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The Economics of CAFE Reconsidered: A Response to CAFE Critics and A Case for Fuel Economy Standards

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Executive Summary

Economists have long criticized the Corporate Average Fuel Economy (CAFE) standards as distortionary and costly ways to conserve fuel. Two recent analyses from the AEI-Brookings Joint Center argue that the costs of increasing the CAFE standards more than offset the modest conservation benefits (Kleit, 2002; Lutter and Kravitz, 2003). We review these studies and find that these cost estimates reflect pervasive problems with U.S. transportation policies. Specifically, the analyses estimate that externalities associated with safety, congestion, air pollution, greenhouse gas emissions, and national security range from eight to more than 10.4 cents per mile or more. Internalizing these existing distortions via a gasoline tax would more than double U.S. gasoline prices, which would reduce distortions in the product market and sharply reduce driving externalities. Thus, we conclude that indictments of the CAFE program are actually arguments for sharp increases in gasoline taxes and other transportation policy reforms. Next, we revisit the economic logic of minimum government fuel economy standards. We show that even rational, well-informed consumers will choose vehicles with fuel economies that are inconsistent with social preferences for fuel conservation. Therefore, there is a case for the CAFE standards even if existing problems with the transportation system are addressed. We conclude that the CAFE critics have made a good case for increasing the gasoline tax $1.50 per gallon or more, but that they have not made a compelling argument against the CAFE program itself.

The Economics of CAFE Reconsidered:
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1. Introduction

In 1975 Congress established Corporate Average Fuel Economy (CAFE) standards as a means to conserve petroleum and to reduce U.S. reliance on imported oil. The program continues to enjoy solid public support as a means to conserve fuel, enhance domestic petroleum security, reduce air pollution, and curb greenhouse gas emissions. Many economists and free-market proponents argue that the CAFE program has a host of direct and indirect costs that overwhelm its conservation benefits.

Congress has revisited the CAFE question on numerous occasions,[1] and there have been dozens of studies evaluating the program.[2] A recent National Academy of Sciences (NAS) panel addressed a number of salient issues. The panel estimated that gasoline consumption carries external costs of about $0.26 per gallon,[3] which are approximately 20% of the current pre-tax price of gasoline. The panel also found that current technology makes cost-effective a fuel economy improvement of two to three miles per gallon, with no penalty for performance or vehicle size (NAS, 2002). These two conclusions suggest that fuel conservation measures have the potential to generate social gains, and that these conservation measures can be self-financing. The question that remains is whether the CAFE program is a good approach for achieving conservation goals.

Although many readers took the NAS recommendations as a modest endorsement of CAFE increases, two recent studies from the AEI-Brookings Joint Center have criticized both the necessity and the effectiveness of the CAFE program. Kleit (2002) evaluates the impacts of a three-mile per gallon (MPG) increase in the standards.[4] He finds that increasing the CAFE standards would result in product market distortions, resulting in billions of dollars in lost

[1] Bamberg (2003) describes the CAFE program and provides a running account of congressional activity.
[2] See, for example, NAS (2002, 1992), Greene (1998), Crandall and Nivola (1995), Crandall (1992), Kleit (1990), and Leone and Parkinson (1990).
[3] The 2001 figures on vehicle miles traveled and fuel consumption show a fleet fuel economy of 17 miles per gallon, eliciting an external cost estimate of approximately 1.5 cents per mile.
[4] The AEI-Brookings Joint Center paper (Kleit, 2002) has been revised for publication in *Economic Inquiry*. Professor Kleit provided us with a copy of the revised paper, and we rely on estimates from this paper in our discussion.

consumer and producer surplus. Moreover, greater fuel efficiency lowers per-mile driving costs and therefore encourages more driving. As a result of this *rebound effect*, an increase in the CAFE standards would lead to more crashes, more congestion, and more pollution. All told, he estimates that the CAFE program results in average costs of about $0.70 to $0.78 per gallon of gasoline saved. Lutter and Kravitz (2003) focus specifically on the NHTSA proposed (and recently finalized) rule to increase standard for light trucks from 20.7 to 22.2 MPG by 2007. They find that the external costs from the rebound effect are so extensive that they overwhelm any benefits of an increase in fuel efficiency.

The points made by these critics are important, but they imply policies quite different from those drawn. Specifically, the costs of market distortions and the external costs stem from the failure of current gas prices to reflect the full social costs of gasoline consumption. Lutter and Kravitz (2003), for example, argue that, at the margin, there are external costs of 10.4 cents *per mile* associated with additional crashes (7.8 cents), congestion (2.4 cents), and pollution (0.2 cents).[5] If so, gasoline is under-priced dramatically, insurance markets are inefficient, and congestion policy needs fundamental reform. The authors do not explore the role of the CAFE program in generating these costs, nor do they offer any policy prescription for mitigating them. Given that the current realized fleet average fuel economy is 17 miles per gallon MPG),[6] a corrective Pigouvian tax increase of about $1.75 per gallon would be needed to internalize these externalities.

Implementing a corrective tax would lower the critics' cost estimates markedly. The market distortions exist because, at current gasoline prices, consumers place a low priority on fuel economy. Higher gasoline prices would reduce these distortions by reducing driving and the associated externalities and by leading consumers to demand vehicles with greater fuel economy. Thus, we conclude that the recent criticisms are not as much an indictment of the CAFE program as a vivid illustration of the failure of current transportation policy to internalize enormous external costs.

After examining the arguments against CAFE, we discuss the economic arguments for the program. First, most vehicle lines have a range of fuel economies where the lifetime cost of

[5] NAS (2002) includes external cost estimates for national security and global warming, but these costs are not included in the 10.4 cent per mile estimate.

[6] The figure is derived from the Office of Highway Policy Information's figures on vehicle miles traveled and total motor fuel consumption. The adjusted EPA estimate for the average fuel economy of new vehicles has been falling since 1995, and is currently 20.4 MPG.

vehicle ownership are roughly constant (NAS, 2002). That is, technology exists to improve fuel economy at some up-front cost, and this cost will be paid back in fuel savings over the lifetime of the vehicle. Current market outcomes provide vehicles with lower up-front costs, though social preferences would tend to favor vehicles with greater fuel economy. Second, most analysts assume that private agents employ discount rates that are far higher than reasonable social discount rates for fuel conservation. As a result of this discrepancy, market outcomes systematically under-provide fuel efficiency. A combination of higher gasoline taxes and modifications of the CAFE program would be superior to either instrument on its own.

2. An Overview of the CAFE Program

Congress created the CAFE program as part of the Energy Policy and Conservation Act in 1975. The current CAFE standard for cars is 27.5 miles per gallon (MPG) and 20.7 MPG for light trucks. Figure 1 plots average new vehicle fuel economy for cars and light trucks, as well as the overall new vehicle average.[7]

High gasoline prices from 1975 through the early 1980s provided consumers with the incentive to purchase more fuel-economic vehicles. Gas prices fell dramatically in the 1980s, leading consumers to emphasize performance features such as power, size, styling, and safety over fuel economy. Persistently low gasoline prices send consumers a signal that contradicts social conservation objectives. Automakers must simultaneously satisfy the CAFE standards and consumer demands for larger, high-performance vehicles.

Predictably, the mixed signals have led producers and consumers to look for ways to get around the standards. In 1986 and 1987 Congress simply relaxed the standards so that Ford and GM would not be saddled with millions in fines. Producers are also allowed to allocate credits forward and backward to avoid paying fines. Automakers began to redesign trucks to serve as passenger vehicles partly to take advantage of lower fuel economy standards. In 1975 cars accounted for 90% of the passenger-vehicle fleet, but as a result of the introduction and proliferation of minivans and sport utility vehicles (SUVs) current vehicle sales are about equally split between cars and light trucks.[8] The overall average for new vehicles peaked in 1987 at 22.1

[7] Vehicles are certified under ideal conditions, and therefore the standards of 27.5 and 20.7 MPG are not realized in practice. EPA estimates that certified MPG is 10 to 15% higher than in-use vehicle performance.

[8] At least initially, U.S. producers enjoyed a competitive advantage in producing these vehicles, as there is a stiff import tariff on trucks. However, many foreign companies have established production facilities in the U.S. and are

MPG, but has since decreased to 20.4 MPG predominantly because of increasing market share of light trucks.

Figure 2 plots trends in vehicle miles traveled (VMT) and fuel consumption, and Figure 3 shows the average fleet fuel economy implied by these two metrics. The figures show gains in fuel economy as more fuel-efficient vehicles were introduced in the late-1970s and into the 1980s. Fleet fuel economy increased from 12.5 MPG in 1979 to 16.9 MPG in 1991, where it remains today. As the fuel economy of new vehicles leveled off, fleet fuel economy did as well, and it has remained roughly constant since 1991. Because of continued, steady increases in driving, however, domestic fuel consumption has been increasing since 1991.

Clearly, current gasoline prices are inconsistent with fuel economy mandates. CAFE critics have seized this fundamental point to show that increasing the CAFE standards would exacerbate this conflict and create welfare losses associated with product market distortions. However, the critics are implicitly assuming that current gasoline prices are correct and it is CAFE that creates distortions. Their assumption is contradicted by their data showing that current gasoline prices are far too low because of significant externalities. If these externalities were internalized, the fuel economy demanded by consumers would be higher than the current CAFE standards.

3. The Economics of CAFE

The recent critics are not the first to take shots at the CAFE program. Economists generally do not have a favorable opinion of the CAFE program, arguing that standards are neither wanted, nor needed, and have had a series of bad unintended consequences. Crandall, Gruenspecht, Keeler, and Lave (1986) argue that it was high gas prices, not the CAFE standards, that led to the sharp increases in fuel economy. By the mid-1980s, however, the drop in gasoline prices meant that CAFE was responsible for maintaining the fleet fuel economy gains of the past decade. As a result, questions turned from whether CAFE mattered to evaluating the market distortions and other costs associated with the program.

The estimated costs of the CAFE program include product market distortions, safety concerns, and costs associated with CAFE-induced increases in driving. As we have seen, the

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now entering this segment of the market. As a result, share of GM, Ford, and (Daimler)-Chrysler dropped from 86% in 1993 to 75% in 2001 (NAS, 2002)

CAFE requirements forced producers to offer vehicles that most consumers do not find appealing. Automakers must offer and subsidize vehicles with high fuel economy in order to sell the larger, powerful vehicles that are highly profitable; thus the CAFE standards lead to reductions in both producer and consumer (for some consumers) surplus. Year in and year out, the CAFE constraints force automakers to offer an economically inefficient product mix, resulting in billions of dollars in lost producer and consumer surplus (Crandall, 1992; Kleit, 1990; 2002). Moreover, foreign producers gain at the expense of domestic producers and consumers (Kleit, 2002). The product market distortions are also the cause of safety concerns. To meet the CAFE standards, automakers were forced to reduce vehicle weight. Because occupants of smaller vehicles are less safe in crashes, these weight reductions were estimated to result in several thousand traffic fatalities each year (Crandall and Graham, 1989; NAS, 2002).

More recently, there have been concerns that fuel-economy improvements increase the external costs associated with driving. Because CAFE reduces marginal driving costs and encourages more driving, there are costs associated with the CAFE-induced vehicle miles traveled. An average point estimate is that a 10 percent increase in fuel economy (or decrease in fuel prices) leads to a two percent increase in driving (Greene, Kahn, and Gibson, 1999). The "take-back" or "rebound" effect cuts into the conservation benefits of improved fuel economy. Moreover, because there are significant externalities associated with driving, e.g., crashes, congestion, and pollution, any additional driving generates enormous social costs.

The rebound effect has figured prominently in recent attacks on the CAFE program. Figure 4 illustrates the private and social benefits and costs of fuel economy improvements and the rebound effect. Fuel economy improvements reduce the price of driving ($/mi) from P0 to P1, inducing a movement along the demand curve and vehicle miles traveled (VMT) increase from VMT0 to VMT1. The private benefit of the improvement is represented by the trapezoid bounded by P0, P1, and the demand curve ($VMT1 * \Delta P - 0.5*\Delta P*\Delta VMT$). Assuming that the performance and size of the vehicle are unchanged, there will be an additional manufacturing cost to increase fuel economy. Thus, the net private benefit is the trapezoid less these up-front capital costs. With per-mile external costs, S, the CAFE-induced social costs from the additional VMT are $S * \Delta VMT$.

Economists generally support gasoline tax increases as the most efficient means for increasing fuel economy. The intuition is straightforward. First, CAFE standards apply only to new vehicles and therefore the effects are introduced over fifteen or more years. Second, fuel efficiency increases reduce per-mile fuel costs, thus encouraging more driving. In contrast, fuel taxes both encourage consumers to drive less now, and demand more fuel-efficient vehicles in the future. The cost estimates are also difficult to argue with: Gasoline taxes achieve the same fuel conservation levels at costs that are seven to 10 times less than those of the CAFE program (Crandall, 1992).

4. Recent Cost Estimates of Increasing the CAFE Standards

A recent, careful study of the CAFE program by Kleit (2002, forthcoming) offers a useful starting point for thinking about the costs and benefits of fuel efficiency standards. The study looks at the effects of a three-mpg increase in the CAFE standards for both cars and light trucks. First, he uses GM data to examine the effects of CAFE on producer and consumer surplus. The models assume that the product markets are perfectly competitive and the prices of all vehicles are set at marginal cost.[9] The model is calibrated as a long-run equilibrium model in the sense that producers can add fuel economy at a given fixed cost, while holding vehicle quality, reliability, durability, and performance characteristics constant. Consumers are assumed to be willing to pay an upfront fixed cost for fuel economy improvements, if the discounted lifetime fuel costs warrant the investment.[10] Consumers are assumed to have a discount rate of 20%, while gasoline is priced at $1.25 per gallon.

Kleit runs the model twice. In the first case, producers are unconstrained by CAFE when the three-MPG increase is mandated. The second case considers the more likely scenario that CAFE is already a binding constraint. The product market changes have repercussions for driving and scrappage decisions; these changes translate into changes in average fleet fuel economy, driving costs per mile, vehicle miles traveled, and total gasoline consumption.

Table 1 summarizes the results of several model runs against baseline levels of VMT,

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[9] This assumption is inconsistent with the conventional wisdom that producers sell small vehicles at cost in order to allow for production of larger vehicles with larger profit margins. Assuming that markets are not competitive can lead to much different conclusions. For example, Kleit (1990) finds that in an oligopoly setting the CAFE constraints are not as costly to U.S. producers, and that such a constraint can decrease deadweight losses by increasing production in certain product segments. Similarly, Goldberg (1998) assumes an oligopoly setting and finds the distributional effects to fall primarily on producers, whereas Kleit's model finds that consumers shoulder a larger burden.

[10] In effect, this assumption sidesteps a central empirical issue: Many CAFE supporters contend that consumers do not do a very good job of determining whether fuel savings are worth the added up-front costs, limiting producer incentives to improve fuel economy (Greene, 1998).

gasoline consumption, average fuel economy, and fuel costs. The average vehicle fuel economy increases from 22 to 24.1 mpg. With gas prices of $1.25 per gallon, the change results in about a half-cent decrease in per-mile fuel costs (to $0.052 from $0.057). Overall, the estimates reveal that the CAFE program reduces domestic gasoline consumption by 5.2 to 5.4 billion gallons per year.[11]

Product Market Distortions

Not surprisingly, when consumers and producers are rational maximizers, adding a constraint reduces social welfare. Table 2 reports estimated losses in producer and consumer surplus.[12] The table reveals differential impacts on domestic and foreign producers, with total producer surplus declining between $243 and $612 million. The heavier producer losses are associated with the case where CAFE is already binding. The changes in consumer surplus are approximately $1 billion in each scenario. Total social welfare losses range from $1.196 to $1.708 billion. The estimated cost is $0.22 to $0.33 per gallon saved.

External Costs of Driving

The half-cent decrease in driving costs is estimated to induce a moderate rebound effect, leading to nearly 27 billion additional miles driven. Because there are external costs associated with driving, these additional miles generate significant costs associated with more crashes, more congestion, and more pollution.

One estimate of these costs includes the costs of accidents of 7.8 cents per mile (Edlin, 1999), congestion costs of 2.4 cents per mile (Lutter, 2002), and pollution costs of approximately 0.2 cents per mile from the Office of Management and Budget. This comes to 10.4 cents per mile. These externality cost estimates do not include any benefits from reducing greenhouse gas emissions or enhanced energy security of about a 1.5 cents per mile ($0.26 per gallon) reported in the recent NAS study (2002). NHTSA uses an estimate of 6.15 cents per mile in its recent

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[11] The U.S. uses approximately 120 billion gallons per year, so from this baseline the savings is about 4% of total consumption. However, Kleit calculates savings against a baseline of 75 billion gallons (see Table 1) and comes up with a savings of 7%.

[12] Kleit breaks producers into domestic (GM, Ford, and Chrysler) and foreign (BMW, Honda, Mercedes-Benz, and Toyota), and reports losses in terms of U.S. producer surplus. Thus, the estimates overstate costs because they ignore gains by foreign manufacturers. The stratification is potentially objectionable for several other reasons. First, the CAFE standards would affect the luxury producers BMW and Mercedes-Benz differently than Honda and Toyota, so it is not clear why these producers are all lumped together. Second, Daimler purchased Chrysler in 1998, so it is not clear why Daimler-Chrysler is considered a U.S. firm.

cost-benefit analysis of the proposed increase in the light-truck standard.

Kleit splits the difference between 10.4 and 6.15 cents per mile, using an estimate of 8.27 cents per mile. At this level, the additional VMT lead to approximately $2.2 billion per year in costs associated with accidents and congestion. Thus, there is about $0.40 of driving externalities result for each gallon saved. The remarkable result is that the driving externality effects are significantly higher than the costs of product market distortions. In a similar vein, Lutter and Kravitz (2003) argue that with external driving costs of 10.4 cents per mile, the costs of NHTSA's proposal to increase the light-truck standard from 20.7 to 22.2 completely overwhelm the benefits in terms of fuel savings.[13]

The costs of the CAFE program fall into two categories. The first is the product-market distortions that lead to losses in producer and consumer surplus, and fall disproportionately on domestic producers. Overall, these estimated costs range from $0.22 to $0.33 per gallon saved, which is right around the NAS (2002) estimate of $0.26 in external costs of petroleum consumption. Because these are average rather than marginal cost estimates, it is difficult to draw any conclusions other than that on average the costs of increasing CAFE are about the same as the benefits. Thus, the second set of costs, external costs associated with CAFE-induced driving, are the lynchpin of the argument against increasing the CAFE standards. By including these external costs, even modest incremental increases in the CAFE standards seem absurd.

5. How Big is the Rebound Effect?

The implication of the rebound effect is that people who own more fuel-efficient vehicles drive them more. Specifically, a one-half cent decrease elicits more driving. Certainly, we find this logic intuitively appealing, yet the empirical reality is murkier. Consider the Ford Taurus. The American Automobile Association (AAA) estimates that the average cost of driving a Taurus 15,000 miles in the first year is 51.2 cents per mile. The fixed costs of insurance, license fees, depreciation, and finance charges account for 38.2 cents per mile, and the remaining 13 cents include variable costs of 7.1 cents per mile for gas and oil, 4.1 cents for repair and

[13] Lutter and Kravitz (2003) employ different underlying assumptions. Kleit follows the NAS committee assumption that vehicle performance will not be affected by the modest CAFE increase. Lutter and Kravitz assume that even a small increase in CAFE will result in light trucks that are smaller and less powerful. The NAS committee and many other analyses show that modest increases in CAFE could be achieved with no performance penalty and at additional manufacturing cost that could be offset by lifetime fuel savings.

maintenance, and 1.8 cents for tire wear. Americans have a great deal of experience with cars, and certainly recognize the costs of tire wear, oil, and maintenance. Consumers also understand that the price of a used car depends on the number of miles that it has been driven.

For each mile beyond the first 15,000, AAA estimates that the Taurus depreciates at a rate of 18.8 cents per mile. Furthermore, external costs from additional driving are unlike train sparks on a farmer's field, or factory emissions affecting a neighboring laundry. The driver of the car and her passengers are likely to absorb personally a significant portion of costs associated with injury and death due to accidents, along with some portion of congestion costs. The estimated cost of driving an additional mile is 13 cents in variable costs, 18.8 cents of depreciation, and some portion of the "external" crash and congestion costs, leading to an estimated cost of driving an additional mile to be more than 33 cents. In contrast, fuel efficiency gains are estimated to lower fuel costs by a half cent per mile, which is about 1.5% of total variable costs. If these sets of estimates are accurate, then the savings from improved fuel economy are a storm in a teacup, and we expect that the estimated rebound effect is overstated.

Driving a vehicle more implies either that a vehicle is scrapped at an earlier age or that they put more miles on a vehicle before scrapping it. This leads to the question of when and why consumers scrap vehicles. If owners scrap vehicles purely because they become unfashionable, then we expect that miles driven would increase. If, at the other extreme, vehicles were "one-hoss shays" that disintegrate into dust at 150,000 miles, then no additional miles would be driven with this vehicle.

A more realistic model is that, as a vehicle ages, maintenance and repairs rise and the vehicle becomes increasingly unreliable. An owner will scrap the vehicle when its maintenance and repair costs and costs of unreliability are higher than the costs of a newer vehicle. We could not find estimates of the cost of owning and driving a 12 to 15 year old vehicle that had traveled 150,000 miles. However, the fact that vehicles are scrapped before turning into dust shows that consumers do weigh the marginal costs and unreliability costs against the costs of a newer vehicle. An older vehicle's depreciation would be small, but maintenance and repairs would be large and the vehicle would be spending more time in the repair shop, would not start when needed, and otherwise would be unreliable. Assuming that gasoline and tires cost the same, that maintenance more than doubles, that depreciation is zero, and that safety and congestion costs to the driver are the same, the half cent a mile fuel savings would only amount to a 2 to 2.5% cost reduction. This thought experiment suggests that the small reduction in fuel costs per mile stemming from a CAFE increase would have little effect on the number of miles driven over the lifetime of a vehicle.

6. Implications of the Rebound Effect Analysis

We concur that there are significant distortions in the product market, that the rebound effect is real, and that fuel-economy improvements can have incremental effects on these costs. However, criticizing the CAFE program for creating market distortions and exacerbating driving externalities is like complaining about the taste of rabbit in a horse and rabbit stew. The CAFE program is not the source of the extant market distortions and driving externalities. Market distortions exist because current gas prices do not reflect the full cost of fuel consumption. Driving externalities exist because insurance markets do a poor job of aligning private driving decisions with insurance rates, and the road system in the U.S. is a congested public resource. Thus, we find that the conclusion that CAFE is bad policy because of high external costs associated with driving to be peculiar. If at the margin driving generates 10 cents worth of costs per mile, then social policies should target these externalities.

The lion's share of the external costs of driving is from crashes. Nevertheless, insurance rates are not closely tied to vehicle miles traveled and subsidize high-risk drivers. It is costly for insurance companies to monitor driving, and these transaction costs are evidently higher than the potential gains of charging consumers for their additional miles driven (Edlin, 1999). Moreover, the economic estimates of the value of life and pain and suffering are higher than insurance coverage, leaving a large chunk of crash costs uninsured. Therefore, even an efficient private insurance market would not cover external costs of driving.

In absence of some public policy measure to reform insurance markets and reduce congestion, a gasoline tax could serve as a proxy to internalize the costs of congestion and crashes. For a fleet that averages 17 to 20 MPG, the appropriate tax for an external cost of eight to 10-cents per mile would be in the range of $1.36 to $ 2.00 per gallon.[14] This needed increase in the gas tax is the most important implication that can be drawn from the recent criticisms of the CAFE program – current costs of highway injuries and deaths, congestion, and air pollution

[14] Gasoline tax revenues are typically earmarked for road construction and improvements, meaning that U.S. gasoline taxes are effectively treated as user fees. If gasoline taxes were to be used as a corrective instrument, then the revenues would have to be allocated differently.

are enormous and require a dramatic public policy response. Raising the gas tax by $1.36 to $2.00[15] would induce a sharp reduction in vehicle miles traveled and encourage consumers to demand fuel-economy improvements in new vehicles.

The basic question addressed in these two studies is whether raising CAFE is a good idea in the current environment. In each case, the authors argue that CAFE creates market distortions in the product market and exacerbates external costs associated with driving. Indeed, the fact that gasoline is dramatically under-priced is an underlying implication of the work of both Kleit and Lutter and Kravitz, yet neither explores the implications of CAFE policy in a world where these distortions are not so glaring. At current gas prices, a CAFE increase is incompatible with consumer preferences, and an increase in CAFE will amplify these distortions. However, it does not necessarily follow that CAFE is the root cause of these costs or that the CAFE program is bad public policy. At higher gasoline prices consumers would demand more fuel-efficient vehicles, thus reducing the estimated product-market distortions that result from higher CAFE standards. Similarly, if the baseline level of driving externalities were zero, then any CAFE-induced increases in driving would produce negligible external costs.

7. Economic Justifications for CAFE

There is a spirited debate among CAFE proponents and opponents concerning whether consumers are rational in choosing fuel economy for their vehicles. Many CAFE proponents argue that consumers select a vehicle based on a variety of performance characteristics, but have difficulty assessing whether benefits of added fuel efficiency are worth the costs. In contrast, CAFE opponents, including many economists, argue that information is readily available and that consumers are capable of evaluating whether the higher vehicle price is worth the gasoline savings. Although assuming consumer rationality makes the CAFE debate less interesting, we argue that CAFE is justified even for rational, well-informed consumers, since there are social benefits of fuel conservation that private decision makers do not internalize. We do not argue that CAFE is necessarily the best instrument for achieving conservation objectives, but we judge that a combination of gas taxes and CAFE will be superior to gas taxes alone.

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[15] These estimates are derived by multiplying eight cents per mile times 17 MPG and 10 cents per mile times 20 MPG.

Lifetime Costs

A series of studies have found that the total cost of owning a vehicle over its lifetime is about the same for vehicles across a range of fuel economies. Subsequent studies have confirmed this conclusion by determining the range of fuel economies where the lifetime savings in gasoline would pay for the higher manufacturing cost of making a more fuel economic vehicle that had the same performance.

NAS (2002) finds that fuel efficiency improvements are cost-effective for current technology, since the higher sticker price would be off-set by fuel savings over the lifetime of the vehicle. The implication of this finding is that the current market conditions lead to equilibrium where vehicles are at the low end of the feasible fuel economy range.

Greene (1998) estimates that the lifetime cost of owning a subcompact car vary by less than $100 for cars that got between 30 and 40 miles per gallon.[16] While consumers should be indifferent between vehicles in this range, a number of empirical studies suggest that consumers prefer lower up-front costs to lower operating costs. This suggests that consumers will purchase at the low end of the fuel economy range. Since a 40 mpg car would use 1,250 fewer gallons of gasoline over its 150,000 mile lifetime, society strongly prefers vehicles that will consume less gasoline. Green's calculation suggests that requiring the 40 mpg car would save gasoline at a cost of less than 8 cents per gallon. Note that higher fuel prices will not solve this problem, but only raise the minimum end of the range.

Table 3 presents the NAS (2002) estimates of break-even levels across different market segments. The numbers suggest both that a large range exists where lifetime vehicle ownership costs are constant, and that there is room for significant improvements in fuel economy across every market segment. Consumers are assumed to have a discount rate of 12% and gasoline prices are $1.50. The most striking numbers are that the biggest potential fuel savings come from the market segments that currently have the worst fuel efficiency. The lower-bound estimate for large cars is that a 4.2-MPG improvement is possible while keeping lifetime ownership costs approximately constant. Such an improvement would save 882 gallons of gasoline over the life of the vehicle. Similarly, for the large SUV segment, the lower-bound estimate is an improvement from 17.2 MPG to 23.2 MPG – a 28% increase, resulting in fuel savings of 2477 gallons of gasoline over the vehicle lifetime.

[16] The estimate is made using Department of Energy data, assuming consumer discount rates of 20% and gas prices of $1.50 per gallon. He finds a range of 30 to 35 MPG using industry data.

Social Versus Private Willingness to Pay for Conservation

Crandall (1992) recognized that differences in social and private discount rates are a potential justification for minimum fuel efficiency standards. High discount rates lead consumers to choose lower levels of fuel efficiency than society would choose with its lower discount rate. If the divergence were small, the effect might be neglected. However, CAFE critics assert that consumers have high discount rates. For example, Kleit (2002) assumes that consumers discount at a rate of 20% for new vehicle purchases, and Lutter and Kravitz (2003) argue that NHTSA should employ discount rates of seven to 10%, or even higher, to reflect consumer discount rates in evaluating the program benefits.

Given Kleit's assumption of a 20% discount rate for consumer purchases, he calculates that the average vehicle is driven 55,000 discounted miles. A consumer would be willing to pay $275 for a two-MPG improvement in fuel economy (a half-cent per mile cost decrease). Using a 7% discount rate, society would see the vehicle as going nearly 100,000 discounted miles, implying that the fuel sayings is worth $500. Thus society would value the fuel savings at $225 more than the rational consumer for the same fuel-economy improvement. Thus, the assumptions underlying recent criticisms imply that even if there were no external costs, market outcomes would under-provide fuel economy.

Figure 5 illustrates the differences by contrasting the willingness to pay for a three-mile per gallon increase in fuel economy using a private discount rate of 20 percent and a social discount rate of four percent. We choose the four percent rate because this is closer to typical social discount rates (and it is also the discount rate that Kleit uses to analyze effects of gasoline savings). Assuming a fuel price of $1.50, the social WTP for an increase from 22 to 25 MPG is approximately $400 more than private WTP. Moreover, the divergence in WTP is highest for vehicles that get the poorest fuel economy. For example, the adjusted average fuel economy for a large SUV is 17.2 MPG. Figure 5 shows that society would be willing to pay almost $660 more for fuel economy improvements than the rational consumer.

The significant divergence between public and private discount rates creates a social inefficiency that could be internalized either by a fuel tax increase that offsets the externality, by a CAFE standard that is derived from the social discount rate, or by some other market intervention. Justifying fuel economy standards on the basis of a divergence of social and private discount rates opens the door to regulation of air conditioners, furnaces, light bulbs, and any number of products that have tradeoff between up-front costs and operating costs. We observe that the federal government has intervened in each of these markets to regulate the efficiency of the units, prohibit units of lower efficiency, or at least to inform consumers of the savings from the more efficient units. As emphasized above, we do not view CAFE alone as an efficient mechanism for internalizing social costs. We do note that CAFE opponents draw the wrong implication for the large divergence in consumer versus social discount rates that they assume. If new car consumers have discount rates that are much higher than the social discount rate for fuel conservation, then consumers will choose vehicles with too little fuel economy, resulting in a benefit to a market intervention to correct the problem.

7. Recommendations

The CAFE program has the potential to provide a useful signal to automakers concerning what they will have to achieve in future years, giving them time to perform the needed research and development and build the needed plant and equipment. CAFE keeps automakers' attention on fuel economy, getting them to figure out how to squeeze each tiny increment of fuel economy out of their vehicles. Consumer desires for greater fuel economy would have the same effect, but signals from buyers are scrambled by the range of consumers with differing desires.

A first best policy would address each of the important externalities, including congestion tolls, specific incentives to prevent crashes and protect occupants, and increased gasoline taxes to mitigate the externalities of petroleum consumption. Even if each of these externalities were internalized, consumers would still choose vehicles at the lower end of the fuel economy range where the lifetime cost of owning a vehicle is constant for some fuel price, and consumers would still discount gas savings at less than the value that society puts on them. Given transactions costs and the mischief that Congress gets into when enacting and earmarking taxes, a simpler, slightly less optimal solution is likely to be superior to one that internalized all the externalities. A higher gasoline tax is an important first step. In our judgment, this tax plus CAFE would be still more efficacious. If a higher gas tax is impossible, most of the efficiency gain would be lost. In that case, raising CAFE would lead to political battles, consumer revolts, and likely widespread cheating. Nonetheless, a CAFE increase alone would be better than no action. The U.S. currently has a fuel price that is inconsistent with CAFE. The result is that consumers want larger, more powerful vehicles than CAFE allows. Consumers and automakers spend a great deal of effort trying to get around the CAFE standards, creating large social losses. For example, if gasoline taxes were raised 25 cents per gallon, the average consumer would demand a 27.5-mpg vehicle and it is doubtful that light trucks would retain their 50% market share. In addition to the gas tax increase, an increase in CAFE would send an unequivocal signal to automakers, getting them to squeeze each drop of fuel economy out of their vehicles, while the gasoline tax would signal producers and consumers, leading consumers to demand higher levels of fuel efficiency.

In this paper we have evaluated recent economic evaluations of CAFE standard increases and discussed whether there was any reasonable economic justifications for the CAFE program itself. We find that CAFE is most likely to be effective if it is supported by increases in gasoline prices. We have not evaluated whether reforming the CAFE program has any potential benefits. For example, one possibility would be to eliminate the separate standards for cars and light trucks and set a single standard for all passenger vehicles. A second possibility would be to allow for inter-firm trading of CAFE credits. A third possibility would be to make the fines for violating the CAFE standards into fees rather than penalties. Each of these changes has been advocated, and each has the potential to reduce the costs of CAFE. However, the CAFE program will continue to create distortions and generate social costs unless accompanied by an increase in gas prices.

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Figure 1: New Vehicle Fuel Economy

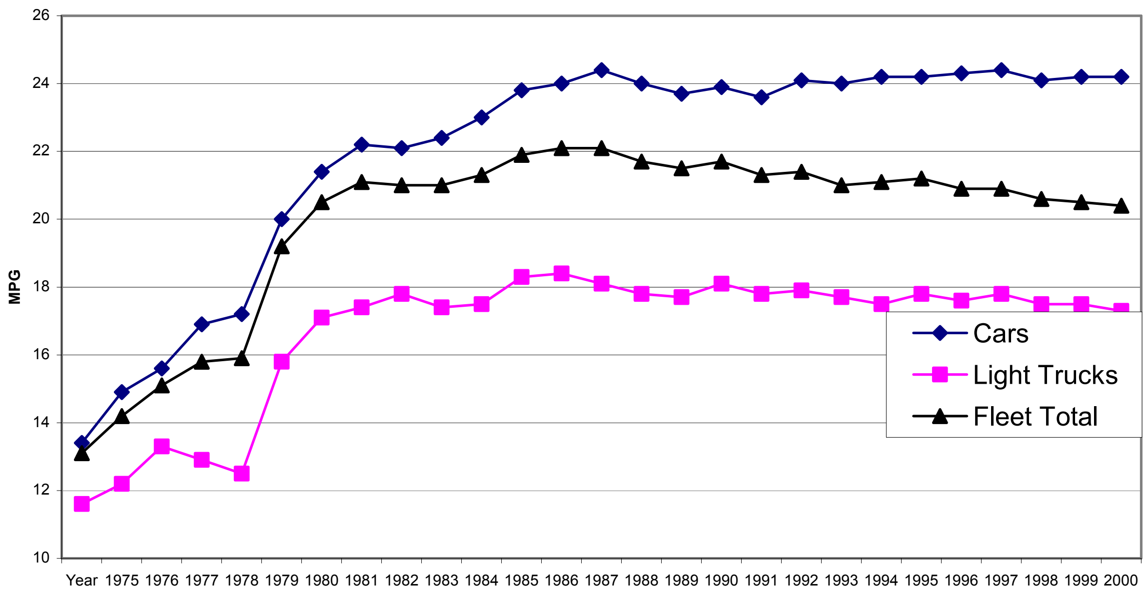

Figure 2: Vehicle Miles Traveled (VMT) and Motor Fuel Consumption, 1970-2000

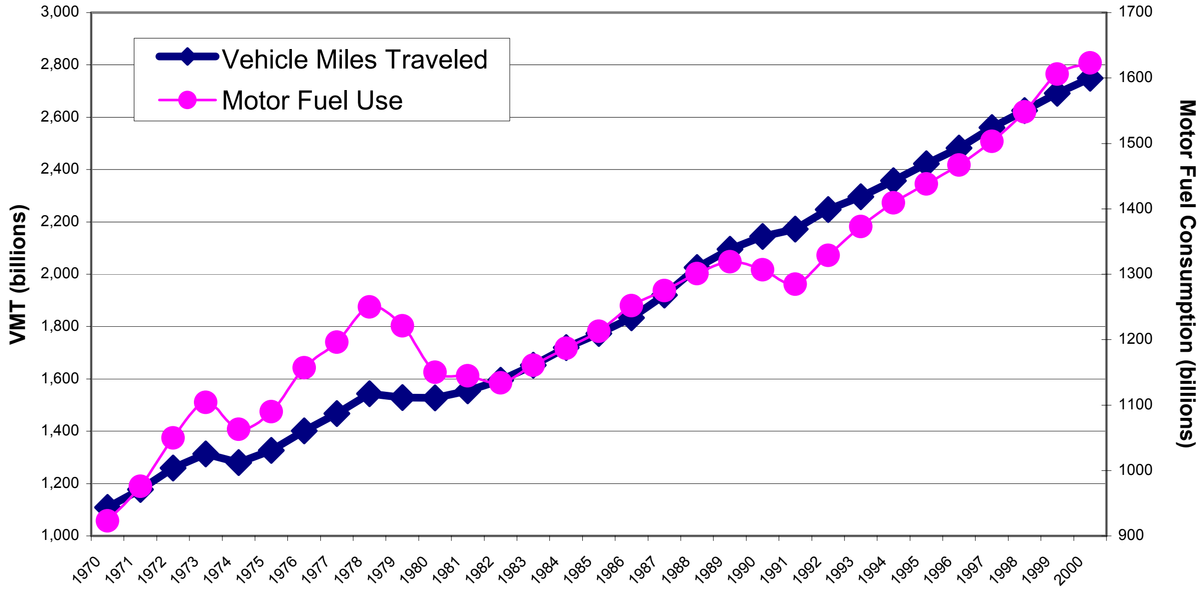

Figure 3: Average Fleet Fuel Economy (MPG), 1970-2000

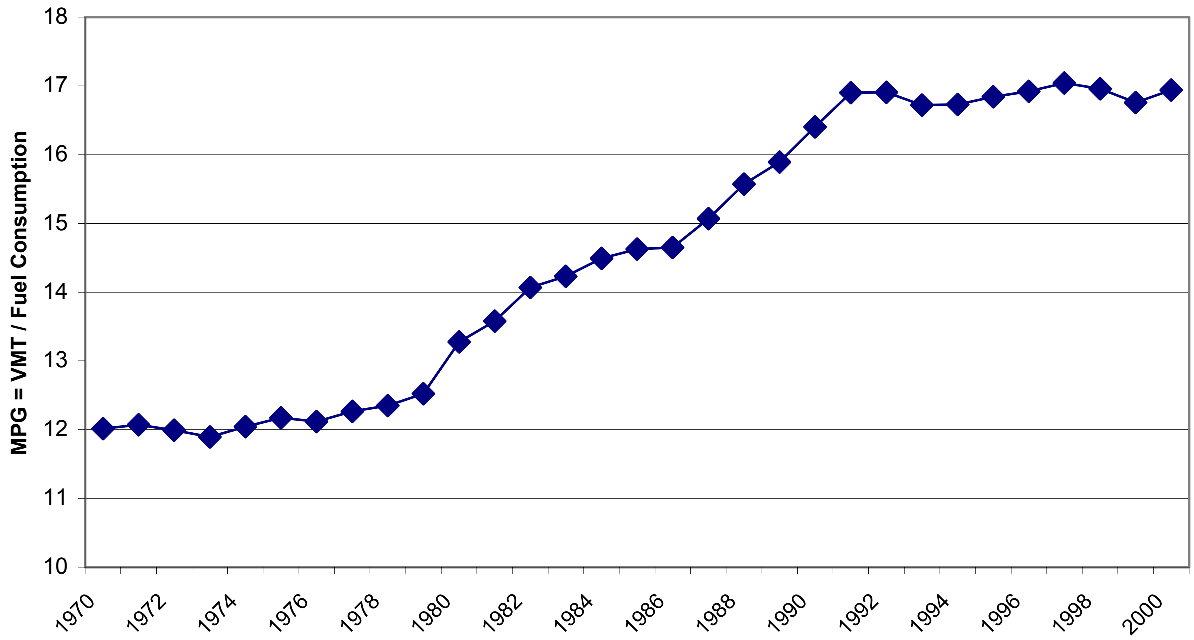

Figure 4: Demand for Driving

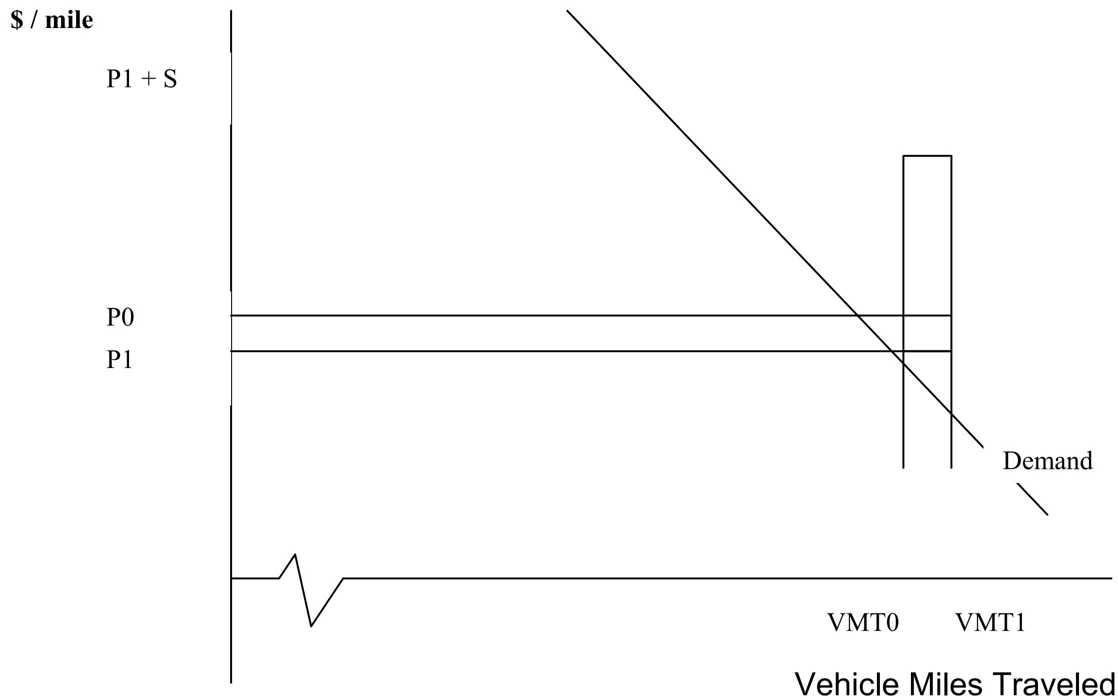

Figure 5: Social and Private WTP for a Three-MPG Improvement in Fuel Economy
(absent external effects)

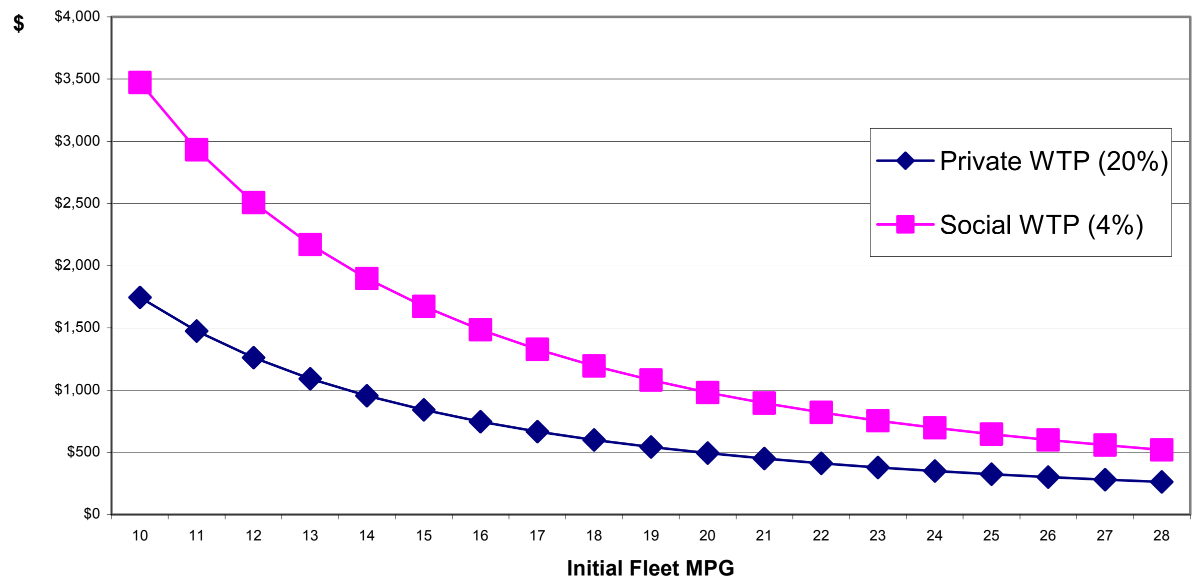

Table 1: Estimated Fuel Costs, Vehicle Miles Traveled,
Gasoline Consumption, and Fleet Fuel Economy

	Pre-CAFE Baseline	Constraint Not Binding	Constraint Binding
Per Mile Fuel Costs (at $1.25/gal)	$0.05677	$0.05185	$0.05198
Δ Fuel Costs		$0.0049	$0.00479
Vehicle Miles Traveled (mil)	1,652,362	1,679,134	1,678,513
Δ VMT	--	26,772	26,151
Gasoline (billion gallons)	75.045	69.653	69.805
Δ gas	--	5.392	5.240
Miles per Gallon (VMT/gas)	22.018	24.107	24.0457

Source: Kleit, *Economic Inquiry* (forthcoming)

Table 2: Estimated Costs of CAFE (million $)

	Constraint Not Binding	Constraint Binding
Producer Surplus Losses	$243	$612
U.S. Producer Losses	$463	$804
Foreign Producer Gains	$220	$192
Consumer Surplus Loss	$953	$1,097
Total Lost Surplus	$1,196*	$1,709*
Externality Cost (ΔVMT * $0.0827)	$2,214	$2,188
Total Losses	$3,410*	$3,897*
Gallons Saved (millions)	5,392	5,240
$ lost surplus / gallon saved	$0.22	$0.33
$ external costs / gallon saved	$0.41	$0.42
Total $ / Gallons Saved	$0.63	$0.74

* The reported estimates count producer losses of GM, Ford, and Daimler-Chrysler, but do not include increases in producer surplus from foreign manufacturers. Our estimates calculate changes in total surplus.

Source: Kleit, *Economic Inquiry* (forthcoming)

Table 3: Break-Even Fuel Economy Improvements*

Vehicle Class	Base MPG	FE in average scenario	high-cost, low MPG scenario	net consumer savings in high-cost scenario	percentage FE increase in high-cost scenario	lifetime fuel savings in high-cost scenario (gallons)
Cars						
Subcompact	31.3	35.1	31.7	$19	1	66
Compact	30.1	34.3	31.0	$32	3	159
Midsize	27.1	32.6	29.5	$97	9	494
Large	24.8	31.4	28.6	$210	15	882
Light Trucks						
Small SUV	24.1	30.0	27.4	$193	14	823
Midsize SUV	21.0	28.0	25.8	$426	23	1459
Large SUV	17.2	24.5	23.2	$946	35	2477
Minivan	23.0	29.7	27.3	$310	19	1128
Small Pickups	23.2	29.9	27.4	$291	18	1088
Large Pickups	18.5	25.5	23.7	$669	28	1953

*The calculation assumes a 12% discount rate, a payback period of 14 years, gasoline prices of $1.50 per gallon, and 15,600 miles driven in the first year, with a 4.5% annual decrease in each year thereafter.