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The New CAFE Standards: Are They Enough on Their Own?

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RESOURCES FOR THE FUTURE

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Abstract

New Corporate Average Fuel Economy (CAFE) standards were recently passed in the United States with the twin goals of reducing greenhouse gas emissions and oil use. The new standards represent a dramatic change from recent policy. This paper examines the key features of the new rules, and compares them to previous CAFE standards in terms of flexibility and structure. The importance of consumer preferences and market forces on CAFE outcomes are identified. In the second part of the paper, the perspective of the consumer is explored. Consumer assessments of fuel economy savings with more fuel-efficient vehicles may be biased or incomplete, leading many to argue that there is an "energy efficiency gap" in consumer demand for vehicles. Reasons for such a gap, such as market failures, behavioral responses, and market barriers, are summarized. The implications for policy are discussed, including the role of combining CAFE with other policies.

Key Words: CAFE, vehicle regulation, energy efficiency, environmental policy

JEL Classification Numbers: Q42, Q48, Q54, Q58

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Virginia McConnell*

I. Introduction

In recent years, the United States has identified addressing global climate change and energy security as critical long-term challenges. There has been much debate over policies to attain these goals, but when it comes to reducing oil use by and greenhouse gases (GHGs) from light-duty vehicles in the United States, the Corporate Average Fuel Economy (CAFE) standards are about the only policy on which all of the parties involved have been able to agree. CAFE standards, which establish minimum average fuel economy limits for each manufacturer's new car fleet nationwide, shouldered much of the burden for reducing oil use from cars and light trucks during the oil crises of the late 1970s and through the 1980s.[1] Then, for many years, the standards remained relatively unchanged. Over the last few years, however, much stricter standards have again been established, this time under two new regulations, the first setting minimum limits for 2012 to 2016 model year cars and light trucks, and the second for the 2017 to 2025 model years. The new standards are designed to reduce oil use and GHGs.

Although the early CAFE requirements are considered a success by many, they are not without their critics. Debate continues among economists and policymakers about whether fuel economy standards required of automakers are better for reducing gasoline use and carbon emissions than policies that influence fuel prices, such as a gas tax or a carbon tax (Fischer et al. 2007; Jacobsen 2012; and Karplus at al. 2013). Increases in fuel prices provide incentives for manufacturers to build, and consumers to buy, more fuel-efficient vehicles. In addition, such price policies raise the cost of driving and may therefore reduce the amount people drive.

CAFE policies, on the other hand, because they increase the fuel efficiency of vehicles, tend to lower the cost per mile of driving and can result in greater total vehicle miles traveled (VMT), which is referred to as the "rebound effect." Another unintended consequence of CAFE standards in the past was that having lower standards for trucks compared to cars appears to have contributed to a change in the vehicle sales mix toward more sport utility vehicles (SUVs) and

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1 Light trucks weigh up to 8,500 pounds.

vans in the 1980s and 1990s. The resulting increased average vehicle size has meant lower overall energy savings from CAFE than anticipated. Finally, a study of CAFE in the 1990s found that the effects of the regulations are complicated by how they influence both new and used vehicle markets (Jacobsen 2012). Because prices of new cars increase with CAFE requirements, owners may hold onto older vehicles longer, slowing the decline in energy use from the fleet. Also, accounting for the effects on both new and used car prices, the overall effects of the regulations can be regressive.

Despite concerns over CAFE, the policy has been effective in improving overall fuel economy of the fleet, and it remains the most politically acceptable approach to reducing oil use and carbon emissions from the transportation sector. However, in the recently passed revisions to the standards, a great deal is being asked of CAFE. After a period of over 16 years during which the requirements for cars and trucks were virtually unchanged, average fuel economy of vehicles in the fleet must almost double by 2025 from its 2012 level. Also, for the first time, both fuel economy and the associated GHG emissions from vehicles will be regulated by the standards. The goals of reducing oil use and, in particular, reliance on foreign oil have always been the primary motivation for setting CAFE standards, but the 2007 Supreme Court ruling that found carbon dioxide (CO_2) to be a pollutant under the Clean Air Act[2] has made CO_2 reduction from vehicles the subject of US Environmental Protection Agency (EPA) regulation. The GHG emissions from the new vehicle fleet must fall by close to 40 percent for new cars by the 2025 model year compared to current levels. The regulating agencies, the National Highway Traffic Safety Administration (NHTSA), and EPA, have tried to harmonize the regulations so that manufacturers will have to comply with a consistent set of rules that become tighter over time to meet both goals.[3]

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[2] Supreme Court ruling (*Massachusetts v. EPA*, 2007).

[3] CAFE requirements are set by NHTSA, which is part of the US Department of Transportation, and CO_2 emissions limits are set by EPA. The final rule for the first phase of the reformed standards can be found at http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/Model+Years+2012-2016:+Final+Rule. The final rule for Phase II for MY 2017–2025 vehicles can be found at http://www.nhtsa.gov/fuel-economy and http://www.epa.gov/otaq/climate/regs-light-duty.htm#new1. Under the Phase II rule, the MY 2017–2021 standards are considered final, but those for MY 2022–2025 are considered augural for now and will be finalized at a later time, based on data and evidence gathered during implementation of the earlier rules. The state of California has also agreed to these same standards, although it could have set separate tougher statewide standards, allowed under a special waiver provision of the Clean Air Act (http://trid.trb.org/view.aspx?id=884357).

In this paper, these new regulations are assessed for how they are different from past CAFE rules, in terms of stringency and new opportunities for reducing the overall social costs. Potential issues that may make the standards less effective or more costly than anticipated are also identified. Although the new standards are enforced on vehicle manufacturers, consumer responses and demand for fuel economy are also important to the success of the policy. In the second part of the paper, the perspective of the consumer is explored. Consumer assessments of fuel economy savings with more fuel-efficient vehicles may be biased or incomplete, leading many to argue that there is an "energy efficiency gap" in consumer demand for vehicles, as there is for other energy-saving technologies.[4] Reasons for such a gap, such as market failures, behavioral responses, and market barriers, are also summarized. Finally, implications for policy are discussed, including the role of combining CAFE with other policies to improve the likelihood CAFE will meet its goals.

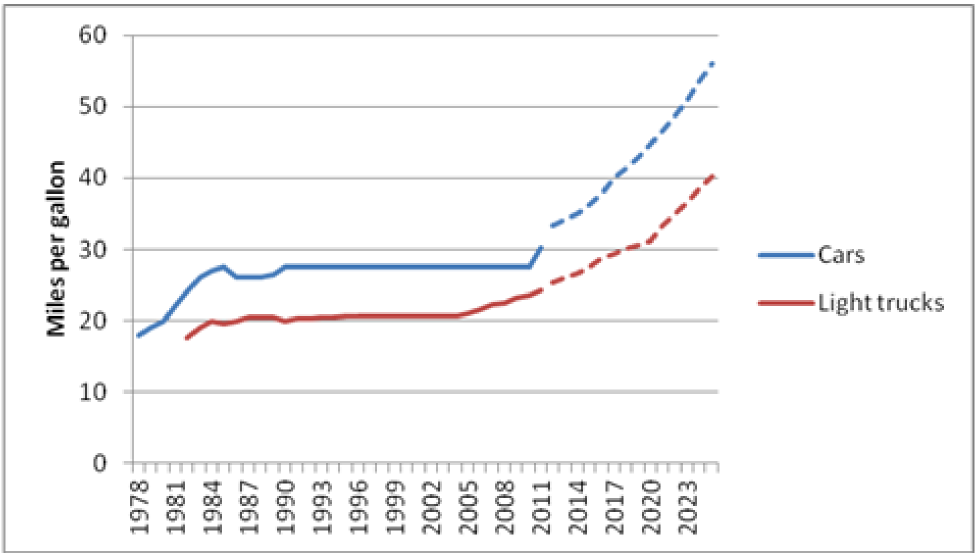
II. CAFE: Past, Current, and Proposed New Standards

The first CAFE standards were implemented in the late 1970s after the Arab oil embargo and the resulting worldwide run-up of oil prices.[5] Two different standards existed, one for cars and a less stringent standard for light-duty trucks, and were changed at times during the period from 1978 to 2011. Figure 1a shows the actual CAFE standards in terms of average miles per gallon (mpg) to be met by each manufacturer up to 2011 for cars and trucks, with the predictions of the effects of the new revised standards on average mpg shown as dotted lines after 2011. Figure 1b shows the same standards, but in terms of fuel consumption (gallons per 100 miles) on the left axis and GHG emissions (grams per mile) on the right axis. Figure 1b better captures the effects of the recent regulations on the two goals of reducing both oil use and GHGs.

[4] See Gillingham and Palmer (2013) for a review.

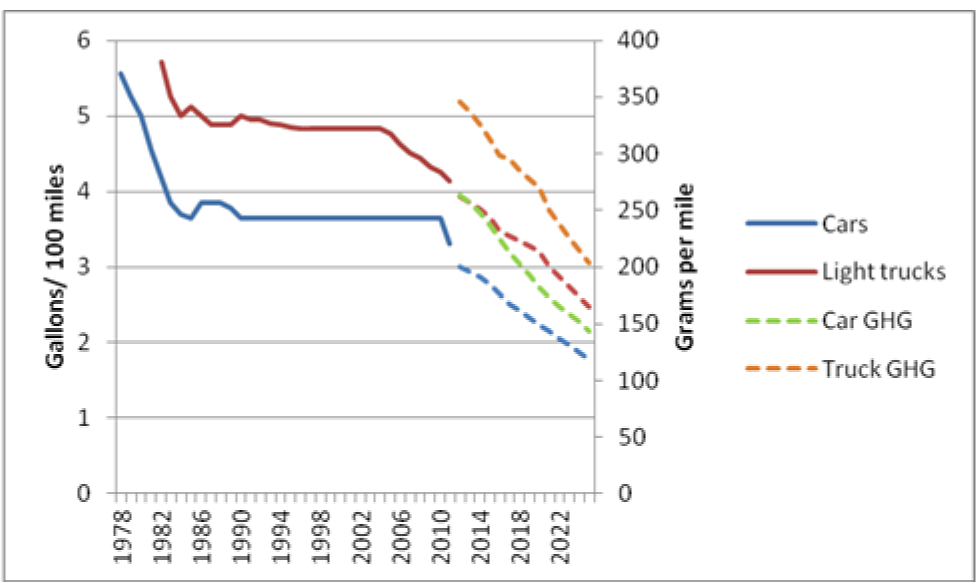
[5] The initial standards were set as a production weighted harmonic average that is applied to each manufacturer's fleet. The harmonic average accounts for fuel consumption, unlike a simple average of miles per gallon (mpg). It gives greater weight to vehicles with lower mpg, and it gives less influence to vehicles with very high miles per gallon (fuel efficiency).

Figure 1a. CAFE Standards, Past and Future (mpg)



Notes: The standards shown up to 2011 reflect the fuel efficiency minimum each manufacturer must meet for all cars (domestic and imports) and for all light-duty trucks. The standards after 2011 are based on vehicle footprint, so each manufacturer faces a separate standard. The average standard shown here is based on NHTSA predictions of vehicle sales and technology adoption.
Source: NHTSA, CAFE Rules, http://www.nhtsa.gov/fuel-economy.

Figure 1b. CAFE Standards, Past and Future (Gallons per 100 Miles), and EPA CO_2 Emissions Standards (Grams per Mile)



Source: Derived from Figure 1a. Grams per mile forecasts from www.epa.gov/oms/climate/documents/420f12051.pdf

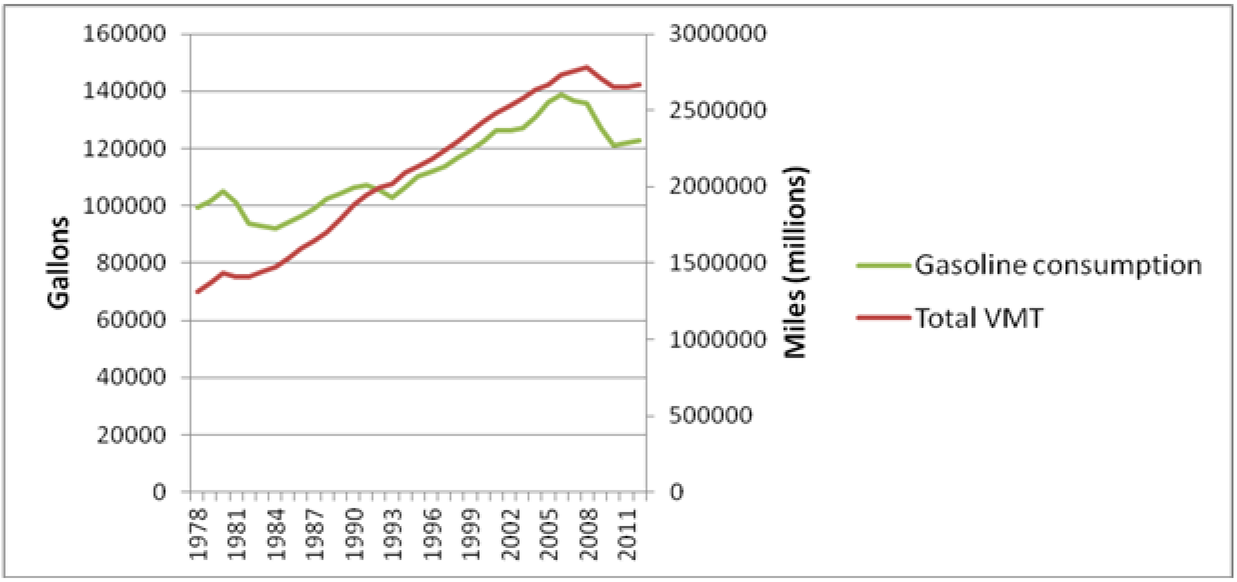
A. CAFE to the Present

As Figure 1a shows, the CAFE standards were increased rapidly each year through about 1985 for cars, and then they stayed constant for almost 20 years from 1990 to 2010. Figure 1b shows that the change in fuel consumption—the percentage reduction in fuel used per 100 miles—was substantial, falling by 35 percent by 1985 from the 1978 value. For trucks, the standards were also tightened through about 1985, but less rapidly than for cars, and stayed constant through the 1990s. Truck standards were then tightened again in 2005. As discussed above, lower standards for trucks may have provided an incentive for domestic manufacturers, which produced greater numbers of larger vehicles than foreign manufacturers selling in the United States, to shift toward passenger vehicles such as SUVs that could be counted under the CAFE rules as trucks.[6] Trucks, as a share of all light-duty new vehicles sold in the United States, rose from about 20 percent in 1980 to 50 percent by 2000. Of course, other factors, such as the falling price of gasoline through this period, are likely to have contributed to this enormous shift as well.

Although the standards did not change much for almost 20 years and may have helped bring more trucks into the market, it is clear that they have succeeded in making vehicles more fuel-efficient. Figure 2 bears this out. In the light-duty fleet, total vehicle miles traveled have increased much faster over the last three decades than has total gasoline use, even though the fleet of vehicles on the road has grown heavier and more powerful.

[6] One example of this is the virtual disappearance of station wagons and the emergence of the mini-van.

Figure 2. Gasoline Consumption and Vehicle Miles Traveled, Light-Duty Vehicles



Note: VMT = vehicle miles traveled.

B. Revising the Standards

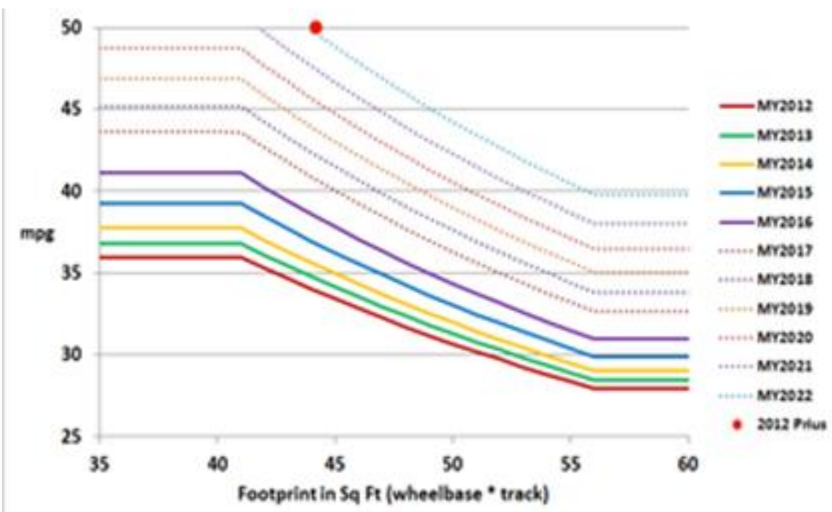
In 2008, under the Energy Independence and Security Act (EISA), NHTSA's authority to set the CAFE standards was altered. First, EISA mandated attribute-based standards for cars, meaning that each vehicle would be subject to its own standard based on its attributes (in this case vehicle size), rather than using one standard for all cars or for all trucks, as in the past. In addition, under the new rules, NHTSA was *required* to set standards for vehicle fuel efficiency each year (whereas before, the agency was *allowed* to do so) and was required to set them at the "maximum feasible" levels through 2030. The other major change was that EPA was given authority to regulate GHG emissions and would now do so under the CAFE standards. The so-called "reformed standards" were established jointly by NHTSA and EPA, with the first phase for model year (MY) 2012–2016 vehicles finalized in 2011, and the second phase for MY 2017–2025 vehicles finalized in August of 2012.

The change to a size-based standard instead of a single standard for all vehicles in a class ("class" refers to cars or trucks) occurred for a number of reasons. It was clear that domestic manufacturers, because of the size of the vehicles they produced, had been the most affected by CAFE regulations in the past. In contrast, some Japanese manufacturers did not appear constrained by the standards, and were actually able to lower the average fuel economy of their fleets during the late 1980s and early 1990s (EPA 2012, 85). To protect domestic manufacturers, and also for safety concerns, NHTSA moved to a *footprint* standard. Each vehicle now is identified by a footprint, which is determined by multiplying the length of its wheelbase by its average track width (or the area between the points at which its four wheels touch the ground). Figure 3 shows the CAFE standards for cars (fuel economy in miles per gallon) for MY 2012–2022.

Each manufacturer in each year then has a different standard, in terms of both miles per gallon and grams of CO_2 per mile, depending on the mix of car sizes it produces. Thus, a company such as General Motors, with greater sales of large vehicles in the “cars” category, would have a lower CAFE requirement (average miles per gallon) and a higher allowed CO_2 emissions standard than Honda, which tends to produce relatively smaller cars.

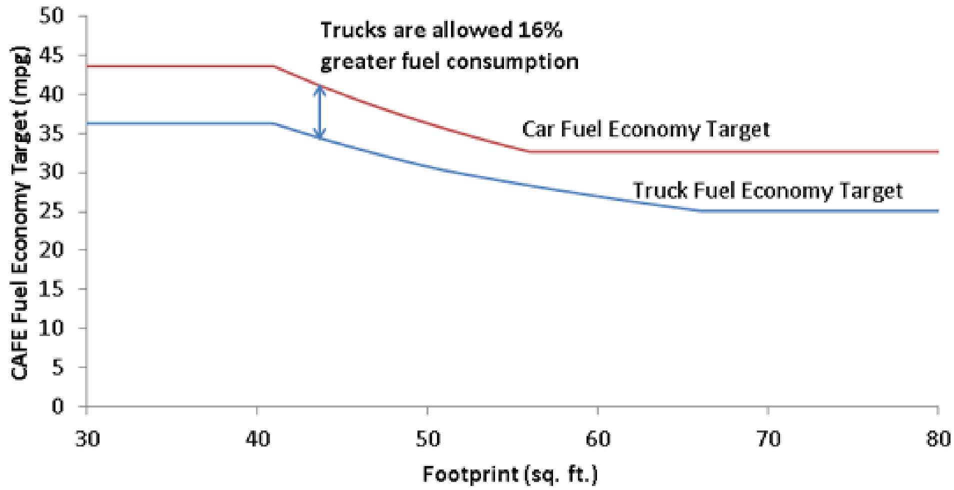
The truck footprint standards over time are not shown, but they continue to be less stringent than those for cars, even for vehicles of the same size. Figure 4 shows an example of this difference for one year, for MY 2017 new vehicles. For the same footprint size, a vehicle that is considered a truck is required to attain about 16 percent lower fuel economy (in mpg) than a car of the same size.

Figure 3. CAFE Fuel Economy Standards for Cars by Footprint, MY 2012–2022



Source: Adcock 2012.

Figure 4. Car and Truck Fuel Economy Standards by Footprint, MY 2017



Source: Anair 2012.

Because each vehicle has its own standard, and each manufacturer produces a mix of vehicle sizes that can change over time, there is no longer a single standard for cars or for trucks. The actual fuel economy that the fleet of cars will attain in any forecast year under the reformed standards is uncertain. If there is a relative shift toward larger vehicles within either the car or truck category, the sales-weighted average fuel economy of the fleet will be lower. The opposite is true if there is a shift toward smaller vehicles. However, the current NHTSA and EPA forecasts of the effects of the rule on fuel economy assume there will be no changes in the size mix of vehicles that each manufacturer produces. These forecasts are shown as dotted lines in Figure 1a, and the fuel consumption and GHG emissions reduction estimates are shown as dotted lines in Figure 1b. Future analysis of the effects of the new reformed rules on oil consumption and GHG emissions will need to assess the effects of the rule on the mix of vehicles, as discussed in more detail below.

The first phase of the standards affects the MY 2012–2016 vehicles and requires fuel economy for cars in terms of miles per gallon to increase by over 4 percent per year, and for truck to increase by slightly less. For cars, the requirement was 27.5 mpg in 2010, and the average across manufacturers with no change in vehicle size mix is predicted to be 37.8 mpg in 2016, or about 37 percent higher. Light-duty trucks standards have always been lower: they were 23.5 mpg in 2010, and under the Phase 1 rules, they are forecast to increase by 23 percent from that level by 2016. The associated fuel consumption and CO_2 reductions are shown in Figure 1b.

The second phase of the joint rulemaking requires continually improving fuel economy and reduced CO_2 levels for MY 2017 to 2025 vehicles (improvements of roughly 3 to 4 percent a year). Under these rules, cars are predicted to reach an average of 55 mpg by 2025, a 48 percent increase over 2016, and truck fuel economy is predicted to improve by an average of 33 percent over that time period. Again, Figures 1a and 1b show the predicted paths of these changes, assuming no change in the mix of vehicle sizes due to the regulations.

It is important to note another feature of the fuel economy standards shown in Figures 1a and 1b. They are set based on specific laboratory test cycles for vehicles that were established in 1975. Those test cycles do not accurately reflect average driving behavior and patterns of vehicle use on the road today, but they nonetheless continue to be used for certification purposes. Actual fuel economy is quite variable, even for a given vehicle, because it varies with types and conditions of roads, driver behavior, climate, and type of fuel used. To better reflect current driving conditions, EPA developed a different test cycle, and as of 2008 the results are now on the "window sticker" label of new vehicles and in advertisements by manufacturers. This new labeled fuel economy is about 20 percent lower in miles per gallon than the official CAFE test levels. For many vehicles, however, real-world fuel efficiency tends to be even lower than these "window sticker" ratings.

In summary, whichever measure of fuel economy is used, the reformed standards represent a striking departure from the almost constant standards over the past 20 years. For cars as a whole, fuel economy will be required to almost double from 2010 to 2025, meaning CO_2 levels will decline by close to 45 percent. For trucks, the requirements are less strict, but test fuel economy levels will need to increase by close to 70 percent, and CO_2 levels to decline by about 40 percent.

C. The New Reformed Standards: Opportunities and Concerns

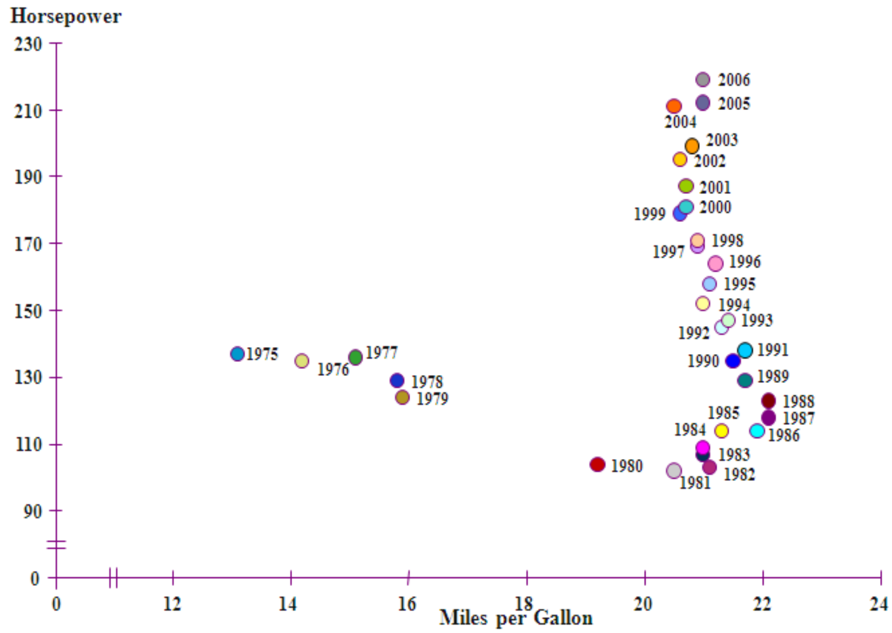
Under CAFE standards before 2012, firms could pay fines in lieu of meeting the standards. The fine was $55/mpg above the standard on a per-vehicle basis. This fine effectively set a limit on the cost of fuel use reduction under CAFE. Under the reformed combined CAFE and EPA standards, it appears that the CAFE fines will remain unchanged, but the Clean Air Act does not have a similar provision for the CO_2 standards set by EPA. Thus, any effective CO_2 fines are likely to be prohibitively high. This is likely to mean there will be a new focus on the credit market as a means to comply with the standards. Since firms will have to comply, some will need to buy credits to show compliance. For example, in the past, it was the European manufacturers that paid the $55/mpg CAFE fines so that they could sell vehicle fleets with high performance and relatively lower fuel economy than other manufacturers. Now, those manufacturers will be entering the credit market to buy credits to comply.

There is a range of flexible credit mechanisms introduced in the new rules. New credit provisions allow manufacturers to continue to trade fuel economy credits (1/10 mpg) within the car or truck category, but the period over which manufacturers can bank and borrow credits has been increased to five years instead of three years (credits can be sold either forward or backward from a given model year). And, for the first time, manufacturers can buy and sell credits from one another. This credit market is in the early stages of development, and it could become a key feature of the reformed standards.

Note that this credit-trading provision gives all firms an increased incentive to find cost-effective ways to go beyond the standard, over-comply, and sell credits to other firms. If the market in credits develops, it would reduce the cost of meeting the standards and provide general incentives to lower overall costs. Dinan and Austin (2004) used a model of the auto market to conclude that tradable credits can reduce the costs of meeting a given fuel economy standard, resulting in lower vehicle prices for consumers.

The reformed standards for fuel economy require NHTSA to set fuel economy standards every year at the "maximum feasible level." The agency appears to determine this level by balancing "technologically feasible" improvements in fuel economy with what is "economically practicable" given manufacturers' costs, vehicle redesign, and manufacturing cycles. The agency analysis assumes that improvements in technology will all go to fuel economy in the future, while performance is maintained at current levels. However, during much of the recent past, a large share of any technology improvement was going to other vehicle attributes, such as horsepower, acceleration, torque, size, or comfort (Cheah and Heywood 2011; Knittel 2011). Figure 5 illustrates this point. In the 1970s, increasingly strict standards were pushing fuel economy higher (along horizontal axis), but by the late 1980s, when the fuel-economy standards were flat, new technology advances were clearly going into greater horsepower (and likely other attributes), with virtually no changes in fuel economy. There were technological improvements in vehicle powertrain and in vehicle design during this period, but market forces and consumer demand appear to have pushed most of this improvement toward features other than fuel economy (see Klier and Linn 2012).

Figure 5. Sales-Weighted Horsepower and mpg for Light-Duty Vehicles, MY 1975–2006



Source: EPA 2006.

The reformed standards are therefore assuming a dramatic shift in this attribute mix from the historical trends. All technology change is assumed to go into fuel economy improvements, which is likely to mean there will be forgone attributes such as improved acceleration, horsepower, and others. In the current agency analyses of the benefits and costs of the new rules, only benefits to consumers of the fuel economy savings over the life of the vehicle are included, but some of these other attributes could have offered even greater benefits. To the extent that this is true, there are opportunity costs to consumers that are not included in the agencies' analyses. Further, and perhaps more important, consumer preferences are likely to influence purchase decisions, and the type and mix of vehicles sold under the new regulations. This has bearing both on how difficult it may be for manufacturers to meet the standards without additional policies and incentives, and on the overall level of fuel economy that is achieved. Recall that there is no fleet-wide fuel economy or GHG standard under the reformed rules. The reductions in fuel use and GHGs depend on the mix of vehicles that are produced and sold under the footprint standard.

In general, the incentives under the footprint standards are complex, and how they will influence vehicle sales shares is not fully understood. It was the intention of the regulators that the reformed standards require the auto companies to focus more on technology improvement within each footprint size, and less on the mix of vehicles, than under previous standards. But the new rules are likely to change both consumer and producer incentives. The net profitability of any particular vehicle will depend on both the elasticity of consumer demand and the costs of compliance with the standard for that vehicle, compared with all of the other sizes and types of vehicles.

On the cost side, many of the technologies identified for improving fuel economy in the agencies' rulemaking are relatively constant across vehicle sizes, especially within the car and truck classes (NHTSA 2012, Tables V-129 to V-138). For example, a mild hybrid (integrated starter generator) would cost $1,553 to add to a subcompact, or roughly 10 percent of the price, and $1,642 for a large car, or 5.5 percent of the price. The resulting change in fuel consumption would be about 13 percent for both (NHTSA 2012, Table V-147 to V-149). Because the dollar value of the fuel saving is much greater for the larger vehicle, the net increase in cost to the consumer will likely be larger in absolute value as well as in percentage terms for the subcompact compared to the large car. This change in relative price is likely to cause a shift toward larger vehicles, though the magnitude of the response will depend on the elasticity of demand for vehicles of different sizes. This is an example for one technology, but the point is that changes in relative costs are likely to influence consumer choices.

One analysis of the new footprint standards attempts to account for both consumer demand and manufacturer production decisions, and finds that these new rules provide an incentive to shift production to larger vehicles under a large range of plausible assumptions about consumer preferences (Whitefoot and Skerlos 2012). That study also found that the incentive to increase vehicle size would likely be greater for light trucks than passenger cars, resulting in a greater divergence in vehicle size for the fleet as a whole. [7] This has implications for safety as well as fuel economy. More analysis of this issue will be important for assessing the effects of the new rules.

The reformed standards include exceptions and credits, which may, in some cases, produce results that are counter to the intent of the rules. For example, the Phase II rules provide additional credits for full-sized pickup trucks if those trucks include hybrid-electric technology. The reason for the additional credits is that these full-sized trucks have been particularly slow to adopt such technology. However, the footprint mpg requirement is already relatively low for

[7] Another analysis of the implications for the new standards is by Kiso (2012).

large trucks, and there is concern that the additional incentives will result in a shift within the light truck category away from small trucks toward large truck production and sales.

Another incentive provision is for sales of alternative vehicles and fuels. Under the new rules, these vehicles will qualify for credits that are greater than the actual fuel economy and emissions reductions they achieve in operation. For example, each electric vehicle produced in 2017 can be counted as two electric vehicles in terms of fleet fuel economy.[8] In addition, EPA rules grant exceptions for electric and fuel cell vehicles—the emissions from the electricity generated to charge the battery or emissions incurred in producing hydrogen are not counted against the GHG emissions reduction goal. The reason for such incentives is to accelerate the introduction of these alterative vehicles, and the intention is to phase out the incentives over time. There is a case to be made that early adoption of new technology vehicles has spillover effects—that is, it provides information to the market and to other potential users, a so-called "learning by using." This aspect of the rule gives incentives to manufacturers to produce these vehicles. But manufacturers may still have to subsidize the price of these new technology vehicles to induce consumers to buy them. And whether and how quickly prices for plug-in electrics and other vehicles will come down over time is quite uncertain.[9]

A final concern is over the difficulty of meeting both the fuel economy standard and the GHG standard. Although the intention of the two agencies, NHTSA and EPA, was to harmonize the standards in both the Phase I and Phase II rules, in practice it is likely that one will have different or stricter requirements than the other. For example, the standards are harmonized when the penetration rate of alternative vehicles, such as PHEVs, EVs, and fuel cell vehicles is at the level assumed in the rule, but if these alternative vehicles penetrate the fleet at a slower rate than the rule assumes, then EPA's requirements would be stricter than NHTSA's, and automakers would have to comply with the stricter rule (Federal Register 2012).[10]

In summary, there are a number of significant changes that are part of the new CAFE standards, and there is still a good deal of uncertainty on how manufacturer and consumer

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[8] This multiple of 2 will fall to 1.5 by 2021 for both all-electric vehicles and fuel cell vehicles. For plug-in hybrids, the factor will start at 1.6 in 2017 and phase down to 1.3 in 2021.

[9] For estimates of cost changes over time, see National Research Council (2013).

[10] Another difference between the standards from the two agencies is on which air conditioning technologies the manufacturers will use.

choices will evolve in response. The credit market is likely to play an important role in the future, and it is not clear yet how and in what direction the size mix of vehicles on the road may change. Continuing evaluation of the response to the rule and the role of different policies in combination with CAFE will be important in the next few years.

III. Energy Efficiency Paradox and What It Means for CAFE

Clearly, the reformed CAFE and GHG standards for light-duty vehicles represent a significant tightening of the standards from those in place over the past 20 years, and provide some increased flexibility in how to meet the standards. Both NHTSA and EPA assessments of the effects of the regulation show benefits well in excess of the costs of these new standards, with the majority of the benefits coming from the fuel savings to consumers that result from great fuel economy.[11] Indeed, for individual consumers, the net benefits of the stricter fuel efficiency rules are positive. That is, the analysis shows that the higher cost of the more fuel-efficient vehicles is more than offset by the resulting fuel savings over the life of those vehicles to owners.

If this is so, why then are such regulations needed? With these benefits, why would manufacturers not produce and consumers not purchase vehicles with better fuel economy? This apparent paradox has been observed in many energy markets for energy-efficient technologies, such as for appliances and home heating (see Gillingham et al. 2009; Greene 2010). The issue is often referred to as either the *energy efficiency gap* or the *energy paradox*. Before examining some of the arguments for whether an energy paradox exists in vehicle markets, why it might occur, and what combination of policies is needed to address it, one must have a sense of the complexity of consumers' decisions over paying higher prices for fuel economy savings over time as they drive the vehicle.

[11] For the two phases of the new rules, the benefits attributable to private sector fuel savings are roughly 75 to 80% of the total benefits. The other benefits are from the reducing GHGs, oil dependence, local air pollutants and other externalities (see Federal Register 2010 and 2012).

A. Consumer Choice over Fuel Economy

A more fuel-efficient vehicle will cost the consumer more up front than an equivalent less fuel-efficient vehicle, if other vehicle attributes are held constant,[12] but will provide the consumer with savings on fuel over time. Economic analysis posits that a rational consumer will choose either the vehicle that provides equivalent services at the lowest cost or, in this case, the vehicle with the lower up-front cost net of fuel savings over time. But making this comparison among vehicles is actually quite difficult and involves many uncertainties and assumptions.

One area of uncertainty is what the actual fuel economy of two different vehicles might be. We saw above that the fuel economy standards that might be discussed in the press are higher than the EPA "window sticker" label for fuel economy that is on any new vehicle (see Figure 1a notes). In addition, actual fuel economy on the road will vary a good deal depending on other factors such as road types, climate, terrain, and driver behavior. Greene (2011) shows that actual fuel economy performance is highly variable across vehicles with the same EPA mpg rating. Either because of this variability or because it is time-consuming or complex to calculate fuel economy, many people are not aware of what fuel economy their vehicles are getting and what the value of that savings might be. In a survey of households, Turrentine and Kurani (2007) find that many people are not aware of the fuel economy of their vehicles—very few of the households they interviewed had even a rough idea.

The comparison among vehicles when consumers are buying vehicles is complex. Calculating the value of the fuel savings is particularly difficult.[13] Consumers must know current

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[12] For actual vehicles, many attributes are linked, so it is difficult to consider fuel efficiency alone, with other things held constant. For example, more fuel-efficient vehicles will often have less acceleration or lower weight.

[13] The following equation shows the required calculations a consumer must make to estimate the fuel savings from the purchase of a more fuel-efficient vehicle (1) over a less fuel-efficient vehicle (2) in any given year in the future, *t*:

$$Fuel\ savings^{1\ vs.2}(t) = p_g(t) \times \left(\frac{1}{mpg^{2}} - \frac{1}{mpg^{1}}\right) \times m(t) \tag{1}$$

where p_g is the future price of gas, which may be assumed to change over time or not; 1/mpg is fuel consumption per mile driven; and *m* is miles driven per year, which is likely to change over time (it tends to decline as vehicles age) but is assumed here to be the same for both vehicles. Consumers must also decide the length of time over which fuel savings will occur and must also discount the savings so they can be compared to the difference in the prices of the two vehicles. The present discounted value of the difference in fuel savings between the two vehicles is then gasoline prices and have some expectation about what those prices will be in the future. They must have an accurate assessment of the actual differences in fuel consumption between the vehicles they are considering purchasing, they must determine over how long a period they should value those fuel savings, and they must decide how to discount those future savings relative to savings today. The uncertainty associated with this type of fuel savings calculation is illustrated for different vehicles in Figure 6 below.

Figure 6 shows fuel savings under different assumptions for three representative vehicle sizes: a small, midsize, and large vehicle. The top bars show the base case savings for each of the three vehicles. The assumptions for this base case are that the expected improvement in fuel efficiency is 7 mpg for each vehicle size, the price of gasoline is \$3.50/gallon and is expected to remain constant, the discount rate is 7 percent, and the fuel economy savings are valued over the entire life of the vehicle, which is, on average for vehicles today, about 14 years.[14] The bars below this baseline in Figure 6 show the effects of varying these assumptions. For example, when the discount rate is changed to 3 percent (instead of 7 percent), fuel savings increase as shown.

A number of findings stand out. First, changing almost any of the assumptions can have a big effect on the estimate of fuel savings for a given vehicle and across vehicles. Many of these variables are highly uncertain to car buyers, so there is the potential for substantial variation in consumer responses. For example, there is evidence of substantial heterogeneity in how fuel prices are forecast across consumers (Anderson et al. 2011). In Figure 6, differences in expected fuel prices between \$2 a gallon and \$5 a gallon, other things the same, have a big effect on the value of fuel savings no matter which vehicle is being considered.

Second, Figure 6 shows that changing assumptions affect savings from large vehicles (blue bars) more than small vehicles. This is because the gain in actual fuel savings when vehicles are already very efficient gets increasingly smaller, and the extent of the uncertainty or

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$$\textit{Present value of fuel savings}^{1\ vs.2} = \sum_{t=1}^{L} \frac{\textit{Fuel savings}^{1\ vs.2}(t)}{(1+r)^t} \qquad (2)$$

where L is the life of the vehicle in years (or length of time the consumer accounts for fuel savings), r is the discount rate, and the fuel savings in each year are defined in equation (1).

[14] It is assumed that mileage declines with vehicle age, according to evidence from the *Transportation Energy Data Book* (Davis et al. 2012).

heterogeneity among consumers in assumptions becomes less important. For the vehicle whose efficiency goes from 35 to 42 mpg, fuel savings vary between about $400 and $2,000 in the examples in Figure 4, compared to the larger vehicle, for which savings vary from $2,000 to almost $12,000. For vehicles that have even greater fuel economy, as many will have under the reformed CAFE regulations (small cars must achieve over 50 mpg by 2020, as can be seen in Figure 3), further improvements in fuel economy will have even lower value.

Figure 6 also illustrates the energy paradox. The base case represents how the average "rational" consumer might view the value of the fuel savings from a more efficient vehicle. The consumer would account for the fuel savings over the life of the vehicle, even if he does not keep the vehicle the whole lifetime, because fuel economy difference will also be reflected in used car prices.[15] The consumer would use a discount rate that reflects the rate of borrowing money; in this case, it is assumed to be 7 percent. That consumer would compare the fuel savings, as shown by the bars for the base case, to the higher purchase price for the more fuel-efficient vehicle to determine whether to make the purchase (assuming that other vehicle characteristics are the same). So, for a midsize vehicle, if the purchase price of the 32 mpg vehicle is $3,000 greater than that of the 25 mpg vehicle, the consumer would buy the more fuel-efficient vehicle because the present discounted value of the fuel savings is greater than $3,000.

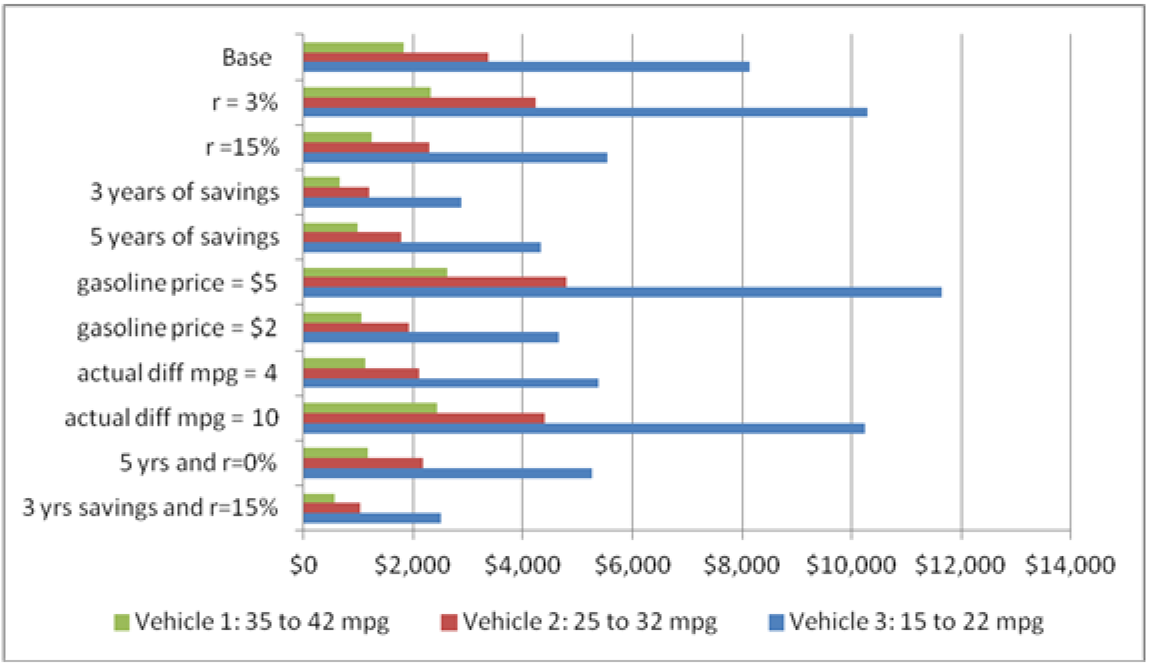
However, if the consumer is not certain about the fuel economy of the vehicle and thinks the difference is only 4 mpg between the two vehicles, the present discounted value of the fuel savings is less than $3,000, so he would buy the less fuel-efficient vehicle. The other sets of bars in the figure show results for other variations in the assumptions.

Perhaps the most likely set of assumptions, according to the auto companies and others who observe consumer choices, is that consumers tend to use very high discount rates or value fuel savings only over a very short time horizon (two to three years) or both. This would argue for something like the bars at the bottom of the figure, which show much lower fuel savings when the discount rate is 15 percent and savings are valued over only three years. In this case, the buyer would not buy the more fuel-efficient midsize car unless the difference in price is less than $1,000. And yet, with well-functioning loan markets and efficient used car markets, that consumer would appear to be leaving money on the table—hence the term "energy paradox." We

[15] Busse et al. 2013; Sallee et al. 2009.

turn next to the arguments about what is rational or efficient in this context, and what may be driving consumer choices. The need for policies or combinations of policies is also discussed.

Figure 6. Present Value of Estimated Fuel Savings for Three Vehicles as Fuel Efficiency Improves by 7 mpg, with Variation in Assumptions (base case assumptions in notes below and results at the top of the figure)



Notes: The base case for each of the three vehicles includes the following assumptions: 14-year average vehicle life over which fuel economy is realized, miles driven decline with age according to data from the *Transportation Energy Data Book* (Davis et al., 2012), discount rate is 7%, gasoline price is assumed to be $3.50/gallon throughout the life of the vehicle, and the fuel economy attained is what is shown in the figure legend. Each set of bars is identified with the changes from the base case. For example, for r = 3%, everything is the same as the base case except that fuel economy is discounted at 3% instead of 7%.

B. The Debate on the Extent of a Fuel Efficiency Paradox in Vehicle Choice

The existence and extent of an "energy paradox" will influence how difficult CAFE standards will be to meet, and how well pricing and other policies work both in conjunction with CAFE and on their own. So, is there evidence of an energy paradox in vehicle markets? There has been a good deal of interest in this question in the economics literature in recent years, and although much has been learned, the evidence so far is mixed. The two excellent review papers of this literature, by Greene (2010) and Helfand and Wolverton (2011), both conclude that there is no consensus on whether consumers undervalue fuel savings, and in fact some studies find that for some groups of consumers and types of vehicles, they may overvalue fuel savings. Several of the most recent studies do not find much evidence of consumer underinvestment in fuel economy in purchases of new or used vehicles (Busse et al. 2013; Allcott 2012), but many others of the more than 20 reviewed find evidence of undervaluation, with the extent of that undervaluation varying widely. Identifying the separate effect of fuel economy or fuel savings, when vehicle attributes are often bundled and closely related, has proved to be quite difficult. Moreover, forecasting fuel savings is difficult, as is clear from the example above, and the literature has shown that accounting for heterogeneity of both consumer preferences and decision-making is likely to be important. It also means there is no simple answer to the question.

C. Reasons for the Fuel Efficiency Paradox and Policy Implications

To the extent there is an energy paradox for some consumers, it can result from a number of possible causes. Most of these fall under the category of what economists call inefficient markets, where something is preventing private markets from working efficiently and providing the right signals to consumers and producers. For example, the price of gasoline should reflect the full cost of bringing gasoline to market, including any environmental or energy security costs. When markets are working, private gains to individuals and overall social welfare are aligned. One of the arguments for why the CAFE standards are needed is that consumers undervalue fuel savings compared to the full social value of those fuel savings.

The reasons for inefficiency in the market for fuel consumption can be broadly grouped into three categories: market failures, behavioral responses from consumers, and externalities that are not accounted for in market prices. Each of these is described below in the context of fuel economy, along with what each implies about policy responses.

1. Market Failures

a. Consumer misperceptions or lack of information.

One of the most compelling arguments for the presence of market failures in vehicle markets is that consumers are not able to account for fuel economy differences between vehicles because they are uncertain about the potential savings. That uncertainty could arise for a number of reasons:

- *Buyers may have a difficult time calculating fuel savings*. As the example above shows, calculation of the monetary value of fuel savings between vehicles is complex, and many consumers may not be able to do the calculation or may not have an interest in spending time and effort to come up with a good estimate. This lack of information will lead consumers either not to consider fuel economy in the purchase decision or to account for it only generally.

- *Buyers may understand the dispersion in outcomes for actual fuel economy*. It could be that new car buyers perceive that there is a great deal of individual variation in what drivers experience with vehicles in use, and therefore they have little faith in fuel economy labels. They may then discount possible fuel savings.
- *Buyers may know that labeled or advertised fuel economy in the past has tended to be higher than actual fuel economy in practice*. As discussed earlier in this paper, test cycle fuel economy for CAFE standards is quite a bit higher than EPA sticker labels on new cars. Even sticker labels tend to slightly overstate fuel economy, on average. As in the point just above, this could cause consumers to discount the information conveyed by fuel economy labels.
- *Some evidence shows that consumers have misperceptions about actual fuel savings in comparing potential savings across vehicles*. Allcott (2012) finds evidence from a survey of vehicle owners of what has been referred to as “mpg illusion.” Consumers with mpg illusion believe that fuel savings will increase at a linear rate with changes in miles per gallon. But it is clear from the example in Figure 6 above that for the same increase in miles per gallon (7 mpg improvement for each vehicle), the fuel saving are much greater for a vehicle that has lower initial fuel economy. In the base case in Figure 6, Vehicle 3 (fuel economy improvement from 15 to 22 mpg) gets more than four times the total fuel savings compared to vehicle 1 (fuel economy from 35 to 42 mpg). [16] The presence of mpg illusion will cause consumers to either overestimate fuel savings from improvements to more fuel-efficient vehicles or underestimate fuel savings from vehicles that have low initial fuel economy.
- *Buyers may not have information about the effect of fuel economy on used car prices*. If this is the case, buyers will only consider the fuel savings over the estimated period that they will own the car, and not account for the higher value in the used car market.[17] This will cause them to undervalue fuel savings from any vehicle.

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[16] This issue that there is a nonlinear relationship between fuel use and mpg was first referred to as “mpg illusion” by Larrick and Soll (2008).

[17] Sallee et al. (2009) and Busse et al. (2012) find that used car prices do reflect potential fuel savings.

And, if consumers do not fully consider the value of fuel economy savings in their decisions, manufacturers will not have the right incentives to produce vehicles with better fuel economy.[18]

*Policy Implications***:** These arguments about information suggest that fuel economy standards, like CAFE, will be effective policy because they require manufacturers to produce a fleet of vehicles that reflects the full social value of vehicle fuel efficiency, even if consumers are not clear about that value. However, manufacturer requirements do not mean that consumers' preferences are satisfied. Consumers may still need to be induced to buy the vehicles that manufacturers produce, and fuel economy standards do not ensure this outcome. Under previous CAFE standards, the market found a way around the standards by a shift toward larger vehicles. Additional policies or actions that better inform consumers about fuel savings may be important in combination with CAFE. These might include real-time dashboard data that indicates actual fuel economy or provides drivers with other driving-related fuel consumption information. Also, EPA's recent program to improve labeling may lead to changes in consumer information and understanding.

Another possible policy to be used with CAFE is to use the market to provide price incentives to consumers to purchase the more fuel-efficient fleet of vehicles. Klier and Linn (2011) show that automakers would have to adjust prices to sell the mix of vehicles to meet the standard, raising the prices of the less fuel-efficient vehicles and lowering prices of the more fuel-efficient ones. One such policy is a feebate, which imposes a fee on less fuel-efficient vehicles and a rebate on more fuel-efficient vehicles (see German 2010).

b. Inefficient lending markets.

Another possible market failure in the new vehicle market is liquidity constraints on consumer borrowing. Close to 75 percent of new cars are financed through loans. Some consumers may not be able to borrow for the additional cost of more fuel-efficient vehicles because lenders will not count the additional savings from tax credit subsidies (if any) or from lower gasoline costs as "income" in terms of approving the loan, or they will not grant lower interest rates for the same reason. This suggests that the private market lending rate may be

[18] See Jaffe and Stavins (1994) for a discussion of this type of *principal–agent* problem in energy markets.

higher than what would be socially optimal. On the other hand, there may be a good deal of uncertainty in the actual fuel savings, as evidence suggests.

Policy Implications: If there is a market failure, it would argue for better information and evidence for lenders about cost savings from more fuel-efficient vehicles.

c. Spillovers in development and adoption of new technologies.

There is much uncertainty about the costs and potential returns of new technologies to improve fuel economy, including alternative fuels and drivetrains. Manufacturers often cannot capture all of the returns to development of new technologies because there are “spillovers” to other firms. When new technologies are developed by one firm, they inform future pathways and profits for other firms who benefit from the information. Development of battery electric vehicles has been enhanced by what manufacturers have learned from early development and production of vehicles by Honda and Toyota. Because of the potential for such spillovers, there is a long-standing argument that innovation and development of new technologies will be under-provided if left solely to the private sector (Jaffe et al. 2004). Spillovers can also affect consumer adoption rates for new vehicle technologies. First adopters can provide valuable information to other potential buyers.

Policy Implications: Because of the uncertainty over which technologies will be most successful, policies that avoid “picking winners” are likely to the most cost-effective. This suggests policies such as general R&D support for fuel economy innovations, or incentive policies such as feebates, or subsidies. Also, the reformed CAFE policy with tradeable credits, and additional incentives for alternative drivetrain vehicles could also be effective for addressing spillover externalities.

2. Behavioral Responses

Consumers may have systematic biases that will cause them not to choose the vehicle with the expected lowest cost even when they have, or could obtain, accurate information about those costs.[19]

- One argument is that consumers may rely on various types of bounded rationality in making decisions about fuel economy. They may not want, or be able, to assess all

[19] For additional reviews of these behavioral issues, see Helfand and Wolverton (2011) and Greene (2010).

possible outcomes. Instead, they may, for example, use simple rules of thumb in assessing potential fuel savings, such as considering a three-year or five-year period, especially if this time period corresponds to their loan period or other seemingly relevant information.

- As discussed above, there is evidence that there is a good deal of uncertainty in the actual fuel economy performance of vehicles in real world driving conditions, and therefore in the savings buyers will get for a more fuel-efficient vehicle. This uncertainty, combined with consumers' likely preference for an immediate sure gain (lower vehicle cost) from the less fuel-efficient vehicle, can explain why consumers choose less fuel economy than would be optimal (Greene 2011). This preference for a sure gain is a form of loss aversion that has been observed in a number of consumer decision-making contexts (Kahneman 2011).
- Another argument is that consumers are more sensitive to up-front costs, or that they have a bias for the present. This so-called *time inconsistency* causes them to underweight future time periods in the present period. For vehicles, this makes buyers less willing to spend money up front for fuel-saving technologies than might appear economically rational.[20]
- A final behavioral argument is that consumers cannot consider all factors when making a decision about vehicle attributes. They focus instead on those factors that they consider *salient*, such as size, cargo or seating capacity, and acceleration. If fuel prices are low, or as vehicles become more fuel-efficient over time, fuel economy becomes even less salient and is less likely to be considered as part of the economic decision in vehicle choice.

Policy Implications: These behavioral arguments suggest that fuel economy standards such as CAFE may be the most efficient policy for achieving overall reductions in vehicle fuel consumption. But fuel economy standards will not necessarily make consumers behave differently. Some may still not want to buy the more fuel-efficient vehicles for the reasons outlined above. Policies that are complementary to CAFE should be considered.

[20] Note that a high discount alone does not necessarily mean there is a market or behavioral failure. High discount rates may be rational on the part of consumers if, for example, they face high borrowing rates. For example, see Tsvetanov and Segerson (2011).

3. Externalities

The recent renewed interest in improving fuel efficiency in the United States is motivated in large part by heightened concern over climate change on the one hand and insecure sources of oil to world markets on the other. Ensuring that energy prices reflect these social costs, which are not currently reflected in private markets, is a key element of any set of efficient policies for light-duty vehicles.

A recent joint study by 12 government agencies developed a range of estimates of the "social cost of carbon" using well-known modeling approaches, and including extensive uncertainty analysis (Interagency Working Group 2010). These estimates represent an estimate of the monetized damages associated with an increase of one ton of carbon emissions in a given year, and the costs are estimated over time to 2050. The damage estimates include effects on human health, agricultural productivity, damages from increased flooding, and the changes in ecosystem services. To give an example of the magnitude of the costs per ton of CO_2, in 2015 the estimates range from about $24 per ton (average estimate) to $73 per ton (95th percentile).[21] This translates to roughly 22 cents per gallon of gasoline to 70 cents per gallon. The costs per ton increase by close to double these levels by 2050.

The types of social costs or externalities from oil dependence, and the magnitude of such costs, have been a subject of much controversy over the years. A recent summary of the literature provides a range of estimates from $10 to $38 a barrel of oil in 2009 dollars (National Research Council 2013, 102). At a price of $100 for oil and a $3.50 price for gasoline, this externality cost translates into roughly a 25- to 94-cent increase in the gasoline price.[22]

Policy Implications: The most direct and arguably the most efficient policy to deal with the externalities would be to put a price or tax on vehicles or fuels so that they are fully accounted for in vehicle and gasoline markets. The reformed CAFE standards are an alternative way to address these externalities in the context of the new vehicle market. However, gasoline prices affect both the types of vehicles consumers buy and the amount they drive. As we discussed in the introduction, CAFE standards can actually increase driving because they lower

[21] These estimates are based on Table 5.4.1 in Interagency Working Group (2010), using the 3% discount rate and 2007 dollars.

[22] This assumes that oil cost is about 72% of the cost of bringing gasoline to market.

the per-mile costs of driving. Gasoline prices that reflect full social costs would be complementary to CAFE standards that are already being implemented.

D. Importance of the Gasoline Price

The extent of the energy paradox in consumer choices about fuel efficiency will affect how much fuel prices matter to consumers as they make choices to buy more or less fuel-efficient vehicles. But there is clear evidence that fuel prices *do* influence consumers regarding the kinds of vehicles they buy. For example, Busse et al. (2012), using data on individual vehicle sales from 1998 to 2008, estimate that a $1 increase in fuel prices during this period resulted in the market share of vehicles that get at least 24 mpg to increase by 28.7 percent, and the market share of vehicles with gas mileages less than 16 mpg to decrease by 22.8 percent. Klier and Linn (2010) also found that the run up in gasoline prices from 2002 to 2007 had a significant effect on the sales of larger vehicles, primarily from domestic manufacturers. Consumers do care about fuel efficiency, and they care more when gasoline prices are high, even if there is an energy paradox in fuel consumption.

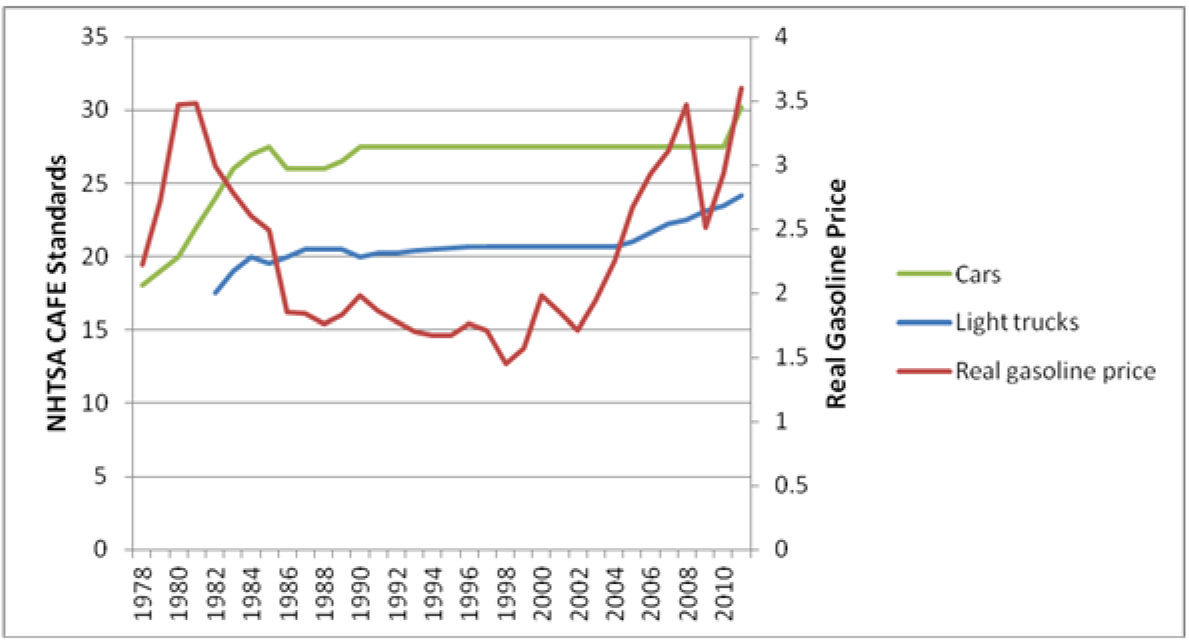
Low or fluctuating gasoline prices are likely to discourage consumers from choosing more fuel-efficient vehicles. If prices are low because they do not reflect full social costs, then this is an externality and is already discussed above. However, in general, low gasoline prices certainly create a disincentive for manufacturers to develop, and for consumers to buy, more fuel-efficient vehicles. Consistent and gradually rising prices can also reduce uncertainty in future price expectations.

Figure 7 shows real gasoline prices and the CAFE standards from 1970 to 2010. During the period when the original CAFE standards were ramped up, from 1975 to 1982, the real cost of gasoline at the pump was rising rapidly. This was during the second oil crisis, when prices on world oil markets rose by a factor of three. Real prices of gasoline also rose in the United States, but not as rapidly, and after 1984, they fell. Prices of oil and the linked price of gasoline were very low during the 1990s, when CAFE standards remained constant. The recent, though volatile, increase in oil prices since 2005 spurred interest in strengthening CAFE, but high and increasing gasoline prices are likely to be essential for the success of CAFE. Political and economic pressures to postpone and loosen the new standards will be strong if oil and gasoline prices fall and stay low. Figure 8 shows the recent Energy Information Agency (EIA) forecast for oil prices out to 2040. There is, of course, a great deal of uncertainty about future oil prices, as evidenced in the figure. But the low oil price scenario would mean low gasoline prices, and this would make CAFE more costly to implement for the auto companies and more difficult to maintain and enforce by the government.

Policy Implications: Policies that make oil prices relatively high and stable would be complementary to the new, stricter CAFE standards. One such policy is a tax that is implemented only when the price of oil falls below some designated *price floor*; the tax rate varies inversely with the price of oil. The more oil prices fall, the higher the tax rate, to maintain the price floor (Borenstein, 2008).

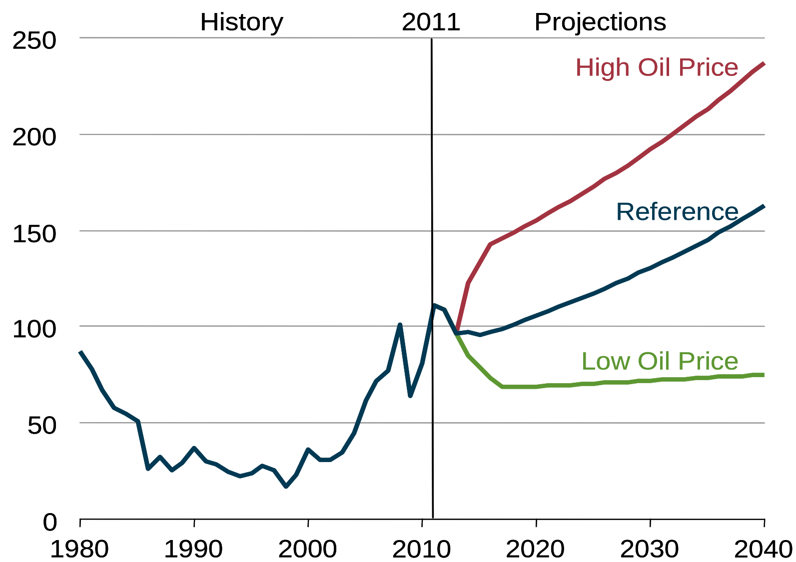
Another policy is a gasoline tax, as discussed above, as it reflects externalities. Gramlich (2010) finds that a gasoline price of about $4.35 may be needed to achieve a fleet average mpg of 35.

Figure 7. Real Gasoline Prices in the United States (2012$) and CAFE Standards (mpg)



Source: See Figure 1a. above for CAFE standards; annual average gasoline price from US Energy Information Administration, inflation adjusted by CPI.

Figure 8. Average Annual Crude Oil Price Forecasts, EIA (2011$/barrel)



Source: EIA, Energy Outlook 2013, Early Release, Brent Crude Price, http://www.eia.gov/forecasts/aeo/er/early_prices.cfm.

IV. CAFE and Complementary Policies

There are a range of arguments about why vehicle and fuel markets may not result in efficient levels of fuel consumption. The extent of such inefficiency is still not well understood, but it is important because of its implications for determining which policies are most appropriate for reducing oil dependence and GHG emissions. If market and behavioral failures of the types discussed above are present, a standard such as the new CAFE policy may be the best economic choice, and it is clearly the political choice over relying only on policies that affect prices.

But the new reformed standards will require a dramatically different fleet of vehicles over the next 15 years from what the market might provide otherwise. And although there are many flexibilities built into the new rules, the success of the new CAFE standards is uncertain and will depend on the cost of new technologies, the behavior of consumers, and market outcomes in fuel markets. It is likely that the goals of the CAFE standards can be more readily attained in combination with other complementary policies. We have only touched on a few of the policy options here, but these will need to be considered in more detail as the effects of the new CAFE standards are evaluated over time.

One issue identified in this paper is that because of consumer preferences and relative costs of different sizes of vehicles, the mix of vehicles manufacturers end up producing to meet the standards may mean that the goals of the standards are not met. If there is a shift to larger vehicles, for example as there was under the previous CAFE standards, both oil and greenhouse gas emissions reductions will be smaller than envisioned in the regulations. Feebate policies are often seen as a alternative policy to CAFE (Klier and Linn, 2012, and Gillingham, 2013) , but there are potential ways that they could be designed to be complementary to CAFE that need to be explored. Under a feebate, more fuel-efficient vehicles get a subsidy, and larger, more fuel-using vehicles pay a penalty, and the policy can be designed to be revenue neutral. There are already elements of such taxes and subsidies in current and past policies. There has been a gas guzzler tax since 1978 on cars (not on trucks) that do not meet a minimum fuel economy standard—that standard that is linked to the existing CAFE standard. On the other side, there are subsidies available for vehicles with certain alternative less polluting technologies, such as hybrid electric vehicles and plug-in electrics (McConnell and Turrentine 2010). A feebate policy linked to CAFE was introduced in Congress several years ago, but was never passed.[23]

It is also clear that the cost of meeting the standards will depend on the path of gasoline prices. When gasoline prices are higher, reflecting the full externality costs as discussed above, consumers will be more willing to purchase more fuel-efficient vehicles. A previous study at Resources for the Future of policies to reduce oil consumption and GHG emissions found that certain policy combinations were more cost-effective than single policy options (Krupnick et al., 2010). For example, a CAFE policy with a gasoline tax was much more effective and cost-effective than CAFE alone. Other studies have also concluded that policies can be complementary, such as adding pricing policies when efficiency standards are already in place (Tsvetanov and Segerson 2011; Howarth and Andersson 1993).

Finally, mechanisms or policies that provide information to consumers about fuel costs and fuel use could be effective in overcoming some of the market failures discussed above.

[23] A bill was introduced in the 108th Congress in 2010 by Richard Durbin (S. 795) that would have created an income tax credit of between $770 and $7,700 for purchasers of cars and light trucks that get at least 5 mpg better than the CAFE standard. This bill also would have increased the existing gas guzzler excise tax, and expanded the gas guzzler tax to cover light trucks.

V. Conclusions

Recent changes to CAFE rules require manufacturers to shoulder the burden of reducing oil use and GHGs. These new reformed CAFE rules would require fuel use and CO_2 emissions by light-duty vehicles to fall by close to 40 percent over the next 15 years. These new NHTSA CAFE and EPA CO_2 rules are directed at the fuel efficiencies of vehicles sold by manufacturers. But for a number of reasons, consumers may not accurately assess the value of fuel savings in the purchase of a new car, and they may not be willing to trade off the up-front costs of more fuel-efficient vehicles for the future fuel savings from those cars. How will the strategies of the manufacturers to meet the standards interact with the responses of consumers to prices and attributes of vehicles over time? Will the goals of reductions in greenhouse gases and oil dependence be met? We have argued that the new reformed CAFE rules by themselves do not guarantee that the hoped-for outcomes will be attained. Past history of CAFE policies has shown that market forces can indeed play an important role in the effectiveness and success of the policy. It is important to consider policies that can be combined with the current CAFE policy, and this depends in part on the sources of market and behavioral failures. But it is clear that a set of complementary policies should be considered—including carbon or fuel taxes, feebates and information programs.

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