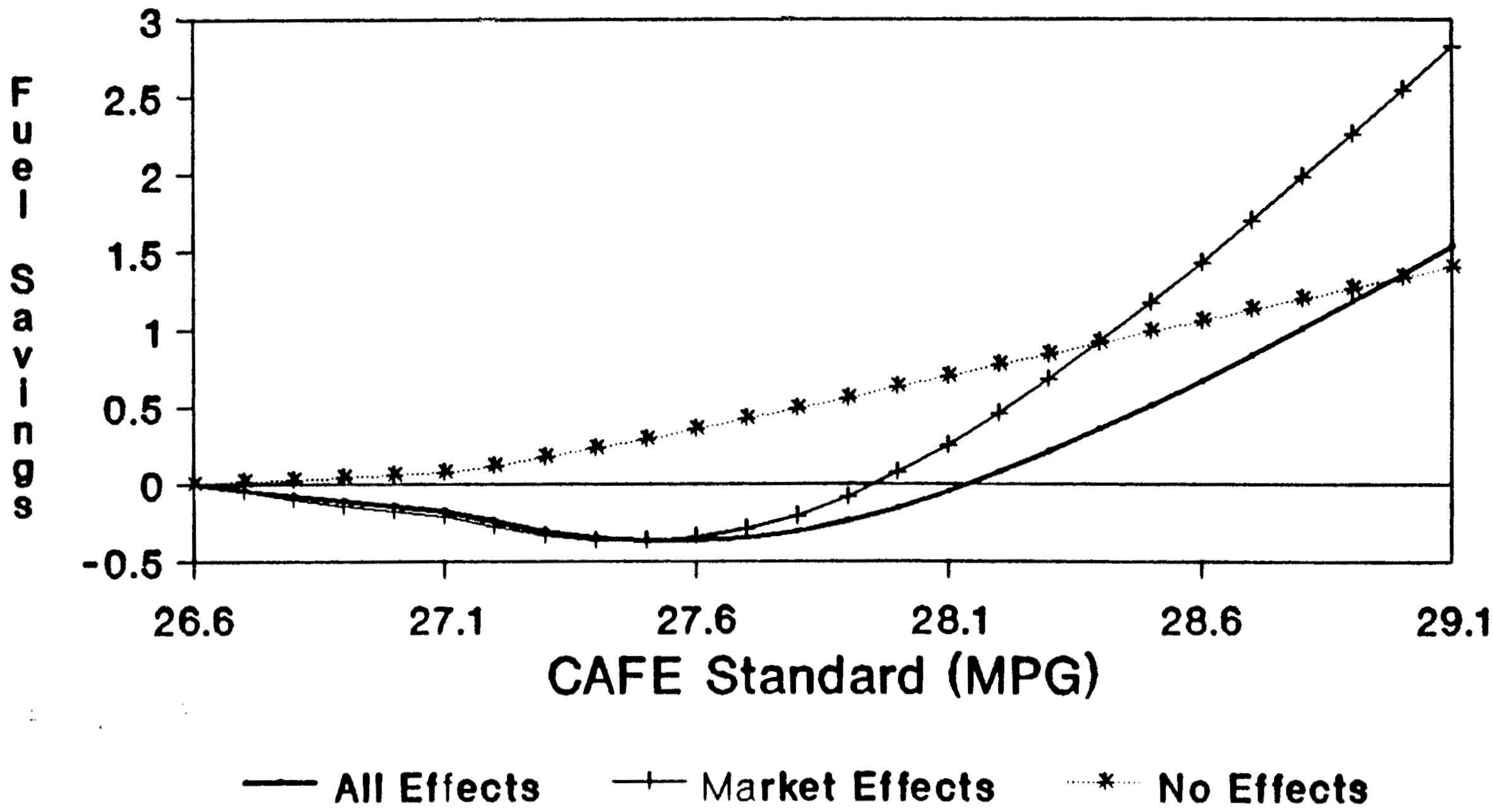
[27] The figures presented here are not meant to be precise estimates of the effects of any particular CAFE policy that NHTSA may pursue.

is binding. It therefore fails to account for any of the four effects discussed above. The dotted "No Effects" line is always positively sloped and very close to linear (except for the kink between 27.1 and 27.2 MPG, where the CAFE constraint would become binding on General Motors). According to this initial analysis, stricter CAFE standards generate ever increasing gasoline savings.

The thin solid line, labeled "Market Effects," traces the estimated savings after taking account of the "market substitution" and "market elasticity" effects. This line is below the dotted "No Effects" line for CAFE standards up to 28.4 MPG. The reduction in gasoline savings in this range is largely driven by the "market elasticity" effect. That is, this analysis suggests that a binding CAFE standard below 28.4 MPG would have acted to put more vehicles on the road, leading to more gasoline consumption. Above 28.4 MPG, this analysis suggests that CAFE standards would have acted to decrease the number of cars on the road, increasing the amount of gasoline conserved relative to the "No Effects" case.

The thick solid line, labeled "All Effects," traces the estimated gasoline savings after taking account of the "scrappage effect" and the "mileage effect," as well as the two "Market Effects." The "All Effects" line is roughly equivalent to the "Market Effects" line for CAFE standards of less than 27.6 MPG (CAFE increases of up to 1.0 MPG over the nonbinding level). In this range, the gasoline savings due to increased small car scrappage rates, and replacement by more fuel-efficient new small cars, roughly equals the increased consumption due to decreased large car scrappage rates. Above 27.6 MPG, the "All Effects" line is well below the "Market Effects" line, largely because in this range sufficient

Figure 1
Gasoline Savings From CAFE Standards
Various Assumptions - MY 1989



Fuel Savings from FTC Staff Model in Billions of Gallons (Present Value) numbers of used large cars remain in service to decrease estimated gasoline savings.

Taking account of all four effects, the model estimates that CAFE standards up to approximately 28.1 MPG (increases of up to 1.5 MPG above the nonbinding level of 26.6 MPG) for MY 1989 would cause increased gasoline consumption relative to what would have occurred with a standard at or below 26.6 MPG. The model also estimates that CAFE standards above 28.1 MPG would have decreased gasoline consumption relative to a nonbinding standard.[28] Indeed, the model estimates that a 29.1 MPG CAFE standard would have led to slightly greater gasoline consumption savings than indicated by the "No Effects" model, because a good deal fewer cars would have been on the road.

These results indicate that some CAFE standards may not reduce gasoline consumption. We note that alternative policies directed towards reducing the consumption of gasoline (and thereby reducing pollution),

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[28] While the model set forth in the appendix estimates that a standard of 28.5 MPG would have reduced gasoline consumption by 505 million gallons, it would have cost the U.S. economy an estimated $9.7 billion in economic deadweight loss. $5.3 billion of this loss accrues to U.S. consumers (with the costs of higher prices on large cars greatly outweighing the benefits of lower prices on small cars) and U.S. producers lose $4.4 billion (as losses on small cars greatly outweighing higher profits on large cars). This generates a cost to society of approximately $19.22 per gallon saved. In other words, the benefits of such a CAFE policy would have exceeded the costs if the negative externality associated with consuming a gallon of gasoline was greater than $19.22. A 28.5 MPG standard would have also led to a decrease in domestic automobile industry employment of approximately 100,000 jobs. Similar results pertain to other CAFE standard levels in this region. Again, we note that these figures, whose derivation is explained in the appendix, are not meant to be precise estimates of the effects of any particular CAFE standard. Rather, they are meant to be qualitative estimates of the impacts of binding CAFE standards.

such as a gasoline tax which would directly discourage consumers from using gasoline, may generate higher gasoline savings.[29]

We reiterate that these estimates use an explicitly short-run model that tracks the gasoline consumption changes caused by a higher CAFE standard for a particular model year close at hand. Standards set for several years in the future, if they can be credibly enforced, may have greater impacts on gasoline savings. We believe, however, that this model gives us reason to conclude that the four factors discussed here have important consequences for any estimate of gasoline savings due to CAFE standards.

VI. Conclusion

When NHTSA calculates an estimate of the gasoline savings due to CAFE standards that may be required for an EIS or for other regulatory proceedings, we urge that it take account of possible effects of CAFE standards on (1) the scrappage rates of used vehicles; (2) the tendency for drivers to alter miles driven for different fuel-efficiency levels; (3) total industry output; and (4) producers unconstrained by CAFE standards. These factors, individually and together, may serve to significantly affect the potential for gasoline savings for CAFE standards. Therefore, we believe NHTSA should consider these factors in estimating gasoline savings from CAFE standards.

[29] See the discussion on this issue in FTC Staff Comments (1988).

Technical Appendix*

Andrew N. Kleit

* This appendix has been prepared by a staff member of the Bureau of Economics of the Federal Trade Commission. It does not necessarily reflect the views of the Commission or any individual Commissioner.

I. Description of Automobile Market Model

The automobile market model presented here is the same as that used in FTC Staff Comments (1988). It is an extension of the model used by Kleit (1987, 1988), and is very similar to the simulation used in FTC Staff Comments (1986). Model year (MY) 1987 serves as the base period.

In the model there are five types of automobiles: (1) Asian Basic Small, which includes regular minicompacts and subcompacts such as the Sentra, the Corolla, and the Hyundai; (2) Asian Luxury Small, which includes specialty subcompacts and regular compacts such as the RX7 and the Stanza; (3) American Basic Small, which includes minicompacts and subcompacts such as the Cavalier and the Escort; (4) American Luxury Small, which includes specialty subcompacts and regular compacts, such as the Reliant K and the Mustang; and (5) American Large, which includes intermediate and large cars such as the Cutlass, the LTD, and the New Yorker. This breakdown is based on categories used by *Ward's Automotive Yearbook*.[1] Luxury European cars, which constitute about 4 percent of the market, are excluded from the model. Volkswagen and Yugo cars are included in the American Basic small segment. On-shore Asian production (autos built by Asian firms in the United States) is included in the Asian segments. "Captive" imports (autos built by Asian firms but sold under American nameplates) are included in the Asian segments.

During the 1980s, Japanese car sales in the United States have been restricted by import quotas ("voluntary restraint agreements").[2] Currently the quota is set at 2.3 million units. However, during MY 1987 Japanese imports were only about 2.25 million units. In model year 1988 Japanese imports fell to 2.05 million units, as on-shore Japanese production increased.[3] Thus, the initial implicit tariff is set in the model to 0.

Each segment is divided into constrained and unconstrained production. Constrained are Japanese imports (potentially by the import quota) and General Motors and Ford (by CAFE standards). Unconstrained production includes on-shore Asian and off-shore non-Japanese Asian (Korean) output,

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[1] *Ward's Automotive Yearbook* (1988), p. 155 and 233.

[2] On-shore Japanese production is not covered by the import restraints.

[3] Data received from Oak Ridge National Laboratory.

Chrysler, Volkswagen, and Yugo.[4] The quantities, prices, and fuel-efficiencies for each type of car for MY 1987, are shown in Table A-1.

Equilibrium automobile prices and quantities are computed through a series of five demand and thirteen supply equations. Quantity demanded is determined by a set of linear demand curves[5]

$$(1)\ Q^D = AP + B$$

where Q is the vector of five quantities, P is the price vector, A is a five by five matrix of slope coefficients, and B is a vector of intercepts.

Quantity supplied is determined by a set of linear supply curves

$$(2)\ Q^S = C(P-T) + D(P-V) + EP + F$$

where C is a diagonal five by five matrix of supply coefficients for GM and constrained Japanese firms, D is a diagonal matrix of supply coefficients for Ford (with the first two diagonal elements equalling zero), E is a diagonal five by five matrix of supply coefficients for the unconstrained firms, F is a vector of supply curve intercepts, and T is a vector of implicit taxes, $T' = (T_1, T_2, T_3, T_4, T_5)$. T is applied to General Motors and offshore Japanese production. T_1 and T_2 are the implicit tariffs for each type of off-shore Japanese car, $T_1 = T_2$. T_3, T_4, T_5 are the implicit CAFE taxes applied to each type of American car produced by GM.[6] V is a vector of implicit taxes applied to Ford. $V' = (V_1, V_2, V_3, V_4, V_5)$, where $V_1 = V_2 = 0$. The level of these implicit taxes will be generated by the model. The model assumes that GM and Ford will choose to meet the relevant CAFE standard rather than pay CAFE fines.

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[4] The closest of these producers to being constrained by CAFE standards is Chrysler, which generally obtains CAFE ratings in the range of 27.5 to 28.5 MPG. P.E. Godek ("The Corporate Average Fuel Economy Standard: 1978-1988," Mimeo, Economists Inc., Washington D.C., January, 1989) indicates that for model year 1989 Chrysler would have approximately 5.6 MPG worth of CAFE credits available. For example, if the standard for model year 1989 had been set at 27.5 MPG, Chrysler could have had a CAFE rating as low as 21.9 MPG before it would have run out of credits. Chrysler could also have borrowed credits from the future. Thus, the model will assume that Chrysler would be unconstrained by any of the CAFE standards used in Section VI of our comments above.

[5] With the imposition of a CAFE standard, linear demand curves generate less deadweight loss than constant elasticity curves.

[6] Assume that under one scenario the implicit tariff on Japanese cars is $500 and the implicit CAFE tax is $300 per MPG for General Motors. Using the formula for calculating implicit CAFE taxes (see Section III below) and the MPG per class in Table A-1 yields an implicit tax vector T' = (500, 500, 300*27.5*((27.5/32.45)-1), 300*27.5*((27.5/27.42)-1), 300*27.5*((27.5/25.31)-1)) = (500, 500, -1258, 24, 714).

CAFE standards are assumed to be just nonbinding in the initial conditions (that is, that the levels reached by automobile companies under a lower CAFE standard are the same as those they would have reached without any CAFE standard at all), but differentially binding on the "Big Two" (General Motors and Ford) if a binding standard is enforced. This is likely to yield an underestimate of deadweight loss (DWL), as DWL is a function of the implicit tax squared. Crandall and Graham[7] suggest that even a CAFE standard of 26.6 MPG was binding on GM and Ford in MY 1989, meaning that an implicit tax already applies to these two firms. If CAFE standards are imposed, they are assumed to be binding, and the implicit tax per "Big Two" car is calculated accordingly. The system of 21 equations (five demand curves, thirteen supply curves, two CAFE constraints, and one import constraint) in 21 unknowns (five prices, thirteen quantities, and three implicit taxes) is solved and the implicit tariff and the shadow tax per MPG for GM and Ford are iterated until the desired quota and CAFE standard level are reached.

Based on past studies of the demand for automobiles we assume that a 10 percent increase in the small car price will generate a 20 percent decline in the quantity of small cars demanded and that a 10 percent increase in the price of large cars will lower the quantity of large cars demanded by 30 percent.[8]

The point elasticities of demand at the original 1987 equilibrium are shown in Table A-1. The own-price elasticity of demand for automobiles is assumed to be one. (This is consistent with the results reported in Irvine (1983).[9]) The cross-elasticities shown should not be interpreted as precise figures, but merely internally consistent with the overall market demand and the own-elasticities for each of the segments which range from 2 to 3. The method for the derivation of the cross-elasticities is available upon request.

To our knowledge, no study exists of short-run cost curves for automobile production. Results obtained by Friedlander *et al.*[10] indicate

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[7] Robert W. Crandall and John D. Graham, "The Effect of Fuel Economy Standards on Automobile Safety," *Journal of Law and Economics* 32:2 (April, 1989), 97-118.

[8] These sensitivity (or elasticity) estimates are those found in James Langenfeld and Michael Munger, "The Impact of Federal Automobile Regulations on Auto Demand," unpublished draft, Federal Trade Commission (June 1985) and were those used in FTC Staff Comments (1986) and FTC Staff Comments (1988).

[9] F. Owen Irvine Jr., "Demand Equations for Individual New Car Models," *Southern Economic Journal* (1983), 764-782.

[10] A. F. Friedlander, C. Winston, and K. Wang, "Costs, Technology, and Productivity in the U.S. Automobile Industry," *Bell Journal of Economics* (1982), 1-20.

that the industry may have constant long run marginal cost curves. In the short-run, however, it seems likely that marginal costs are increasing. Thus, the point elasticity of supply (marginal cost) in the model is set equal to 2 for MY 1989. This assumes that while the industry has a competitive structure, there are short term economic rents to be earned in the sale of automobiles.

We assume that without higher CAFE standards General Motors would have reached 27.2 MPG in MY 1989, while Ford would have reached 26.6 MPG.[11] Thus, if the MY 1989 CAFE standard had been set at 27.5 MPG, the model assumes that meeting that standard would have required a "stretch" of 0.3 MPG for GM in MY 1989 and 0.9 MPG for Ford.

II. Derivation of Gasoline Consumption Changes

To measure the change in gasoline consumption over time that will result from changing the CAFE standard in MY 1989, it is necessary to estimate and compare (1) the lifetime gasoline consumption of new cars sold under the standard, (2) the estimated gasoline consumption of the cars that would have been produced had the higher CAFE standard not been imposed, and (3) the "scrappage effect" (the change in the stock of used cars that results from a change in the price of new cars) to determine the total stock of cars in operation.[12]

Data on miles driven and scrappage rates are incorporated into the gasoline consumption calculations used in the estimates represented by the solid "Total Effects" line of Figure 1.[13] The scrappage rates are adjusted for new car price changes using Gruenspecht's estimates.[14] Gruenspecht showed that if the price of new cars is raised (lowered), it causes a significant decrease (increase) in the scrappage rates of used cars. Here we assume that Gruenspecht's results can be applied to each of the three classes

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[11] NHTSA Final Rule, 53 Federal Register 39282. While the model requires such a "starting point", the results of Section VI are not sensitive to which particular starting point is selected.

[12] Several studies, such as Howard K. Gruenspecht, "Differentiated Regulation: A Theory with Applications to Automobile Emission Controls," Yale University Ph.D. dissertation, 1982, and Gruenspecht, "Differential Regulation: The Case of Auto Emissions Standards," *American Economic Review* (1982), 328-331, have found that scrappage rates of used cars are significantly affected by new car prices. See also James A. Berkovic, "New Car Sales and Old Car Stocks," *RAND Journal of Economics* (1985), 195-214 and Richard W. Parks, "Determinants of Scrappage Rates for Postwar Vintage Automobiles," *Econometrica* (1977) 1099-1115.

[13] Figures obtained from the Motor Vehicle Manufacturer Association, *Motor Vehicle Facts and Figures* (1987).

[14] Gruenspecht (1982b).

of automobiles (Basic Small, Luxury Small, and Large). For purposes of the gasoline consumption model, Japanese cars are combined with their corresponding American segments.[15]

Many of the changes in fleet composition reflect large car buyers switching to new small cars in response to changes in relative car prices. But because smaller cars use less fuel, the marginal cost of driving declines, and driving is encouraged. The model uses Blair *et al.'s*[16] findings to adjust for changes in the rate of use of new cars induced by higher CAFE standards for the estimate described by the thick solid line of Figure 1.

For the most part, the changes in gasoline consumption identified here do not occur in the model years to which the CAFE standard would be applied. Rather, they are the summation of gasoline consumption changes for the ensuing 15 years after a one year rise in the binding CAFE standard. A real discount rate of 4 percent is used.

III. The Mathematics of Harmonic Averaging

By statute, CAFE standards relate to the "harmonic" average of a firm's vehicle fuel-efficiency. This section will discuss how harmonic averaging affects the implicit taxes and subsidies generated by binding CAFE standards as well as the relative impact of harmonic versus "simple" averaging.

Assume that a firm makes only two types of cars; a large relatively fuel-inefficient model, and a small relatively fuel-efficient model. As discussed in Section III of the comments above, the explicit fine, F, on a firm for failing to reach the CAFE standard is equal to

$$(3) \quad F = 50^* (Q_L+Q_S)^*(S-MPG) \quad MPG<S$$

if the firm does not reach the standard, where S is the level of the CAFE standard, Q_L and Q_S are the number of large and small cars sold by the firm, and MPG is the firm's average fuel-efficiency.

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[15] The MPG values for each of the three classes can be determined from the information used in the automobile market model. The entire fleet fuel intensity for MY 1973 was about 14.2 MPG. The fleet fuel intensity for MY 1987, which can be calculated from Table A-1, was 28.49 MPG. The model assumes that the ratio of fuel intensity between classes is the same for each year. With this assumption, knowledge of the fraction of cars in each class for 1973, and the entire fleet fuel intensity for 1973, the fuel intensity for each class of new car in 1973 can be estimated. We also assume that, for each class of car, the relevant MPG grew at a constant rate between 1973 and 1987. MPG's are then calculated accordingly. The fuel intensity of cars produced before 1973 is assumed equal to be to the 1973 level.

[16] Blair, Kaserman, and Tepel (1984).

The measurement of a firm's CAFE level was not defined as the simple average of a manufacturer's fleet MPG. Instead, a firm's CAFE level is the harmonic average of that firm's fleet MPG.[17] The harmonic average for the firm is calculated by

$$(4) \quad MPG = (Q_L+Q_S)/((Q_L/M_L)+(Q_S/M_S))$$

where M_L and M_S are the fuel-efficiencies of the two types of cars.

Using the harmonic average, the marginal CAFE fine to the firm of producing a car of type 1 is

$$(5) \quad dF/dQ_1 = 50*(S-2MPG+(MPG^2/M_S))$$

Assume now that the standards are binding. In that case MPG=S, the explicit fine of $50 per MPG per car is replaced by a shadow tax L and the implicit CAFE tax on a car of type 1 becomes

$$(6) \quad dF/dQ_1 = L*S*((S/M_S)-1)$$

where L is the value of the constraint discussed above.

The marginal fine derived above presents a more difficult problem to manufacturers than would occur with a standard based on simple averaging. Consider a firm that is deciding whether or not to produce an additional car with fuel-efficiency equal to 20.0 MPG where the binding CAFE standard is 27.5 MPG. If simple averaging were used, the firm would have to offset that additional unit by producing one car with fuel-efficiency of 35.0 MPG (or the equivalent). Under harmonic averaging, however, to produce another unit of 20.0 MPG, the firm must also produce the equivalent of one unit with fuel-efficiency of 44.0 MPG. Thus, compared to simple averaging, the harmonic averaging used makes the CAFE standard more difficult to meet.

[17] Public Law 46:15-2003. One property of a harmonic average is that if it is doubled, fuel consumed by driving the same number of miles in each type of car is halved.

Table A-1
Parameters Used in CAFE Simulation

Demand Elasticity Table

Class	1	2	3	4	5
1) Asian Small	-2.000	0.243	0.334	0.355	0.704
2) Asian Luxury Small	0.217	-2.500	0.125	0.837	2.661
3) Domestic Small	0.856	0.446	-2.000	0.583	1.160
4) Domestic Lux. Sma.	0.165	0.539	0.103	-2.500	2.237
5) Large	0.015	0.083	0.010	0.103	-3.000

1987 Totals by Class

Class	Price (Initial) ($000)	Quantity (Init.) (million)	MPG	Cars/Job
1	8.689	1.748	35.51	22.65
2	13.764	1.173	29.57	19.38
3	8.373	1.168	32.45	7.55
4	10.719	1.884	27.42	6.46
5	15.077	3.645	25.31	5.40

Initial Quantities by Firms
(millions of units, 1987 production)

Class	GM	Ford	Chrysler	Other	Constrained Asian	Uncstr. Asian
1	0.000	0.000	0.000	0.000	1.343	0.405
2	0.000	0.000	0.000	0.000	0.909	0.264
3	0.416	0.461	0.150	0.140	0.000	0.000
4	0.884	0.466	0.534	0.000	0.000	0.000
5	2.234	1.128	0.283	0.000	0.000	0.000

Supply Elasticity: 2.0 (all firms and classes)

Source for prices: *Ward's Automotive Yearbook*, 1988, pp. 216-221 and 287-293. Source for quantities and fuel-efficiencies: P. S. Hu and L. S. Williams, "Light Duty Vehicle MPG and Market Shares Report: 1st Six Months Model Year 1988," Oak Ridge National Laboratory, 1989, E-41 to E-44.