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Do Regulations Requiring Light Trucks To Be More Fuel Efficient Make Economic Sense?

An Evaluation of NHTSA's Proposed Standards

Randall Lutter and Troy Kravitz

Regulatory Analysis 03-2
February 2003

Randall Lutter is a fellow with the AEI-Brookings Joint Center and a resident scholar at the American Enterprise Institute. Troy Kravitz is a researcher at the Joint Center. They thank Bob Hahn, Andrew Kleit and David Schrank for helpful comments. The authors are solely responsible for the views in this paper. They can be reached at tkravitz@aei.org.

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Executive Summary

The National Highway Transportation Safety Administration (NHTSA) recently proposed increasing the fuel economy of new light trucks by 1.5 miles per gallon for vehicles produced in model year 2007. NHTSA's analysis of its proposal implausibly concludes that the benefits to consumers are more than twice the costs to manufacturers, ignoring effects on the environment or dependence on foreign oil.

NHTSA's proposal has several serious flaws. It wrongly presumes that manufacturers cannot produce items that consumers are willing to buy, even though they could make money by doing so. Its analysis uses overly optimistic measures of net benefits. In addition, NHTSA neglects the adverse effects from the increased driving induced by the proposal. By lowering the cost of driving, NHTSA's proposal increases vehicle miles traveled, thereby boosting traffic accidents and congestion. The increase in the costs of accidents and congestion fully offsets and probably outweighs the social benefits resulting from greater fuel economy.

If NHTSA is interested in a cost-effective way of reducing gasoline use, it should consider giving consumers better information about fuel economy of new vehicles, or suggest a modest gasoline tax. A penny per gallon levy would conserve more fuel in 2007 than NHTSA's proposal, while lowering, rather than increasing, traffic congestion and accidents.

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Introduction

The National Highway Transportation Safety Administration (NHTSA) recently proposed more stringent fuel efficiency standards for light trucks—the minivans, sports utility vehicles, and pickup trucks that now make up about half of the new vehicle market. In its proposal to increase the fuel economy of new light trucks by 1.5 miles per gallon by 2007, NHTSA tentatively concludes such a standard is "within the technological feasibility and economic practicability of the primary contributors to the light truck market, is capable of being met without substantial product restrictions, vehicle weight reductions or adverse effects on air quality, and will enhance the ability of the nation to conserve fuel consumption and reduce its dependence on foreign oil."[1] To justify its proposal, NHTSA presents estimates that the proposed rule would cost manufacturers $370 million for vehicles produced in model year 2007 while saving consumers $790 million in fuel costs.[2] In fact, NHTSA's proposed rule is likely to impose significant costs on vehicle manufacturers and buyers *without* bringing net benefits to society at large.

NHTSA's justification for its proposal has three key deficiencies. First, NHTSA implausibly concludes that the benefits to consumers from more fuel-efficient vehicles are twice the costs to producers, even before estimating any effects on the environment or energy dependence. This conclusion is a red flag event for economists: It implies that

[1] See U.S. Department of Transportation (2002c, p. 77019).
[2] See Department of Transportation (2002a, Executive Summary).

manufacturers cannot produce items that consumers are willing and able to buy, even though they could make money by doing so! If true, it means that NHTSA should prefer better labeling and information disclosure instead of mandatory new fuel economy standards.

Second, NHTSA's analysis inappropriately overstates net benefits. It ignores the value to consumers of reduced performance associated with better fuel economy. It assumes consumers can finance new vehicle purchases at interest rates lower than those available in the market. In addition, it entirely neglects the increased risk of highway fatalities that would ensue from reductions in vehicle weight.

Third, and most importantly, NHTSA ignores the adverse effects of the increased driving that will result from mandating more fuel-efficient vehicles. The greater fuel efficiency will increase driving by reducing its cost, and additional driving will contribute to additional risk of traffic accidents and greater traffic congestion. These two adverse effects fully offset and probably outweigh the social value of reduced gasoline consumption.[3]

NHTSA has authority – and an obligation – to consider the full economic implications of alternative standards. Congress has directed the Secretary of Transportation to set fuel economy standards that are "the maximum feasible average fuel economy level that the Secretary decides the manufacturers can achieve in [a] model year."[4] But NHTSA, in view of the legislative history, has interpreted its mandate to mean it must consider manufacturers' "asserted capabilities, product plans and economic conditions against their projected capabilities, the need for the nation to conserve energy

[3] Emission of nitrogen oxides, which the Environmental Protection Agency regulates on a per-mile basis, would also rise as a result of increased vehicle use, but this effect is too small to matter for our analysis.

and the effect of other regulations (including motor vehicle safety and emissions regulations) and other public policy objectives."[5] Thus, NHTSA sets corporate average fuel economy (CAFE) standards at the "maximum feasible level" based upon "technical feasibility, economic practicability, the effect of government motor vehicle standards on fuel economy and the need of the U.S. to conserve energy."[6]

To the extent that NHTSA has discretion under this legal standard, it has to adopt the least burdensome regulation consistent with meeting its regulatory objectives and must design regulations in the most cost-effective manner, according to President Clinton's Executive Order 12866 on Regulatory Planning and Review – which is still in force.[7] Yet our economic analysis indicates that NHTSA's proposed new fuel economy standard is unnecessarily burdensome and far from cost-effective.

To reduce gasoline consumption in the U.S. cost-effectively, NHTSA should pursue the plain implication of its own analysis and consider improved fuel economy labels on light trucks for sale. If it seeks greater cuts in gas consumption, NHTSA should ask Congress to raise taxes on gasoline.[8] Taxes would be more cost-effective than more stringent CAFE standards because they would decrease traffic accidents and congestion, while more stringent CAFE would raise them.

After describing the existing program regulating fuel efficiency standards, we describe three problems with NHTSA's economic analysis. We show that mandatory standards will not benefit consumers, we then demonstrate that NHTSA's analysis overstates net benefits, and finally we show that the unintended adverse effects of

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[4] See 49 *United States Code* 32902.
[5] See U.S. Department of Transportation (2002c, p. 77019).
[6] See Department of Transportation (2002b, Abstract).
[7] See Clinton (1993).

additional driving will fully outweigh and probably exceed the social benefit of reduced fuel consumption. We conclude with some policy recommendations.

Background

After the Arab oil embargo of 1973 caused a sharp increase in the price of oil, the federal government – in 1975 – began mandating minimum levels of fuel efficiency for new motor vehicles.[9] It set CAFE standards for light trucks (pickups, vans and sport utility vehicles with gross vehicle weight ratings of 8,500 pounds or less) of 17.2 miles per gallon (mpg) for model year (MY) 1979. Over time the standards have slowly increased, with the current level for light trucks of 20.7 mpg in place since MY 1996.[10]

Different CAFE standards for light trucks and passenger cars have been responsible for important changes in the vehicle fleet over the years. Minivans and sport-utility vehicles (SUVs) have become more popular partly because they are subject to the light truck standard, which is significantly less stringent than the one applied to passenger cars: 20.7 instead of 27.5 mpg.[11] In 1999 light trucks constituted approximately 48 percent of new vehicle sales,[12] and in 2000 light trucks were estimated to be 45 percent of the vehicle fleet.[13] Manufacturers have virtually discontinued making traditional big station wagons in part because they are classified as passenger cars subject to the higher standard.

During the 1990s, Congress prevented NHTSA from issuing more stringent CAFE standards. Through a rider to the Department of Transportation's annual

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[8] See Appendix A for a comparison of taxes and CAFE standards. An increase in gasoline taxes need not increase the size of government if coupled with decreases in other taxes.
[9] Firms that did not comply paid a fine. In years 1983-1998 these fines amounted to roughly $475 million. See Congressional Research Service (CRS) (2002a, pp. CRS-2).
[10] See Department of Transportation (2002a, Section I).
[11] See CRS (2002a, Summary).
[12] See CRS (2002b, pp. CRS-2).

appropriations bill for fiscal year 1996, Congress stipulated that funds could not be spent for preparing, proposing, or promulgating any increased CAFE standards.[14] In legislation for fiscal year 2001, Congress requested that the National Academy of Sciences and the Department of Transportation examine the effectiveness of CAFE standards.[15]

NHTSA has developed a proposed new CAFE standard for light trucks increasing gradually to 22.2 mpg for MY 2007 using data from the NRC and vehicle manufacturers.[16] While an increase of 1.5 mpg from the current standard does not seem large, the CAFE standard has risen so much so fast only once—for MY 1983, when a long period of high gasoline prices sustained consumers' interest in more fuel efficient vehicles.[17]

Despite fairly broad academic criticism of CAFE standards,[18] lawmakers have supported CAFE as a politically attractive means to limit U.S. dependence on foreign oil, to conserve fuel, and increasingly, to reduce emissions of carbon dioxide, a greenhouse gas. Senators Feinstein (D-CA) and Snowe (R-ME) recently proposed requiring light-duty trucks to meet the same fuel economy standards as passenger cars by 2011: 27.5 mpg.[19] This latest proposal is similar to legislation introduced by Sens. Kerry (D-MA),

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[13] See CRS (2002a, pp. CRS-7).
[14] See Department of Transportation (1995, Section 330).
[15] See National Academy of Sciences (2002, p. 1). The National Research Council (NRC) examined the effectiveness and impact of CAFE standards for the National Academy of Sciences (NAS). See NAS (2002, Executive Summary).
[16] The estimated laboratory fleet averages under the two alternatives exceed the baselines since some manufacturers' plans for future models already exceed both 20.7 and 22.2 mpg. The estimated laboratory baseline with a 20.7 mpg minimum is 21.83 mpg for MY 2007; the estimated laboratory level after the proposed minimum of 22.2 mpg is 22.35 mpg for MY 2007. See Department of Transportation (2002a, Executive Summary). On-road fuel economy is assumed to be 85 percent of the laboratory test level. See Department of Transportation (2002b, Appendix A).
[17] The current high prices in the U.S. are expected to fall to long-term average levels when tension in the Persian Gulf and Venezuela subside.
[18] See, for example, Crandall and Graham (1989), Coate and VanDerHoff (2001), Dunham (1997), Kleit (2002), and Winston and Shirley (1998).
[19] See *Washington Post* (2003).

Hollings (D-SC) and McCain (R-AZ) less than a year ago. The Kerry-Hollings-McCain bill sought to increase the CAFE standard to 36 mpg by 2015 for most passenger vehicles, including light-duty trucks.[20] While the NHTSA proposed rule is less stringent, requiring 22.2 mpg by 2007, it is silent about what CAFE standard will be required in subsequent years.

Economic Analysis

We describe in turn three problems with NHTSA's proposal.

1. Mandatory fuel economy standards cannot benefit informed consumers.

A threshold question is whether more stringent regulations can offer net benefits to consumers, ignoring any environmental or energy security concerns. According to the Preliminary Economic Assessment of NHTSA, "The benefits [of improved fuel economy] are determined mainly from fuel savings over the lifetime of the vehicle."[21] In particular, NHTSA estimated that the benefits are $794 million for model year 2007 while the costs to vehicle manufacturers are only $373 million.[22] By themselves, these estimates imply there is a fundamental shortcoming—a failure—in the motor vehicle market, because these net benefits occur even in the absence of any environmental effects or dependence on foreign oil.

The only plausible cause of the market failure implied by NHTSA's analysis is inadequate consumer information about vehicle quality, and, in particular, the value of

[20] See Holly (2002).
[21] See Department of Transportation (2002a, Executive Summary).
[22] Using the data contained in the Preliminary Economic Assessment, we were unable to exactly reproduce NHTSA's calculations. We assumed that NHTSA employed a rebound effect of -.15 and on-road fuel economy 15 percent below fuel economy measured in laboratory tests. Under these assumptions, we were able to replicate NHTSA's analysis to within 2 percent. See Department of Transportation (2002a, Section VII).

fuel economy.[23] Although NHTSA cites “the difficulty and time involved in calculating the total savings associated with purchasing a more fuel-efficient vehicle”[24] as a possible reason why consumers have not demanded greater fuel efficiency, such difficulties are insufficient to cause a market failure from inadequate information. Consumers are already well informed about the costs of fueling new vehicles. All new vehicles must display federally mandated stickers with government estimates of city and highway miles per gallon on their windows.[25] Furthermore, these stickers, as illustrated in Appendix B, already provide estimates of the annual fuel costs, so that differences in fuel costs among different vehicles can be easily compared with differences in loan payments. The stickers even recommend comparing the fuel economy and fuel cost of different vehicles in the “FREE FUEL ECONOMY GUIDE available at the dealer.”[26]

Moreover, there is little reason to believe that consumers systematically underestimate the price of gasoline. Consumers are likely to know the price of gas better than the price of, say, eggs, milk or other commodities. Among consumer products bought on a weekly basis, only gasoline is advertised on big street signs. This practice has arisen because drivers can fill up at one gas station pretty much as easily as at another and because drivers choose gas stations largely on the basis of price. Gasoline of a given octane is a homogeneous commodity sold by specialized retail outlets that do not bundle it with other goods. As a result, the returns to advertising are relatively large and service stations post prices prominently.

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[23] See, for example, OMB (2003) and OMB (1996, Section I.A) for explanations of market failure. The other types of market failure (monopoly and externalities) are inapplicable.
[24] See Department of Transportation (2002c, p. 77023).
[25] See 40 CFR § 600.306-86.
[26] See Appendix B.

In addition, spending on gasoline is large enough to get the full attention of consumers when they buy new vehicles. The average household spent $1,055 on gasoline and motor oil in 1999, when gasoline prices were relatively low.[27] This figure represents nearly 3 percent of total out-of-pocket expenditures ($37,027), an amount roughly comparable to total spending on meat, fish, poultry, eggs and dairy products combined, which was $1,071.[28] Yet gasoline is different than these items. If the price of beef or turkey or salmon rises, consumers can switch to pork, chicken, catfish, or even beans to avoid bearing the full burden of the higher prices. On the other hand, to avoid higher gasoline prices, consumers must curtail car trips, use public transit, or join carpools, all of which are inconvenient or time-consuming options. Thus, consumers can shift to less expensive alternatives to gasoline only with considerable difficulty. As a result, they have additional incentives to buy fuel-efficient cars if they are at all concerned about minimizing unnecessary spending.

NHTSA effectively concludes that a market failure exists without direct evidence or other information of such a failure. Although economists have long recognized the possibility that markets fail because of inadequate information about the attributes of products,[29] NHTSA cites no surveys indicating that consumers fail to understand the implications of greater fuel economy for lifetime operating costs. Moreover, NHTSA ignores the considerable indirect evidence summarized above that no such failure exists.

If, contrary to the preceding empirical evidence, consumers were in fact ignorant about the fuel economy of vehicles they are considering purchasing, then the appropriate policy response would not be to mandate greater fuel economy, but, rather, to supply

[27] See U.S. Census Bureau (2001, No. 659).
[28] See U.S. Census Bureau (2001, No. 659).

consumers with the information they lack. New guidance on economic analysis recently proposed by the Office of Management and Budget (OMB) makes this point. It states, "If intervention is contemplated to address a market failure that arises from inadequate or asymmetric information, informational remedies will often be the preferred approach."[30] The guidance document goes on to explain, "A regulatory measure to improve the availability of information (particularly about the concealed characteristics of products) provides consumers a greater choice than a mandatory product standard or ban."[31] In essence, mandatory standards deny consumers access to vehicles they would prefer to buy. The superiority of providing information, instead of mandating standards has been broadly accepted for years. For example, in 1996 OMB advised, "If intervention is necessary to address a market failure arising from inadequate or asymmetric information, informational remedies will often be the preferred approaches."[32] It then elaborated, "As an alternative to a mandatory product standard or ban, a regulatory measure to improve the availability of information (particularly about the concealed characteristics of products) gives consumers a greater choice."[33] Thus, a plain reading of NHTSA's own evidence about the costs and benefits of more stringent CAFE standards – if it were adequately supported by facts – would point to a regulatory approach very different from its proposed mandatory standards. NHTSA should follow the implications of its own economic analysis and consider measures to improve consumer information, instead of mandating new fuel economy standards.

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[29] See Akerlof (1971).
[30] See OMB (2003, p. 5516).
[31] See OMB (2003, p. 5516).
[32] See OMB (1996, Section II.6).
[33] See OMB (1996, Section II.6).

Of course another possible interpretation of NHTSA's economic analysis is that it contains errors.

2. NHTSA's measures of net benefits are too optimistic.

NHTSA uses measures of social cost that are optimistic in three respects. First, it uses engineering-based estimates that exclude the foregone value to the consumer of the declines in performance associated with better fuel economy. NHTSA acknowledges "There is often a trade-off between performance and fuel economy"[34] and that "All [such] tradeoffs necessarily involve costs to the extent that reduced engine size or performance reduces the value of the vehicle to the consumer."[35] But NHTSA "has not attempted to value these performance reductions,"[36] although it does "plan to do so in the event (and to the extent) that such tradeoffs will result from the final rule."[37] NHTSA's neglect of the value of performance reductions is one key reason that it has underestimated the costs and overestimated the net benefits of its proposal. NHTSA should analyze the cost of forgone performance.

Second, NHTSA may have underestimated how much consumers discount future fuel savings. While NHTSA estimated that the improved fuel economy will raise vehicle costs by only $47 per vehicle,[38] some buyers may be unable to borrow this much at the 7 percent interest rate (net of inflation) assumed by NHTSA.[39] The Consumer Expenditure Survey indicates that annual interest rates from 1984-1995 were 10 percent on used cars

[34] See Department of Transportation (2002a, Section IV).
[35] See Department of Transportation (2002a, Section IV).
[36] See Department of Transportation (2002a, Section IV).
[37] See Department of Transportation (2002a, Section IV).
[38] See Department of Transportation (2002a, Table VI-3).
[39] Although recent data indicate vehicle loan interest rates are currently less than 7 percent, we feel that current economic conditions do not represent expected future interest rates.

and 7.6 percent on new cars.[40] Using an interest rate of 10 percent to discount future fuel savings would reduce NHTSA's calculated fuel savings by $15 per vehicle.

There is some evidence that consumers use much higher discount rates in evaluating future energy savings. Train (1985) cites evidence from national surveys suggesting consumers require rates of return as high as 26 and 32 percent before investing in improvements in thermal integrity of their homes. The key rationale for such high discount rates is that investments in energy efficiency are irreversible and uncertain.[41] While we have no direct evidence about the appropriateness of these rates to vehicle fuel economy, we do note that the irreversibility and uncertainty associated with such investments suggests that consumers may impose rates of return significantly above more typical discount rates such as 7 or even 10 percent. NHTSA should discount future fuel savings at the rate appropriate for vehicle buyers.

Third, NHTSA's analysis fails to address the possibility that manufacturers will use lighter, less crashworthy vehicles, saying simply "We believe that manufacturers will meet the proposed CAFE levels without any meaningful deviation from the planned performance and weight of their vehicles."[42] Yet a recent National Research Council committee concluded: "The downweighting and downsizing that occurred in the later 1970s and early 1980s, some of which was due to CAFE standards, probably resulted in an additional 1,300 to 2,600 traffic fatalities in 1993."[43] Although the NRC did not ascribe a particular portion of these deaths to CAFE, Crandall and Graham's earlier analysis suggested that CAFE standards led to "several thousand additional fatalities over

[40] These interest rates are net of inflation. See Attanasio, Goldberg, and Kyriazidou (2000). Attanasio and co-authors find that credit constraints are binding for some groups in the population, particularly young and low-income households, but the implications of this finding for our purposes are complicated and unclear.
[41] See Dixit and Pindyck (1994) for a discussion.

the life of each model-year's cars."[44] Similarly, Coate and VanderHoff found that the greater weight of light trucks were a significant cause of lower fatality rates in single-vehicle accidents associated with light truck use.[45] In multiple vehicle accidents they found that the protective effects of light trucks to their occupants outweighed any increase in fatalities to occupants of other vehicles.[46] Their results indicate that increased use of light trucks prevented approximately 2,000 highway fatalities between 1994 and 1997.[47]

Use of lighter materials is the only important fuel economy measure that NHTSA does not carefully analyze in its proposal. NHTSA's neglect of these costs (and vehicle buyers' aversion to lighter vehicles) may help explain how it is able to conclude (wrongly) that the benefits to consumers of more stringent CAFE exceed the costs to producers. NHTSA should include the possible use of lighter materials in its analysis of costs.

Given the lack of credible estimates about the adverse effects of more stringent CAFE on manufacturers and consumers, it is useful to pursue an alternative analytical approach that sidesteps this issue entirely. In the following section we ignore costs to producers associated with making vehicles more fuel-efficient and the benefits to consumers of greater fuel economy. Instead we focus only on the externalities of the proposed regulation. This approach works provided we stick only to external benefits and costs and exclude those already internal to the decision-making of vehicle purchasers or manufacturers. In particular we address whether the social costs of additional driving

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[42] See Department of Transportation (2002a, Section IV).
[43] See NAS (2002, p. 111). Two committee members dissented.
[44] See Crandall and Graham (1989, p. 98).
[45] See Coate and VanderHoff (2001, p. 24).

resulting from the improved fuel economy are large relative to the social value of the fuel savings that the proposed standard might provide.

3. Net social effects of NHTSA's proposal are nil or even detrimental.

NHTSA acknowledges that more stringent CAFE standards will reduce the cost of driving and thereby increase the annual miles driven per vehicle.[48] Further, its economic analysis concedes that the increased driving is likely to worsen congestion and traffic accidents. Without any empirical justification, however, NHTSA simply asserts that the increases in the social costs associated with congestion and traffic accidents will be "slight."[49] In fact, this effect appears sufficiently large to outweigh the social value of reduced gasoline consumption.

Econometric studies suggest that a 10 percent reduction in the price of fuel increases miles driven by 1 percent to 3 percent.[50] The NRC and NHTSA used these estimates to infer that a 10 percent reduction in fuel cost attributable to mandatory fuel economy standards would increase miles driven in the range of 1 percent to 2 percent.[51] The Congressional Budget Office recently stated that potential gasoline savings from a rise in fuel economy would probably be offset by increases in driving of about 2 percent.[52]

Estimates of the social costs of additional vehicle miles traveled – especially increased traffic accidents and congestion – permit calculations of the social costs of the

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[46] See Coate and VanderHoff (2001, p. 24).
[47] See Coate and VanderHoff (2001, p. 24).
[48] See Department of Transportation (2002a, Section VII).
[49] See Department of Transportation (2002a, Section VII, endnote 4).
[50] See CBO (2002, Chapter 2, footnote 11), Greene (1992), Greene, et al, (1999), and Goldberg (1998).
[51] See Department of Transportation (2002a, Section VII, endnote 5), and NAS (2002, p. 96).
[52] See CBO (2002, p. 19). The different estimates between NHTSA and CBO appear to be more a result of differing emphasis and/or interpretation of surveyed studies and less a product of surveying different studies.

additional driving induced by the higher CAFE standard. First note that the relative change in VMT, (that is, $\Delta VMT / VMT^0$), can be calculated as the product of the percentage change in fuel costs per mile and the rebound effect:

$$(1) \qquad \Delta VMT / VMT^0 = r\ ((GPM^1 - GPM^0) / GPM^0)$$

where GPM^0 is the gallons per mile in the baseline, GMP^1 is the gallons per mile after the change in policy, and r is the elasticity of vehicle miles driven with respect to the cost of gasoline per mile.[53]

The proposed change in the CAFE standard from 20.7 to 22.2 mpg for MY 2007 would increase the estimated fuel economy level for a representative MY 2007 light truck from 21.83 to 22.35 mpg as measured in laboratory tests.[54] Since NHTSA and NRC assume on-road fuel economy to be 85 percent of laboratory fuel economy, on-road miles per gallon will rise from 18.56 to 19.0 mpg, an increase in fuel economy of 2.3 percent.[55] Assuming a rebound effect of -0.15, equation (1) implies an increase in VMT of 0.35 percent. For trucks that would have been driven 10,000 miles per year in the absence of a new CAFE standard, the increase in mileage, ΔVMT, would be about 35 miles per year.[56] This increased mileage results from a CAFE standard that saves 10.6 gallons of gasoline.[57] If the rebound effect were -.2, annual mileage would increase by 46 miles and fuel savings would be 10.0 gallons.

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[53] This equation is consistent with NHTSA's approach. See Department of Transportation (2002a, Section VII).

[54] Estimated laboratory fuel economy levels exceed the standards since some manufacturers' plans for future models already exceed the proposed baseline.

[55] [100 x (((1 / 19.00) – (1 / 18.56)) / (1 / 18.56)) =2.38]. EPA's assumption of a 15 percent fuel economy "gap" may be understated given recent research. The Department of Energy, for example, assumes a fuel economy gap of 24.5 percent for light trucks and large SUVs. See Department of Energy (2000).

[56] As shown in Appendix C, the annual mileage that light trucks are driven is irrelevant for our conclusions; our assumption that mileage is 10,000 is solely for convenience.

[57] The gallons saved are $VMT^1 \times GPM^1 - VMT^0 \times GPM^0 = 10035 \times (1/19.00) - 10000 \times (1/18.56) = 10.63$.

To assess the external social costs of this increase in driving we focus on the cost of accidents and the cost of congestion.[58]

Extra driving boosts traffic accidents. A key question is how much of these costs drivers take into account in their decisions about how and how much to drive. Aaron Edlin of the University of California at Berkeley estimates the marginal cost of accidents to be about 8 cents per additional mile driven,[59] and the insured cost of accidents to be approximately 4 cents per mile driven. Edlin shows insurance premiums are (virtually) invariant with respect to miles driven, although the accident costs vary nearly proportionately with mileage.[60] Thus, in deciding how much to drive, drivers have no incentive to take into account the additional accident costs covered by insurance companies.

Cliff Winston and Chad Shirley present a higher estimate of marginal accident costs – about 20 cents per mile in 2000 dollars – but suggest that the only cost that travelers do not bear are the delays they cause other travelers.[61] They do not distinguish, however, between drivers and other travelers (for example, those that may not be responsible for an accident). They also do not address the lack of a direct relationship between miles driven and insurance premiums. These estimates and others in the literature are summarized in Table 1.

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[58] NHTSA also considers the increased emissions of local air pollutants but finds these to be so small as to be negligible. See Department of Transportation (2002a, Section VII). Some analysts have suggested that we need also to consider the benefits of the increased driving induced by more fuel-efficient vehicles, but these are much too small to matter, as we show in Appendix E.

[59] See Edlin (1999, p. 4). Costs are calculated in fiscal year 2000 dollars.

[60] Researchers have found that fatalities are positively related to vehicle miles traveled. See Coate and VanderHoff (2001, p. 24).

[61] See Winston and Shirley (1998, p. 64.)

Table 1

Accident Cost Estimates

Author	Cost per mile (2000$)		Comment
	Marginal Cost	Average Cost	
Edlin (1999, p.4)	7.8¢		National cost. (The insured cost of 4¢ per mile is external to decision to drive.)
Levinson et al (1996)	6.3¢	5.6¢	Costs estimated by combining an accident rate model with costs per accident.
MacKenzie et al (1992)		3.6¢	Social cost not borne by drivers for the United States.
Parry and Small (2002, p.19)	3¢		External accident cost for the U.S.
Winston and Shirley (1998, p.64)	20¢		Analysis of the largest 116 urbanized areas (with pop. >200,000).

Extra driving also exacerbates delays on crowded roads. According to a commonly cited source, traffic delays cost Americans nearly $70 billion per year in lost time and extra fuel.[62] Researchers have estimated incremental congestion costs between a penny and a quarter per vehicle per mile in key U.S. cities and significantly more on important arteries.[63] To calculate congestion costs in urban areas, we use data from the Texas Transportation Institute (TTI). Its *2002 Urban Mobility Report* implies that the congestion cost among the 75 urban areas studied is about 15 cents per vehicle mile

[62] Congestion costs for 2001—$78 billion—are in Table A-9, *2001 Urban Mobility Report*, Texas Transportation Institute. For 2002, an updated version of the same report gave only $67.5 billion due to a slightly different sample size, an improved speed estimating procedure, and the California recession, which lessened increased congestion. The studies conclude that congestion is increasing.

[63] See, for example, Winston and Shirley (1998, p. 58). California Environmental Protection Agency (1996, p. 6-14) reports values as high as $0.99 per mile on some peak corridors and as low as 12 to 30 cents per mile throughout the Bay Area morning peak (2000$).

traveled during workdays.[64] The average congestion cost per mile of vehicle use is a low-ball estimate of the marginal congestion cost of extra driving.

Congestion costs may be lower because some research suggests that the disutility of congestion, that is, the hassle of traffic jams, is less than assumed by the *2002 Urban Mobility Report*, which figures the cost of travelers' time to be $12.85 per hour.[65] Congestion costs may be lower than these estimates because people choose the location of home and work according to their willingness to put up with traffic jams. In particular, Calfee and Winston estimate that the average willingness to pay to avoid an hour of congestion ranges from 14 to 26 percent of the gross hourly wage, with an average of 19 percent.[66] In 1998, the average gross wage in 64 metropolitan areas was $33,381 per year, or about $16.70 per hour, assuming 2000 hours of work each year.[67] Using this estimate of the hourly wage, Calfee and Winston's estimate of the willingness to pay to avoid congestion suggests that the per hour costs of congestion delays in the TTI sample should be about a fifth of $16.70, or $3.30. This lower estimate of the value of time suggests the average congestion costs in the *2002 Urban Mobility Report* would fall to about 5 cents per mile.[68]

To estimate the marginal costs of congestion, we use data from the *Urban Mobility Report*, which reports, in addition to congestion costs (delays and fuel), data on

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[64] To derive this, note that the total annual cost of congestion-related delays averaged across the 75 cities is 900 million. See Schrank and Lomax (2002, p. A-61). The total daily vehicle miles traveled on freeways, expressways and principal arteries is 24.6 million. See Schrank and Lomax (2002, p. A-71). Since the report assumes 250 working days per year, the average cost of congestion-related delays among these 75 cities is $0.146 per mile: 900 / (24.6 x 250) = $.146 per mile.
[65] See Schrank and Lomax (2002, p.B-1).
[66] See Calfee and Winston (1988, p.91).
[67] See U.S. Census Bureau (2001, p.436).
[68] It is important to note that in the *Urban Mobility Report* congestion cost is composed of lost time and lost fuel. Adjustments to the wage rate only affect the former. Total congestion costs averaged $900 million in the 75 urban areas: $780 million delay cost and $120 million fuel cost. [(780 x .25 + 120) / (24.6 x 250) = $.05 per mile]. See earlier footnote.

vehicle miles traveled (VMT) and lane miles available on freeways and principal arterial roads for select urban areas with populations over 100,000. In particular, we consider data for the years 1994 though 2000 that TTI staff believes are most reliable.[69] After adjusting these data to be consistent with Calfee and Winston and also Winston and Shirley, we estimate marginal costs of congestion of about 23 cents in 2000. We describe the derivation of these estimates in Appendix D.

This estimate is high but close to the range of the published literature contained in Table 2, given the disparate geographic regions, peak periods being considered and methods. Our estimate of 23 cents per mile is different from other results because it represents the increase in congestion costs during the peak period from an additional mile driven during the day. Thus it may significantly understate the incremental congestion costs resulting from additional vehicle miles during the peak period. Other studies have focused on this measure of incremental congestion costs.

Our estimate is closest to Winston and Shirley's finding of 26 cents per mile. Our treatment of the value of reduced travel time is consistent with theirs. Their estimates of the value of travel time range from 8 to 49 percent of average hourly earnings depending on the length of the commute and whether it occurred during peak or off-peak periods, and they state that their findings appear to be consistent with those of Calfee and Winston.[70] Winston and Shirley examined the largest 116 urbanized areas—those with populations over 200,000, and found optimal tolls of 26 cents per mile for the most congested cities during peak periods, although some cities and times reach almost 60

[69] We are grateful to David Schrank, who sent us a file for these data and advised us to choose these years.
[70] See Winston and Shirley (1998, p.38).

cents per mile.[71] Estimates from the TTI database should be lower because it includes smaller cities—75 urban areas with populations over 100,000—such as Boulder, Colorado and Brownsville, Texas. They should be higher, however, because they represent the increase in peak congestion costs associated with an increase in driving at any time of the day. In addition, they include the costs of commercial vehicle delays, which amount to about a fifth of the total congestion costs.[72] Finally, about 5 cents of this estimate reflects fuel costs, an item excluded from the other marginal cost estimates.

To derive an estimate of nationally representative congestion costs, we make several adjustments. The *2002 Urban Mobility Report* studied areas with 50 percent of the U.S. population, but only 18 percent of national VMT occurred in the areas and days assessed by the Report.[73] Assuming conservatively that marginal congestion costs elsewhere and on non-business days are a fifth of those that we estimate using data from the *Report*, a marginal estimate of national congestion cost would be 8.0¢ per mile.

These estimates and others from the published literature appear in Table 2.

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[71] In 2000 dollars. See Winston and Shirley (1998, pp. 59-61).
[72] Private communication from David Schrank.
[73] The average population in year 2000 for the 75 urban areas studied in the 2002 Urban Mobility Report was 1,770,000, implying a total sample population of 132,750,000. See Schrank and Lomax (2002, p. 55). According to the Census Bureau, United States civilian population was 273,936,000 in 2000. See Census Bureau (2001, No. 1). Total vehicle miles traveled in year 2000 for the 75 urban areas during the days and times used in the study were over 461 billion miles. See Schrank and Lomax (2002, p. 71). This figure is about 18 percent of total U.S. VMT in 2000, which was 2,523 billion miles. See Department of Transportation (2001, Table VM-1).

Table 2

Congestion Cost Estimates

Author	Cost per mile (2000$)	Comment
California Environmental Protection Agency, p.6-14	Bay Area morning peak = 12¢ As high as 99¢ on some main corridors in Calif.	Examined congestion costs in California metropolitan areas.
Calfee and Winston (1998, pp.93-94)	12¢	Surveyed the 10 most populous urban areas in the mid-1990s; estimate assumes cost of traffic delays is 20 percent of gross wage.
Parry and Small (2002, p.17)	3.5¢	Marginal congestion cost averaged across the United States.
Schrank and Lomax (TTI) (2001, p.44)	Avg. cost = 19¢[74]	Estimated congestion costs for 68 urban areas. Assumes cost of travelers' time is $12.43 per hour.
Schrank and Lomax (TTI) (2002, p.61)	Avg. cost= 15¢	Estimated congestion costs for 75 urban areas. Assumes cost of travelers' time is $12.85 per hour.
Winston and Shirley (1998, p.59)	26¢, although individual cities and times range from 1¢ to 59¢	For the most congested cities during peak travel times. Analysis was performed for the largest 116 urbanized areas (those with pop. >200,000).

*Note: costs per mile are optimal tolls, except for the Schrank and Lomax estimates.

To estimate the additional societal cost (ΔS) from the additional driving we use

(2) $\Delta S = \Delta VMT \times$ (accident costs + congestion costs)

Given the range of uncertainty in congestion and accident costs, we assume first that the marginal costs of accidents and congestion are 3¢ and 8¢ per mile, respectively.

[74] The *2001 Urban Mobility Report* found total congestion costs to be $77,790 million and total annual VMT of 433,160 million miles (assuming 250 working days) for the 68 urban areas. This works out to an average congestion cost of 17.96¢ in 1999 (18.56¢ in 2000 dollars). See Schrank and Lomax (2001, pp. 44-52).

In this case ΔS would be $3.85 for a vehicle driven 10,000 miles.[75] Since the improvement in fuel economy would save about 10.6 gallons for the year, the social cost of the extra driving is 36¢ per gallon of gasoline saved.[76] With lower estimates, say 2¢ and 6¢ respectively, the social cost of the extra driving is about 26¢ per gallon of gas saved. In a recent study Parry and Small report marginal congestion cost averaged across the United States to be 3.5¢ per mile, and external accident costs to be 3¢ per mile.[77] Given their rebound effect of -.22,[78] the social cost per gallon saved is 34¢. Thus, we estimate that the external social costs from the additional driving induced by NHTSA's proposal to range from 26¢ to 36¢ per gallon.

To judge whether these are high or low requires an assessment of the social value of saving fuel. Both NHTSA and NRC have provided estimates, which appear in Table 3.

[75] $3.85= 35 miles (3¢ + 8¢).
[76] $.36 per gallon = 3.85 / 10.6.
[77] See Parry and Small (2002, pp. 17-19).
[78] See Parry and Small (2002, p. 20).

Table 3

Estimates of the Social Benefits of Reducing Gasoline Consumption
(cents per gallon)

	NHTSA	NRC	Comments
Lower world oil prices	4.8¢	12¢	NHTSA and NRC both believe U.S. influence over oil price is small or limited.[79]
Reduced risk of oil supply disruptions and security component	3.5¢		NRC estimate represents combined effects of the monopsony, supply and security components.
Reduced environmental damages from refinery and distribution emissions	Emission of "some pollutants may decline … while others may increase."[80]	2¢	
Reduced greenhouse gas emissions	NHTSA presented no quantitative estimate of the reductions in greenhouse gas emissions resulting from its proposal.[81]	12¢	According to NRC, "This figure is significantly higher than typical estimates."[82]
Total	8.3¢	26¢	

According to NHTSA, the value of externalities per gallon of gasoline is 8.3¢, of which 4.8¢ represents savings because reduced U.S. demand lowers world oil prices. Another 3.5¢ is for the decreased exposure to oil supply disruptions. Our estimates of external social costs from more driving, 26¢ to 36¢ per gallon, are much greater than NHTSA's estimate of the value of fuel saving.

Considering a different set of effects than those quantified by NHTSA, the NRC arrives at a societal benefit of 26¢ per gallon saved. The social costs of the additional

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[79] See Department of Transportation (2002a, Section VII) and NAS (2002, p. 86).
[80] See Department of Transportation (2002a, Section VII).
[81] See Department of Transportation (2002a, Section VII, Environmental Costs of Oil Refining and Consumption).

driving are as large or larger than this estimate, which includes an estimate of the benefits of controlling greenhouse gas emissions that the NRC describes as "high."

The social cost of the additional driving induced by more fuel-efficient vehicles thus fully offsets and probably outweighs the societal benefit of saving fuel. Importantly, this result holds for any level of driving, as shown in Appendix C. Thus, taking into account the external benefits and the most significant external costs of NHTSA's proposal – including global warming, disruptions to U.S. oil supply, traffic accidents, and congestion – the proposed CAFE revision provides no net benefits and is in fact likely to have detrimental effects.

Policy Choice

NHTSA's proposed rule is inconsistent with Executive Order 12866 on Regulatory Planning and Review. The 1993 E.O. stipulates that

> Each agency shall tailor its regulations to impose the least burden on society, including individuals, businesses of differing sizes, and other entities (including small communities and governmental entities), consistent with obtaining the regulatory objectives, taking into account, among other things and to the extent practicable, the cumulative costs of regulations.[83]

Since NHTSA is justifying its proposal by an alleged inefficiency in vehicle markets, rather than concerns about the environment, or dependence on foreign oil, it needs to consider the plain implications of its view. A regulation mandating greater information disclosure would surely be less burdensome than one requiring more fuel-efficient vehicles. Printing more detailed fuel economy labels and allowing consumers to choose what vehicles to drive would be less expensive than mandating a fuel economy standard. Even a gasoline tax, by reducing instead of increasing driving and the

[82] See NAS (2002, p. 85).
[83] See Clinton (1993, Section 1(b)(11)).

associated traffic accidents and congestion, is likely to reduce gasoline use at lower social cost than CAFE. To comply with E.O. 12866, NHTSA should consider proposing better fuel economy labels, and, if it seeks greater reductions in gasoline use, a modest gas tax.

Conclusion

To conserve gasoline, the National Highway Transportation Safety Administration recently proposed to increase the stringency of corporate average fuel economy standards for light trucks by 1.5 miles per gallon for model year 2007. While the proposal does not seem very stringent, in fact it is the biggest increase since the early 1980s. More importantly, it is a very inefficient way of achieving the stated regulatory goal of reducing fuel use.

To defend its proposal, NHTSA points to the fuel savings that consumers would experience as a result of more stringent CAFE, claiming this benefit alone outweighs costs to producers. This argument presumes that vehicle manufacturers interested in making money are unable to build vehicles that consumers are willing and able to pay for, even though they could profit by doing so. This presumption – which is unsupported by any direct evidence – is the cornerstone of NHTSA's proposal.

NHTSA reached its conclusions that consumer benefits outweigh costs to vehicle manufacturers by using an analytic approach that overstates benefits to consumers and understates costs to manufacturers. If NHTSA's analysis were correct it would mean– according to OMB's own guidelines – that NHTSA should prefer regulations that give consumers better information about fuel economy, an approach that NHTSA has not even considered.

While NHTSA's proposal will reduce gasoline consumption, it will also increase driving. The social costs of the increased driving – accidents and traffic jams – will fully offset the social benefits of reduced fuel consumption and will probably outweigh them.

If NHTSA is interested in a cost-effective way of reducing gasoline use, it should consider improving the fuel economy stickers on new vehicles to give consumers more information. It could also suggest a modest gasoline tax, which would provide incentives to all drivers to conserve fuel—the purported goal of NHTSA's proposal. Indeed, a tax of a penny per gallon effective in 2007 would reduce gasoline use by about as much as NHTSA's proposed standard[84]—while reducing instead of increasing driving and the associated risks.

[84] See Appendix A.

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Appendix A

The Effect of a Modest Gasoline Tax on Fuel Consumption

A very modest gasoline tax is as effective in reducing gasoline consumption as NHTSA's proposed CAFE standard. A tax of 1 cent–per-gallon of gasoline would save as much fuel as the NHTSA proposal in 2007; a mere 3 cents would save almost 150 million additional gallons in 2010. The effectiveness of a gasoline tax results from its applicability to all vehicles, not just new light trucks. The gallons saved from the change in price are:

(1) $\Delta G = G^0 \, r \, ((P^1 - P^0) / P^0)$

where G^0 equals the total gallons of gasoline consumed by motor vehicles in a given year, r equals the rebound effect, P^0 is the initial price of a gallon of gasoline, and P^1 is the price per gallon with the added tax. Thus, P^1-P^0 represents the amount of the tax per gallon.

To show the effects of a modest gasoline tax in 2007, we use Department of Energy forecasts of the *Annual Energy Outlook 2003 with Projections to 2025* (AEO 2003).[85] The *AEO 2003* estimates motor vehicle energy consumption to be 18.59 quadrillion British Thermal Units (Btu) in 2007.[86] Given that one quadrillion Btu is equivalent to 7.75 billion gallons of motor gasoline,[87] fuel consumption by motor vehicles is 144 billion gallons. The *AEO 2003* forecasts gasoline to cost $1.41 per gallon in 2007.[88] Assuming a long-run rebound effect of -.2 and a gasoline tax of just 1 penny

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[85] See U.S. Department of Energy (2003).
[86] See U.S. Department of Energy (2003, Table 2).
[87] See U.S. Department of Transportation (2002d, Human and Natural Environment, p. 3).
[88] See U.S. Department of Energy (2003, Table 12). Although this estimate is slightly lower than the NHTSA forecast, we adopt it here to ensure internal consistency in our calculations.

per gallon, equation (1) yields decreased motor vehicle fuel consumption of 200 million gallons.[89]

The total gallons saved in a given year under the NHTSA proposal is the sum of the gallons saved by each affected model year during the year in question. The gallons saved for a model year, i, in a given year are:

$$(2) \qquad \Delta G_i = LTS_i\,(VMT_i^1 \text{ x } GPM^1 - VMT_i^0 \text{ x } GPM^0)$$

where LTS_i is the light truck sales projection, VMT_i^0 and GPM^0 are the vehicle miles traveled and the gallons per mile before the tightened standard, and VMT_i^1 and GPM^1 are the vehicle miles traveled and the gallons per mile after the CAFE increase.

NHTSA projects light truck sales to be 7.65 million vehicles in 2005, 7.80 million in 2006, and 7.92 million in 2007.[90] NHTSA further estimates vehicle miles traveled to be 12,885 miles in the first year of a vehicle's life, 12,444 miles in the second, and 12,007 in the third.[91] NHTSA's CAFE proposal would increase on-road fuel economy for MY 2005 light trucks from 18.03 to 18.15 mpg, from 18.27 to 18.55 mpg for MY 2006 light trucks, and from 18.56 to 19.00 mpg for MY 2007.[92] Tightened CAFE standards increase VMT according to:

$$(3) \qquad VMT_i^1 = VMT_i^0\,(1 + r\,(GPM^1 - GPM^0) / GPM^0)$$

Employing a rebound effect of -.15, in 2007 NHTSA's proposal would lead to VMT of 12,019 for MY 2005 (in their third year), 12,472 for MY 2006 (in their second year), and 12,930 for MY 2007 (in their first year). Given model year fuel savings derived in

[89] The change in fuel demand is 144,072,500,000 (-.2) (.01/1.41). We use -.2, because it is a better estimate of the long-run response to changes in fuel prices than -.15.
[90] See Department of Transportation (2002a, Section VII).
[91] See Department of Transportation (2002a, Section VII).
[92] Note that on-road fuel economy is estimated as 85 percent of laboratory fuel economy. See Department of Transportation (2002a, Section VII).

equation (2), the NHTSA proposal results in total fuel savings of approximately 200 million gallons in 2007, about equal to the 1 cent-per-gallon tax.

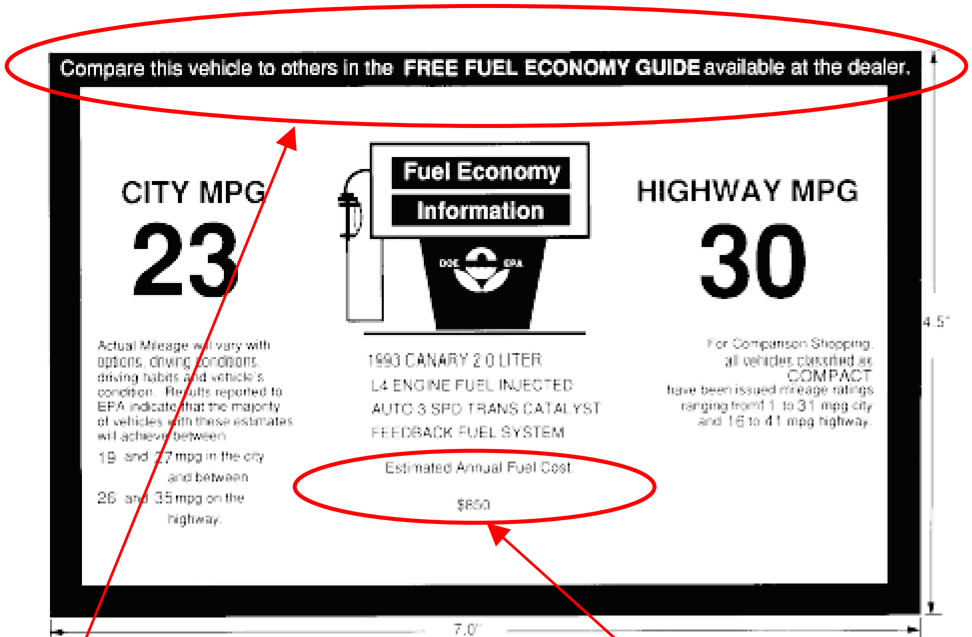
We repeated this analysis in 2010 to derive the effects of a 3 cents-per-gallon tax using predicted motor gasoline consumption of 156 billion gallons at a price of $1.43 per gallon.[93] A tax of 3 cents per gallon of gasoline would reduce consumption by 650 million gallons. The NHTSA proposal would save only 500 million gallons in 2010.[94]

One could calculate the tax burden associated with this idea, however, comparisons of it with the costs of CAFE are premature until NHTSA presents estimates of the full costs to producers and consumers of its proposal.

[93] See U.S. Department of Energy (2003, Tables 2 and 12).
[94] We used a linear regression of the logs of sales projections to estimate light truck sales for MY's 2008-2010. We assumed that on-road fuel economy would remain at 19.00 mpg in these years. See Department of Transportation (2002a, Section VII).

Appendix B

New Vehicle Fuel Economy Window Sticker[95]



a. Gasoline-fueled vehicle label

Note "Estimated Annual Fuel Cost."

Note notice of FREE FUEL ECONOMY comparison guide.

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[95] See 40 CFR § 600.Appendix.

Appendix C

Irrelevance of Annual Mileage

While we have assumed for simplicity of presentation that all new light trucks would be driven 10,000 miles per year, our analysis and conclusions are completely independent of this assumption. In particular, the social cost per gallon saved is independent of initial miles driven, because both the social cost from additional driving and the gallons saved are proportional to the initial miles driven. To see this, first note that

(1) $\Delta VMT / VMT^0 = r((GPM^1 - GPM^0) / GPM^0)$,

which implies

(2) $\Delta VMT = VMT^0 (r (GPM^1 - GPM^0) / GPM^0)$, and

(3) $VMT^1 = VMT^0 (1 + r (GPM^1 - GPM^0) / GPM^0)$,

where $VMT^1 = VMT^0 + \Delta VMT$. Given a social cost, s, associated with an additional mile of driving, the total social cost from the extra driving is simply

(4) $s\Delta VMT = s\ VMT^0 (r (GPM^1 - GPM^0) / GPM^0)$.

The gallons saved from more fuel-efficient standards can be computed as

(5) $\Delta G = (VMT^o GPM^o) - (VMT^1 GPM^1)$,

or using (3)

(6) $$\Delta G = VMT^o\ [GPM^o - ((1 + \frac{r(GPM^1 - GPM^0)}{GPM^0})\ GPM^1)]$$

Thus, social cost per gallon saved ($s\Delta VMT / \Delta G$), is independent of initial miles driven since both (4) and (6) are proportional to VMT^0.

Appendix D

Incremental Congestion Costs In Urban Areas With Populations Greater Than 100,000

We received, courtesy of David Schrank of the Texas Transportation Institute, data on the congestion costs, vehicle miles traveled and lane miles of freeways, and principal and arterial roads for 75 U.S. cities for the years 1994 to 2000. TTI staff suggested that these 525 observations were the ones most likely to be fully comparable over time and space. Summary statistics for these data appear below.

Variable	Obs	Mean	Std. Dev	Min	Max
Year	525	1997	2.00197	1999	2000
Cost (2000$)	525	7.48×10^{8}	1.74×10^{9}	0	1.46×10^{9}
VMT	525	5.75×10^{9}	7.58×10^{9}	1.90×10^{8}	4.97×10^{10}
Lane Miles	525	2305.8	2633.9	140	16350

Cost is the sum of congestion costs, that is, both fuel and traveler time. VMT denotes vehicle miles traveled, in miles.

Inspection of the cost data revealed that it was fairly highly skewed, with 26 observations with no reported congestion costs. The 5th percentile cost was $5,000,000, the 10th was $2.0 x 10^{7}, and the 90th was $1.64 x 10^{9}.

Further examination of these data suggest that they are lumpy, in that city-years with congestion costs less than or equal to $10 million consist of the 26 observations of zero, 7 observations with congestion costs of $5 million, and 14 observations with congestion costs of $10 million.

To make these data consistent with the results of Calfee and Winston (1998) and Winston and Shirley (1998) we adjust these cost estimates. In particular, for each year, we adjust total cost to equal

(.12) total cost + (.88) total cost (x)

where x, the ratio of 19 percent of gross wages in selected major cities to the time cost of travel used in the TTI study, varies from .24 to .27 among the different years.[96]

The Cook-Weisberg test indicates substantial heteroskedasticity in the errors of a fixed effect regression of congestion costs on VMT, lane miles and dummy variables for years. The chi-squared statistic for this test is statistically significant at better than the 0.1 percent level.

A linear OLS fixed effects regression of total cost on vehicle miles traveled and total lane miles suggests marginal costs of 18 cents.

A nonlinear Box-Cox regression procedure yields[97]

Variable	Value	Std. Error	Z	P>|z|	[95% C.I.]
Lambda	.4338	.03164	13.71	0.00	.3719-.4959
Theta	.2377	.01366	17.40	0.00	.2109-.2645

Lambda and theta are the Box-Cox transformations for VMT and congestion cost, respectively. The confidence intervals suggest that the data reject both linear and logarithmic models. In this model the coefficient on the transformed VMT, which is statistically significant at better than the 99 percent confidence level, is .01706. These data imply that the marginal cost of an additional mile of driving is $.23.[98]

[96] The TTI data set use McFarland and Chui's (1987) value of travel time of $8.03 in 1985 adjusted to the appropriate year. See Schrank and Lomax (2002, Appendix B, p.1). The Statistical Abstract of the United States reports average annual pay by select metropolitan areas for the years in question in the Labor Force, Employment, and Earnings section. See U.S. Census Bureau (Average Annual Pay by Selected Metropolitan Area). These 71 metropolitan areas are not the same as the 75 cities in the TTI dataset. The TTI values range from 69 to 79 percent of the average annual pay, assuming 2000 working hours per year, and correspond to values of x between .27 and .24.

[97] The Box-Cox transformation requires strictly positive values, so we experiment with replacing the congestion costs reported to be zero with congestion values of $1 million and $2.5 million. We find that the marginal cost estimate is little affected by these assumptions. David Schrank confirms that the estimates of congestion costs close to zero involve significant rounding so these alternatives to zero congestion costs appear reasonable.

[98] The STATA 7.0 software that we used for this regression does not compute standard errors for non-linear functions of the relevant parameters, so we do not have a confidence interval for this estimate, although each of the relevant parameters is statistically significant at better than the 99 percent confidence level.

Although the model rejects a logarithmic transformation, we note that the log model implies a marginal cost of 16¢ to 17¢ (depending on whether the zeros are rounded to $2.5 million of $1 million before our adjustments) with a 95 percent confidence interval of 14¢ to 18¢ for the former case, and 14¢ to 18¢ for the latter.

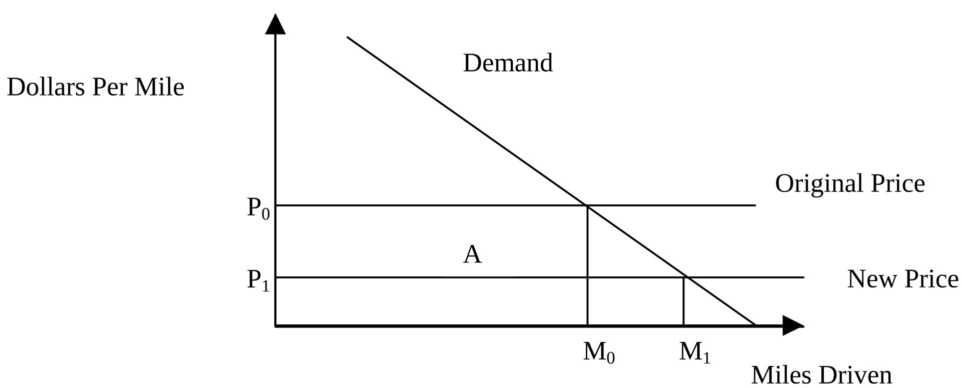
We also estimate this regression after subtracting the fuel costs of congestion. In this case we find that the marginal delay costs are 18¢ per mile, suggesting that the fuel costs of congestion rise by 5¢ with every additional vehicle mile traveled.

Appendix E

The Benefits of Additional Driving From Mandated Fuel Efficiency are Small[99]

While consumers find that additional driving induced by greater fuel economy has value, this benefit is too small to matter for our analysis. To show this, it is useful to distinguish between two different scenarios. First, more stringent CAFE standards may induce a consumer to buy a different vehicle. But, the consumer's utility of purchasing and operating one vehicle versus another is already subsumed in the demand curves for new vehicles. Thus, there is no reason in this scenario to account (in welfare terms) for the increase in miles driven.

Second, with more stringent CAFE standards a consumer may continue to buy the same vehicle he would have bought without the standards. In this scenario, there is an added consumer surplus to driving more miles, but it is so small as to be negligible. To see this consider a simple graphical model of demand for vehicle travel.



Given that the price of driving is initially P_0, the consumer will choose to drive M_0 miles. If more stringent CAFE standards lower the price of driving to P_1, driving

[99] Thanks go to Andrew Kleit for help with this appendix.

increases to M_1. The consumer gains are the rectangle A plus the familiar triangle, which we call B. The area A is what NHTSA refers to as the benefit of CAFE standards.

It is straightforward to show that the triangle B is small in relation to the area A. The area A is $M_0(P_0-P_1)$. The area of B is ½ $(M_1-M_0)(P_0-P_1)$. Thus, the ratio of B to A is simply ½ $(M_1-M_0)/M_0$.

To calculate this ratio, we have to solve for M_1-M_0 in term of M_0. Let $\Delta M=M_1-M_0$. We have already discussed the "rebound effect," r, which is the elasticity of miles driven with respect to fuel economy. Thus we estimate $(M_1-M_0)/M_0$ using

(1) $$(M_1-M_0)/ M_0 = r \ ((GPM^1 – GPM^0) / GPM^0)$$

where GPM^1 and GPM^0 are the gallons per mile under the current and the proposed CAFE standards.

The proposed change in the CAFE standard from 20.7 to 22.2 mpg for MY 2007 will increase the estimated on-road fuel economy level for a representative MY 2007 light truck from 18.56 to 19.00 mpg, an increase in fuel economy (measured in gallons per mile) of 2.3 percent.[100] Assuming a rebound effect of -0.15, the increase in VMT is 0.35 percent. The ratio of the area B to the rectangle A is about .17 percent.

The consumer surplus benefits of additional driving are also too small to matter for our conclusion that the social costs of additional driving are large relative to the value of the gallons saved. The consumer surplus per mile over the range from M_0-M_1 can be calculated as one half of the difference in the price of driving, P_0-P_1. Using NHTSA's assumed price of gasoline ($1.50/gallon), $P_0-P_1 = \$1.50 \ (GPM^1 – GPM^0)$, so the average

[100] These estimates are 85 percent of the MPG that NHTSA expects the new fleet to deliver in laboratory settings. See Department of Transportation (2002a, Section VII) for a discussion of its projections of MPG of the new fleet and see Department of Transportation (2002b, Appendix A) for the difference between laboratory and on-road performance.

consumer surplus per mile is about 0.08¢ = (½)($1.50) (.00107). This consumer surplus, which applies only to the households that did not change their choice of vehicle as a result of the more stringent fuel economy standards, is inconsequential.