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REGULATORY STUDIES PROGRAM

Public Interest Comment on
Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011–2015[1]

Docket No. NHTSA–2008–0089

The Regulatory Studies Program (RSP) of the Mercatus Center at George Mason University is dedicated to advancing knowledge of the impact of regulation on society. As part of its mission, RSP conducts careful and independent analyses employing contemporary economic scholarship to assess rulemaking proposals from the perspective of the public interest. Thus, this comment on the National Highway Traffic Safety Administration's (NHTSA) proposal to modify the corporate average fuel economy standards for passenger cars and light trucks in model years 2011–2015, does not represent the views of any particular affected party or special interest group, but is designed to evaluate the effect of the proposal on overall consumer welfare.

I. Introduction

The Department of Transportation (DOT), as required by the Energy Policy and Conservation Act, sets corporate average fuel economy standards for all major vehicle manufacturers who sell vehicles in the U.S. The recently passed Energy Independence and Security Act (EISA) requires the Department of Transportation to set separate standards for passenger cars and light trucks such that the average fuel economy of the combined fleet of all passenger cars and light trucks sold in the U.S. in model year 2020 equals or exceeds 35 miles per gallon (mpg).[2]

On May 2, 2008, the National Highway Traffic Safety Administration (NHTSA) published a Notice of Proposed Rulemaking in the *Federal Register* that describes its intentions to modify the corporate average fuel economy (CAFE) standard in model years 2011–2015.[3] In the Notice of Proposed Rulemaking (NPRM), NHTSA proposes significant increases in the CAFE standards for both passenger cars and light trucks. The

[1] Prepared by Patrick A. McLaughlin, research fellow, Mercatus Center at George Mason University. This comment is one in a series of Public Interest Comments from Mercatus Center's Regulatory Studies Program and does not represent an official position of George Mason University.
[2] Pub. L. 110-140, 121 Stat. 1492 (Dec. 18, 2007).
[3] Department of Transportation, National Highway Traffic Safety Administration, *Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011-2015*, Notice of Proposed Rulemaking (Docket No. NHTSA-2008-0089), Federal Register 73:86 (May 2, 2008). [Hereinafter "NPRM"]

stated intention for the increase in the CAFE standards is to improve fuel economy.[4] NHTSA asserts that improving fuel economy "would enhance energy security" and "would address climate change by reducing tailpipe emissions" of carbon dioxide (CO_2).[5]

The proposed rule would set fuel economy standards for vehicle manufacturers that vary according to vehicle footprint. A vehicle's footprint is the product of its wheelbase and average track width.[6] The proposed CAFE standards would assign specific mpg targets to each different vehicle footprint value. Vehicles with larger footprints would have less stringent fuel economy standards than vehicles with smaller footprints. Depending on the mix of vehicles produced by manufacturers each year, each manufacturer would have an individualized CAFE standard that it must achieve in model years 2011-2015. Footprint-based fuel economy standards might reduce the incentive for manufacturers to reduce vehicle weight and size in order to increase fuel economy. With footprint-based standards, manufacturers might not be able to simply reduce the size or weight of a vehicle in order increase fuel economy enough to comply with the CAFE standard, because smaller footprint vehicles have to achieve even more stringent standards. Reduction of vehicle weight and size might contribute to decreased safety.[7]

The proposed average fuel economy standards for the entire U.S. fleet for each vehicle category, passenger cars and light trucks, in each model year (MY) are listed below in Tables 1 and 2, along with the percentage increases in the CAFE standard compared to the previous year's standard. The exact level that each manufacturer will be required to meet for each model year is actually incalculable, because of the aforementioned attribute-based individualization of CAFE standards for each manufacturer's fleet. The proposed CAFE standards in Tables 1 and 2 come from averaging the estimated required CAFE standards for the largest manufacturers in each MY and are the numbers reported by NHTSA in its proposal.[8] Calculations of percentage increases for the initial MY, 2011, are based on the existing standards for MY 2010, which are 27.5 mpg for passenger cars and 23.5 mpg for light trucks.

Table 1: NPRM's proposed CAFE standards for passenger cars

Passenger Cars		
Model Year	CAFE Standard	Percent Increase on Previous Year's Standard
2011	31.2 mpg	13.4%
2012	32.8 mpg	5.1%
2013	34.0 mpg	3.7%
2014	34.8 mpg	2.4%
2015	35.7 mpg	2.6%

[4] Department of Transportation, National Highway Traffic Safety Administration, Preliminary Regulatory Impact Analysis, Corporate *Average Fuel Economy for MY 2011-2015 Passenger Cars and Light Trucks*, p. XI-1.
[5] NPRM, p. 24352.
[6] Ibid., p. 24388.
[7] National Academy of Sciences, "Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards," National Academy Press, Washington, DC. 2002. P. 3, Finding 2. [Hereinafter "NAS"]
[8] NPRM, pp. 24443-24447.

Table 2: NPRM's proposed CAFE standards for light trucks

Light Trucks		
Model Year	CAFE Standard	Percent Increase on Previous Year's Standard
2011	25.0 mpg	6.4%
2012	26.4 mpg	5.6%
2013	27.8 mpg	5.3%
2014	28.2 mpg	1.4%
2015	28.6 mpg	1.4%

NHTSA estimates that the total benefits from the passenger car CAFE standards would be approximately $31 billion and that those from the light truck CAFE standards would be approximately $57 billion.[9] These estimates include the value of the cost of fuel saved as well as the reduction of the externality costs of tailpipe emissions and dependence on oil. Fuel consumption costs are estimated using Energy Information Administration (EIA) projections of retail gasoline prices and a 7 percent discount rate. NHTSA also attempted to include the offsetting social costs from the rebound effect, which is defined as the increase in driving likely to occur due to higher fuel economy.

NHTSA estimates that the total costs to manufacturers for implementing the technology necessary to comply with the passenger car standard in each year from MY 2011-2015 would be approximately $16 billion, and the costs of complying with the light trucks standards would be approximately $31 billion. Most of these additional costs would ultimately be borne by consumers in the form of higher vehicle prices and reduced choices.[10]

Recognizing the Congressional mandate to change the CAFE standard by 2020, NHTSA should be commended for its good faith effort to stringently analyze relevant costs and benefits resulting from a new CAFE standard rule. To further improve the cost-effectiveness of any implementation of new CAFE standards, we recommend that NHTSA consider a few key elements of the proposed rule that are detailed in this comment. Furthermore, NHTSA should consider some proposals for alternative rules, also detailed herein, that would still fulfill the Congressional mandate more efficiently than the current proposal, were the rule finalized "as is". Specifically, this comment addresses the following aspects of the proposed rule:

- Evidence that market forces alone would lead to average fuel economy levels in the U.S. that meet or exceed the levels proposed by NHTSA.

- The possibility that the cost of increased congestion, a product of the "rebound effect," does not take into account likely increasing marginal costs as considered in NHTSA's model.

[9] NPRM, pp. 24355-24356.
[10] Congressional Budget Office. "The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax." December, 2003. [Hereinafter "CBO study"]

- The issue of whether the costs of the technologies manufacturers would have to implement in order to comply with the proposed rule includes the cost of possible decreased vehicular safety.

- The potential for the frontloaded nature of the proposed rule, which includes the largest percentage increases in average fuel economy at the beginning of the rule's effective period, to induce technological lock-in to the gasoline-electric hybrid vehicle type.

- Whether the fuel savings consumers would accrue from driving vehicles with higher fuel economies should be attributed to the proposed rule, given that consumers appear to already be seeking a mix of vehicles with an average fuel economy in excess of the current CAFE standards.

II. Question of Market Failure

When creating regulations, agencies generally need to explain either a market failure or some other systemic problem.[11] In the case of fuel economy, NHTSA and others state that there exist two externality costs that require some form of government intervention in order to maximize net social benefits. The two externality costs considered by NHTSA in this NPRM are (1) tailpipe CO_2 emissions, which may contribute to climate change, and (2) dependence on oil, which allegedly "impose[s] costs on the domestic economy that are not reflected in the market price for crude petroleum, or in the prices paid by consumers of petroleum products such as gasoline."[12] These externality costs have been previously estimated to total about $0.30 per gallon of gasoline.[13] NHTSA uses figures of $0.285 per gallon as the total economic costs of oil imports and $7.00 per metric ton of CO_2 emissions in 2011.[14] The externality cost of CO_2 emissions is assumed to grow at 2.4 percent annually thereafter.[15]

Ample research suggests that, if these externality costs of gasoline usage exist, a gasoline tax would be a more economically efficient than increasing CAFE standards as a way to reduce gasoline usage.[16] The average gasoline tax in the United States in 2003 was about 41 cents per gallon and rose to 47 cents a gallon in 2006.[17] It is possible that the existing gasoline tax alone is sufficient to reduce gasoline consumption to socially optimal levels. Nevertheless, given the Congressional mandate of changing the CAFE standards by 2020, an appropriate question to ask is whether the average fuel economy in the U.S.

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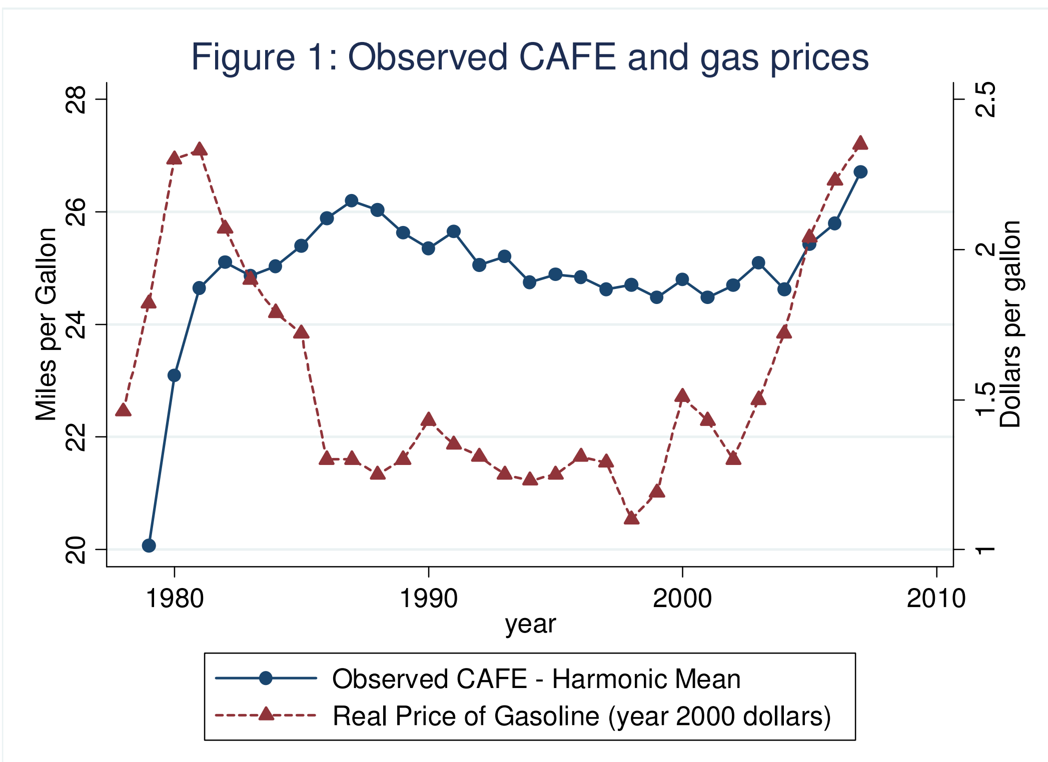
[11] Executive Order 12866.
[12] NPRM, p. 24410.
[13] NPRM, p. 24360.
[14] NPRM, p. 24403.
[15] NPRM, p. 24414.
[16] For example, see Austin, David and Terry Dinan. "Clearing the air: the costs and consequences of higher CAFE standards and increased gasoline taxes." *Journal of Environmental Economics and Management*, Vol. 50, Issue 3, Nov. 2005, pp. 562-582.
[17] CBO study, p. iv and p. 2, and NPRM, p. 24405

would reach 35 mpg by 2020 without changes to the CAFE standards in MY 2011-2015. A second consideration is whether frontloading the changes to the CAFE standards—concentrating the largest percentage changes in the first couple of years—would maximize net social benefits compared to alternative schemes such as a more gradual increase in CAFE standards in the first couple of years.

A. Evidence of Increasing Willingness to Pay for Fuel Economy

Prior to 2005, studies on CAFE standards and the value of fuel economy in general have concluded or assumed that manufacturers in general would not voluntarily create new or use existing technologies to produce fuel savings. For example, a 2003 Congressional Budget Office study of the economic costs of CAFE standards versus a gasoline tax states that "because consumers' preferences over the past 15 years have induced automakers to increase vehicles' size and weight (for safety or other reasons) and horsepower, while holding gasoline mileage ratings steady . . . CBO believes that regulatory intervention would be required to raise average mileage ratings[.]"[18] Over the period of time that pre-2005 studies collected data, consumer valuation of fuel economy may indeed have been low enough that the above statement was true. More current data, however, may cause us to draw a different conclusion.



Consumers appear to be increasingly willing to pay for fuel economy, as one would expect to see as gas prices increase. In the graph above (Figure 1), the observed CAFE—that is, the actual average fleet economy observed in the U.S. in each year and reported by NHTSA—is shown along with the average real retail price of gasoline in the U.S. (in

[18] CBO study, p. v.

chain-weighted 2000 dollars).[19] Throughout the 1990s, the observed CAFE was more or less stable; technology advances allowed manufacturers to increase other vehicle components such as safety and comfort while maintaining an average fuel economy around 25 mpg.

After the real price of gas rose sharply in 2002 and continued upward, manufacturers responded to increasing demand for fuel economy by offering more fuel-efficient vehicles. This is unsurprising: consumers value fuel economy more as the price of gas increases, and they are willing to pay for it. As a result of more fuel-efficient vehicles being offered by manufacturers at the behest of consumers, the observed CAFE also began sharply increasing in 2004. This increase in observed CAFE is not attributable to the increases in the light truck CAFE standard in 2005, 2006, and 2007 alone. In fact, the observed passenger car CAFE has increased by 2.3 mpg—from 29 in 2002 to 31.3 in 2007—even while the passenger car CAFE standard remained constant at 27.5. The bulk of that increase occurred between 2006 and 2007: in 2006, the observed CAFE was 30.2 for passenger cars, while in 2007 it was 31.3.

A 2005 study estimated consumers' marginal value of increased automobile fuel economy.[20] Using passenger car characteristics for 130 different models sold in the U.S. in the year 2001 (fuel economy, size, acceleration, handling, comfort, etc.), list prices, and sales quantities in a hedonic model, the authors estimated that the average consumer was willing to pay $613, in 2001 dollars, for a 1 mpg increase in fuel economy. That was in a year when the average retail price of gas was $1.46 in 2001 dollars ($1.43 in chain-weighted 2000 dollars).[21] This study should be updated to include many more years of data, so as to better understand how consumers' marginal value of increased automobile fuel economy has changed over time. The raw data shown in the graph above suggest that it has increased substantially. Furthermore, using data gathered from *Consumer Reports* and *Ward's* AutoInfoBank for MY 2007 passenger cars, preliminary estimates suggest that marginal willingness to pay for an additional mile per gallon of fuel economy has increased by approximately 31% relative to 2001.[22]

The Energy Information Administration (EIA) apparently agrees. In the *EIA Short-Term Energy Outlook Supplement: Motor Gasoline Consumption 2008*, EIA states, "Consumer sensitivity to gasoline price changes increases during periods when retail prices exceed

[19] Data on observed CAFE from NHTSA, "Revised Summary of Fuel Economy Performance." January 15, 2008. Available online, http://www.nhtsa.dot.gov/portal/nhtsa_static_file_downloader.jsp?file=/staticfiles/DOT/NHTSA/Rulemaking/Articles/Associated%20Files/Oct_2007_CAFE_Summary.pdf.
Data on gasoline prices, deflated to chained 2000 dollars, are from the Energy Information Administration. 1978-2006 - from EIA historic data online, http://tonto.eia.doe.gov/oog/ftparea/wogirs/xls/pswrgvwall.xls. Data on 2007 gasoline price from EIA's May 2008 short-term energy outlook monthly price, averaged to an annual price, and deflated to chained 2000 dollars.
[20] Espey, Molly and Santosh Nair. "Automobile fuel economy: what is it worth?" *Contemporary Economic Policy*, Vol. 23, No. 3, July 2005, pp. 317-323.
[21] EIA historical data, http://tonto.eia.doe.gov/oog/ftparea/wogirs/xls/pswrgvwall.xls.
[22] This figure is from preliminary research presently being conducted by the author. I am happy to discuss this ongoing project and can be reached at pmclaug3@gmu.edu.

$2.50 per gallon."[23] In 2007, for the first time since the 1970s, the annual average vehicle miles traveled decreased relative to the year before.[24] This trend should continue in 2008, given current gas prices in excess of $4.00 per gallon. As the EIA states, "[t]he weakness in gasoline consumption is expected to continue, even as the economy recovers from its current slowdown and [gasoline] prices begin to subside. For the foreseeable future, demographic shifts, the impact of high [gasoline] prices on vehicle efficiency, and the more recent shift characterized by reduced impact of income on vehicle miles traveled are likely to keep growth in gasoline consumption well below that seen for much of the post-war period."[25] Overall, the evidence suggests that market forces alone would likely drive average fuel economy higher and achieve the objective of the CAFE reform: lower overall gasoline consumption.

In fact, NHTSA's estimates of fuel savings from the proposed CAFE standards compared to the manufacturers' costs of implementing the proposed CAFE standards strengthens the case that manufacturers are likely to make these changes without any change in regulations. The estimates of total benefits from the proposed rule are largely attributable to fuel savings of consumers.[26] For passenger cars, $29.5 billion, or 85 percent, of the gross consumer benefits occur in the form of fuel savings.[27] Subtracting away $3.8 billion in costs of additional congestion, noise, and accidents from the rebound effect for passenger cars leaves consumers with net benefit of $25.7 billion, ignoring externalities. NHTSA estimates total costs for manufacturers of complying with the proposed standards for passenger cars to be approximately $16 billion. Thus, even if consumers ignore externalities completely, there is strong incentive for manufacturers to voluntarily improve fuel economy because the value created for consumers in fuel savings alone exceeds the costs by $9.7 billion.

Similarly, by NHTSA's estimate for light trucks, $52.7 billion, or 84 percent, of the gross consumer benefits comes from spending less on fuel.[28] NHTSA estimates the offsetting rebound effect cost to be about $5.4 billion, leaving consumers with benefits of $47.3 billion when they ignore externalities completely.[29] NHTSA estimates the costs to manufacturers of complying with the proposed standards for light trucks to be approximately $31 billion.[30] The value created for consumers ($47.3 billion) that ignore externalities completely exceeds the cost to manufacturers by $16.3 billion. Again, there is strong incentive for manufacturers to willingly bear the costs of increasing fuel economy because the value created is so much greater than the costs.

Although market forces alone would likely increase fuel economy in the U.S. to levels that satisfy the EISA requirement (35 mpg by 2020), this should not be interpreted to

[23] EIA STEO Supplement: Motor Gasoline Consumption 2008: A Historical Perspective and Short-Term Projections. April 2008, p. 1, http://www.eia.doe.gov/emeu/steo/pub/special/2008_sp_02.html.
[24] Ibid., p. 2.
[25] Ibid., p. 14.
[26] NPRM, p. 24449.
[27] NPRM, p. 24449.
[28] NPRM, p. 24449.
[29] NPRM, p. 24449.
[30] NPRM, p. 24449.

mean that the proposed regulation would therefore be harmless. There is a tremendous difference between voluntarily increasing fuel economy and doing so because of regulatory requirements. In the first case, those manufacturers than can increase fuel economy for the least cost can choose to do so, while other manufacturers (who perhaps specialize in producing unique vehicles that do not typically get high fuel economy) that can not cheaply increase fuel economy could still offer their vehicles to consumers. Under the proposed rule, all manufacturers would either have to comply, purchase credits from other manufacturers, or pay fines. This might result in a restriction of choice for consumers. Simply put, with or without the proposed rule, it seems likely that the fuel economy in the U.S. will increase dramatically in the coming years. If this proposed rule is implemented, consumers would be worse off because there might be less choice of vehicles on the market. Furthermore, the proposed rule, as currently structured, could lead to technological lock-in to a potentially inferior technology, as detailed later in this comment.

B. Internalizing the CO_2 Externality Costs

Awareness of the environmental externality costs and of possible oil dependency externality costs may actually induce drivers to behave as if they have internalized those costs. Adequate research has yet to be done on this question. Empirical research into the actions drivers are actually taking and willing to take to reduce their CO_2 emissions from driving would help inform NHTSA in creating this rule. Anecdotal evidence, however, suggests that consumers are willing to pay extra for hybrids because they believe they are helping the environment.[31] Even at gasoline prices above $4.00 per gallon, some hybrids carry such a price premium relative to the conventional engines on the same models that it would take 14 to 18 years to recoup the premium (examples include the Chevrolet Tahoe and Toyota Highlander models).[32] If it is indeed the case that consumers value acting "green" so much that they will pay a premium for hybrids that exceeds likely gas savings, then surely it is also possible that they act green in other ways. It is possible that the externality cost of driving is in the process of being internalized. More research needs to be conducted on the subject.

III. Reexamining the Costs

A. Congestion from the "Rebound Effect"

The rebound effect refers to the reaction of consumers to an increase in average fuel economy: As the price of driving a mile decreases, consumers will drive more. More driving leads to more congestion, accidents, and some mitigation of the decrease in CO_2 emissions that would accompany an increase in fuel economy. NHTSA includes an estimate of the rebound effect in its analysis of the costs and benefits of the proposed rule. This analysis focuses on one particular aspect of the rebound effect that should be reconsidered: congestion.

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[31] Valcourt, Josee. "Pricier gasoline makes hybrids a better deal." *The Wall Street Journal*, June 12, 2008, http://online.wsj.com/article/SB121322652624466085.html.
[32] Ibid.

NHTSA estimates the externality costs of increased congestion, accidents, and road noise from the rebound effect. Their estimates, based on a Federal Highway Administration (FHWA) study produced in 1997, of marginal congestion, accident, and noise costs due to increased light truck use are 5.2 cents, 2.3 cents, and 0.1 cents per vehicle mile, respectively, in 2006 dollars, while the corresponding estimates of those costs due to increased passenger car use are 4.7 cents, 2.5 cents, and 0.1 cents per vehicle mile.[33] These costs are then multiplied by the predicted annual increases in passenger car and light truck use that are the result of the rebound effect, and the resulting product is NHTSA's estimate of the external costs of congestion, accident, and noise externality costs.

The validity of the estimate of marginal congestion cost should be reconsidered. Using these estimates, 5.2 cents and 4.7 cents per vehicle mile, implicitly assumes a constant marginal cost of congestion across all possible total quantities of vehicle miles driven for each vehicle category. Yet the FHWA study from which these costs are derived states that "[c]ongestion cost impacts of changes in traffic levels are extremely sensitive to whether traffic increases occur during peak or off-peak periods. In heavily congested peak period traffic, the addition of a single vehicle to the traffic stream has a much greater effect on delay than the addition of a vehicle during non-peak periods."[34] If it is true that the marginal vehicle mile can have varying costs within a day—costs that vary with the total amount of traffic present when adding on the marginal vehicle mile—then it must also be true that the marginal vehicle mile can have varying costs across years, if the total amount of traffic varies across years as well. The rebound effect will cause an increase in total vehicle miles driven, and as the CAFE in the U.S. increases over time, total vehicle miles also would increase. Holding the amount of roads and congestion-decreasing technology (such as roundabouts) constant, increasing total vehicle miles driven also must increase total congestion and the marginal cost of congestion.

Conversely, total congestion does not necessarily increase with increases in total vehicle miles driven. Additional roads and alterations to existing roads could help offset additional congestion, although it seems unlikely that enough new roads could be added in, for example, New York City to accommodate future increases in vehicle miles driven to the point of keeping congestion levels constant over time. By using constant marginal cost estimates of congestion, NHTSA perhaps assumes that such a feat could be achieved—that is, enough roads could be built to keep congestion constant despite increases in total vehicle miles driven. Although the present high prices of gasoline have likely caused or are causing a decrease in total vehicle miles driven, it seems likely that the rebound effect could cause, on net, an increase in the demand for driving. If this is indeed the case, then the NHTSA notably lacks an estimate of the costs of building these

[33] Federal Highway Administration, 1997. *Federal Highway Cost Allocation Stud,* http://www.fhwa.dot.gov/policy/hcas/final/index.htm. Also, these cost estimates are in the NPRM on pp. 24403-24404 in Table V-3. Later, on p. 24410, the NPRM switches the categories, stating the marginal congestion, accident and noise costs of passenger cars are 5.2, 2.3, and 0.1 cents and those of light trucks are 4.7, 2.5, and 0.1 cents. It is unclear which figures were used for each category in the Volpe model.
[34] FHWA . *Federal Highway Cost Allocation Study*, section III-16, http://www.fhwa.dot.gov/policy/hcas/final/three.htm.

additional roads or altering existing ones. Such an estimate would need to take into account the increasing difficulty of building a new road in an urbanized area. Indeed, the construction of new roads in urban areas is probably one of the best examples of an activity that has rapidly increasing marginal costs.

Furthermore, these costs include not only construction and engineering costs, but also environmental costs. More roads lead to more urban sprawl; strip malls, gas stations, and parking lots would occupy increasingly large proportions of America. While there are certainly benefits to such population dispersal, this can also have many adverse economic and environmental effects. For example, it would affect water supplies in areas that depend on groundwater for drinking, irrigation, and other uses, as paved parking lots and roads prevent seepage from rainfall into aquifers, decreasing their recharge rates.[35] It is incumbent upon NHTSA and the Environmental Protection Agency to produce an inclusive estimate of the costs of the rebound effect—one that either includes both increasing marginal cost of congestion and the cost of the new roads that will lead to increased congestion.

B. Costs of Technology Adoption

NHTSA's assessment of fuel-economizing technologies seems to lack an exhaustive assessment on those technologies' impact on safety. The implicit assumption seems to be that adding any or all of these technologies onto a vehicle does nothing to the net safety of the vehicle; however, this is not always the case. Two possible technologies mentioned, for example, are "Rolling Resistance Reduction" and "Weight Reduction." The first applies to tires, and refers to the "frictional losses associated mainly with the energy dissipated in the deformation of the tires under the load." A reduction in rolling resistance would improve fuel economy, but it might also decrease handling or braking ability. Similarly, a reduction in gross weight of the vehicle has been shown to contribute to higher death and injury rates.[36] NHTSA considered only engineering costs of applying each technology to passenger cars and light trucks, ignoring the safety implications.[37] It could be argued that this safety-technology tradeoff is captured by including an indirect cost multiplier of 1.5 to the estimate of the vehicle manufacturers' direct costs for adding technologies in order to calculate the end price to consumers; however, the markup only "takes into account fixed costs, burden, manufacturer's profit, and dealers' profit."[38] Secondary effects on safety were therefore not considered when estimating this parameter of the Volpe model.

[35] Glennon, Robert. *Water Follies*. Island Press: Washington, DC, 2002. pp. 108-109, 123-125.
[36] National Academy of Sciences, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards*, p. 3, "…the downweighting and downsizing that occurred in the late 1970s and early 1980s, some of which was due to CAFE standards, probably resulted in an additional 1,300 to 2,600 traffic fatalities in 1993. In addition, the diversion of carmakers' efforts to improve fuel economy deprived new-car buyers of some amenities they clearly value, such as faster acceleration, greater carrying or towing capacity, and reliability."
[37] See NPRM, p 24367, for discussion of calculations of technology implementation costs.
[38] NPRM, p. 24384

C. Technological Lock-in

The proposed regulation would require vehicle manufacturers to improve their fleet fuel economy at a very rapid rate in the years 2011-2015, compared to the years 2016-2020. NHTSA correctly notes that lead time is important in the automotive industry, and NHTSA's efforts to give as much advance information as possible about future CAFE standards to manufacturers is laudable.[39] Nevertheless, the dramatic increases in CAFE standards proposed for MY 2011 mean that manufacturers must immediately implement existing technology to comply with the rule.

The creation of CAFE standards in MYs 2011-2015 may induce technological "lock-in." Frontloading the CAFE standards so that the largest increases occur at the beginning of the reform period rather than the end could exacerbate the lock-in problem. Technological lock-in occurs when one technology is widely adopted, and as a result potentially superior alternatives are never explored or adopted.[40] An example of an historical technological lock-in episode is the adoption of light water reactors for nuclear power generation because of heavy development by the U.S. Navy for submarine propulsion.[41] In the case of light water reactors, government intervention in the market (by the U.S. Navy investing heavily in a particular technology) directly contributed to marketwide adoption of what is viewed ex post by most experts to be an inferior technology compared with the alternatives.[42]

Although the proposed CAFE standards have the stated goal of complying with the Congressional mandate of a CAFE of 35 mpg by the year 2020, the largest percentage increases occur in model year 2011. To comply with this frontloaded series of increases, manufacturers will be forced to implement currently existing technology. This is noted in the NPRM:

> "The majority of the technologies discussed in this [NPRM] are in production and available on vehicles today, either in the United States, Japan, or Europe. A number of the technologies are commonly available, while others have only recently been introduced into the market. In a few cases, we provide estimates on technologies which are not currently in production, but are expected to be so in the next few years." —NPRM, p. 24365

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[39] NPRM, p. 24353.

[40] Arthur, W. Brian. "Competing Technologies, Increasing Returns, and Lock-In by Historical Events." *Economic Journal*, Vol. 99, No. 394, pp. 116-13. March, 1989.

[41] Leibowitz, Stan and Stephen Margolis. "Path Dependence, Lock In, and History.. *Journal of Law, Economics and Organization*.

[42] Cowan, Robin. "Nuclear Power Reactors: A Study in Technological Lock-in." *Journal of Economic History*, Vol. L, no. 3, pp 541-567. Sept., 1990. Also, for an more complete review of technological lock-in and its role in innovation, see: Foxon, Timothy. "Technological lock-in and the role of innovation." *Handbook of Sustainable Development*. Atkinson, Giles, Simon Dietz and Eric Neumayer, eds. Edward Elgar Publishing, Cheltenham, UK, 2006. Version available online, http://www.hm-treasury.gov.uk/media/C/0/climatechange_imp_3.pdf.

The proposed rapid increases in CAFE standards beginning in 2011 would require production decisions to be made now. One consequence of this could be that manufacturers opt to invest in many more gasoline-electric hybrid vehicle production facilities. Gasoline-electric hybrids achieve high fuel economy relative to conventional gasoline powered vehicles; however, there is a growing body of scientific work that paints gasoline-electric hybrid vehicles as a stopgap solution at best.[43] At least one scientific publication claims that, in the long run, electric cars with on-board electricity generation offer the most promising technological prospects.[44] Another, by former Acting Assistant Secretary at the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy Joseph Romm, claims that plug-in hybrids that use a combination of electricity and biofuels offer the best alternative fuel vehicle solution.[45] Still others might yet pin their hopes for a sustainable solution on hydrogen fuel cells, although infrastructure costs pose a giant obstacle to this.[46] Importantly, a 2004 study wonders whether the emergence and adoption of hybrid vehicles might forestall the development of the fuel cell vehicle.[47]

Clearly, there are multiple promising technologies that may not be ready by 2011. Market forces have driven manufacturers to offer cars with greater fuel efficiency and to explore alternative fuel vehicles technologies. Frontloading changes to the CAFE standards create a very real danger of technological lock-in to a possibly inherently inferior technology, the gasoline-electric hybrid engine. This danger exists because complying by MY 2011 would require immediate investment in production facilities, and the gasoline-electric hybrid offers the cheapest way of doing that right now. Once manufacturers have heavily invested in gasoline-hybrid production facilities, they will be less inclined to seek out new technologies for alternative fuel vehicles. Indeed, NHTSA recognizes that a "substantial portion" of the cost of this proposed rule could come in terms of forgone alternative investments the auto manufacturers would otherwise make.[48] The proposed rule might induce manufacturers to incur large set-up or fixed costs from investment in gasoline-electric hybrid production facilities, leading to a scenario where future

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[43] Chanaron, Jean-Jacques and Julius Teske. "Hybrid vehicles: a temporary step." *International Journal of Automotive Technology and Management*, Vol. 7, No. 4, 2007.
[44] Granovskii, Mikhail, Ibrahim Dincer and Marc A. Rosen. "Economic and environmental comparison of conventional, hybrid, electric and hydrogen fuel cell vehicles." *Journal of Power Sources* 159, pp. 1186-1193. January, 2006.
[45] Romm, Joseph. "The car and the fuel of the future." *Energy Policy*, 34, pp 2609-2614. August, 2005.
[46]It appears most manufacturers have some hydrogen fuel cell vehicle plans. For example, Honda is preparing to release a limited number of its FCX Clarity—a hydrogen fuel cell vehicle that it claims gets the equivalent of 68 miles per gallon of gasoline based on the energy content of hydrogen vs. gas—in Southern California in the summer of 2008. See Sabatini, Jeff. "The Driver's Seat: Honda Sees a Hydrogen Future." *The Wall Street Journal*. November 30, 2007, http://automobiles.honda.com/fcx-clarity/press/. GM has also launched a test fleet of hydrogen fuel cell vehicles, as has Ford. See online press releases, http://www.chevrolet.com/fuelcell/articles/index.jsp?id=2 and http://www.ford.com/innovation/environmentally-friendly/hydrogen/ford-edge-hyseries/edge-fuel-cell-hybrid-346p.
[47] Hekkert, Marko and Robert van den Hoed. "Competing technologies and the struggle towards a new dominant design: the emergence of the hybrid vehicle at the expense of the fuel cell vehicle?" *Greener Management International.* Vol. 47, I. 29. 2004.
[48] NPRM, p. 24415.

manufacturing decisions are influenced by sunk costs and the economies of scale to be gained by producing increasing quantities of gasoline-electric hybrid vehicles. Once costs are sunk into hybrid production facilities, the marginal cost of production of hybrids is lower than the marginal cost of producing other vehicles whose technologies still require research. Also, situations in which there exist economies of scale diminish the incentives to invest in alternative technologies.[49]

In this case, the proposed rule could encourage widespread adoption of a stopgap solution—gasoline-electric hybrid vehicles, and that may not be better than letting manufacturers decide for themselves how best to meet consumers' desire for greater fuel economy. There are two main reasons for this. First, the stopgap solution could end up being the only long-run solution if technological lock-in occurs. In such a scenario, rather than switching to some technology that does not depend on petroleum, the U.S. would continue using gasoline-dependent vehicles (hybrids) for the foreseeable future. Such a prolongation of petroleum usage is directly contrary to the spirit of EISA: Reduce oil consumption and confront global climate change. Second, the consumers appear to already be adopting more fuel-efficient cars, regardless of CAFE standards.

When considering the maximum feasible level at which the CAFE standards could be set, NHTSA should take into account the potential cost of technological lock-in that could be created by a frontloaded series of CAFE standard increases. To allay the risk of technological lock-in, any changes to the CAFE standard should be delayed or at least implemented more gradually while manufacturers explore other promising technologies. Delaying the changes to the CAFE standard does not mean that the observed CAFE will not improve anyway; as was shown earlier, the rising cost of gasoline, increasing awareness of the environmental costs of driving, demographic shifts, and a lower income elasticity of demand for vehicle miles all are contributing to a rising observed CAFE.

III. Reexamining the Benefits

In NHTSA's estimate, a large component of the benefits of the proposed rule is the result of consumer savings on gasoline used per mile driven (gas savings). Current data suggest, however, that at least a large portion of the gas savings NHTSA includes in its estimate in fact would not be the result of regulation. Perhaps due to high retail gas prices or consumer awareness of the environmental consequences of tailpipe emissions, consumers are already shifting to a mix of vehicles with greater fuel efficiency than the assumed mix used in NHTSA's calculations. The benefits of gas savings from this shift should not be attributed to the increasing of the CAFE standards.

NHTSA's calculation of gas savings depends on both current CAFE standards and the proposed CAFE standards.[50] Specifically, the difference between these two estimates gives the net fuel savings from the proposed rules. In other words, it appears that NHTSA assumes that the observed CAFE for vehicles purchased in MY 2011-2015 would remain

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[49] Foxon, Timothy. "Technological lock-in and the role of innovation." *Handbook of Sustainable Development*, p. 3.
[50] PRIA, p. VIII-17.

at exactly 27.5 mpg for passenger cars and 23.5 for light trucks. Yet, the observed CAFE for passenger cars has exceeded the CAFE standard in every single year since 1984, and the observed CAFE for light trucks has exceeded the CAFE standard in every year since 1997. Furthermore, the difference between the observed CAFE for passenger cars and the CAFE standard for passenger cars has been growing quickly in the last few years, as Figure 2 (below) shows.

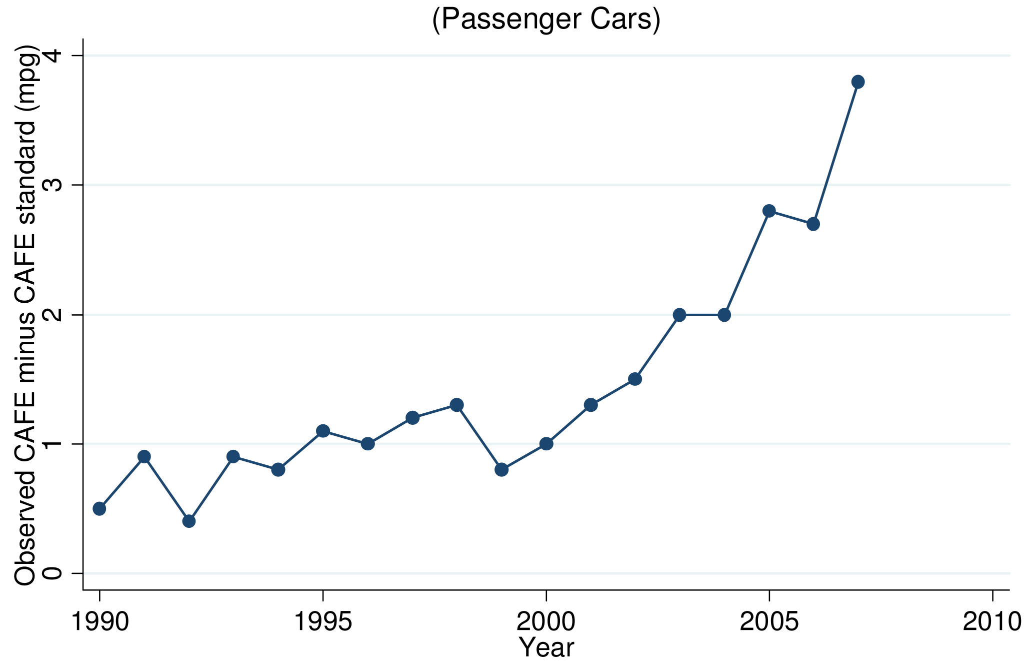
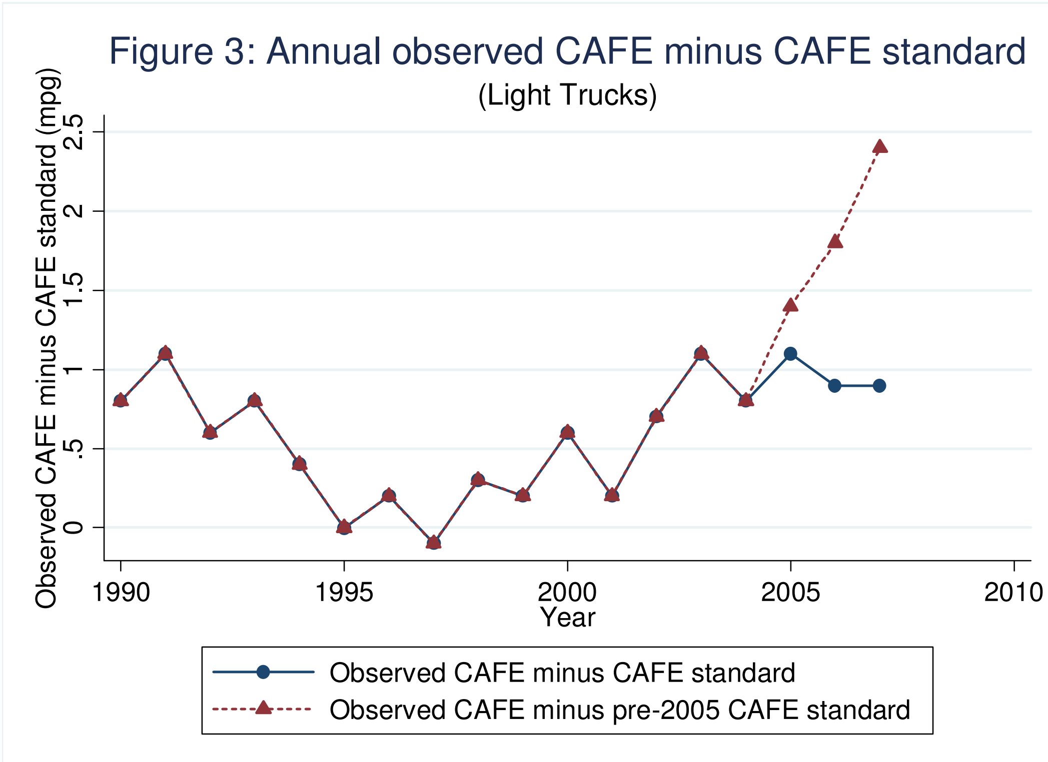


Figure 2: Annual observed CAFE minus CAFE standard

The observed CAFE for light trucks has also been increasing rapidly along with gas prices, although the difference between the observed CAFE for light trucks and the light trucks CAFE standard has remained relatively constant in recent years because the CAFE standard for light trucks increased in years 2005, 2006, and 2007. Figure 3 (below) shows the difference between the observed CAFE and the CAFE standard including the increases in 2005-2007 (solid line); Figure 3 also shows the difference between the observed CAFE and a hypothetical CAFE standard that maintains the 2004 CAFE standard for 2005-2007 (dashed line).



Both Figure 2 and Figure 3 demonstrate that the observed CAFE has historically exceeded the CAFE standard. Figure 2 shows that the level of excess has grown rapidly in the last few years, and Figure 3 seems to indicate that the same sort of pattern would have occurred for light trucks, had the light truck CAFE standard not changed in 2005–2007.

Again, recent data demonstrate that the observed fuel economy in America both regularly exceeds the CAFE standard, and that the amount by which the observed CAFE exceeds the CAFE standard appears to be on a steep upward trajectory. In light of this evidence, the calculation of net gas savings should be revisited to reflect this fact.[51] NHTSA uses the current CAFE standard as the baseline and compares the cost of gas consumption in that baseline case to the cost of gas consumption if the average fuel economy were to just comply with the proposed CAFE standards. NHTSA attributes the gas savings calculated in this comparison to the proposed rule, and includes those gas savings in its benefit-cost analysis as a large component of the benefit. Of the nearly $31 billion in net benefits that NHTSA estimates would result from the proposed rule for passenger cars in MY 2011–2015, almost $25 billion comes from gas savings, calculated as described above.[52]

[51] PRIA, p. VII-17, states, "To determine the impact of improved CAFE standards, fuel consumption is calculated using both current and revised CAFE levels. The difference between these estimates represents the net savings from increased CAFE standards. With the current CAFE standard assumed to remain in effect, total fuel consumption by each model year's vehicles during each calendar year they remain in service is calculated by dividing the total number of miles they are driven during that year by the average on-road fuel economy they would achieve under the higher of either the manufacturer-specific standard or their production plans."
[52] PRIA, Table VIII-10, p. VIII-43.

Similarly, of the roughly $57 billion in net benefits that NHTSA estimates the proposed light trucks rules would deliver to society, about $45 billion come from gas savings. If NHTSA were to recalculate the gas savings from the proposed rule using a more realistic baseline, the net benefits from implementing the proposed rule would fall dramatically. A more realistic baseline should take into account the steep increases in observed average fuel economy witnessed in the U.S. over the last several years—increases that are not entirely attributable to the changes in light trucks CAFE standards implemented in 2005-2007.

IV. Conclusions and Proposed Alternatives

A. Conclusions

Overall, the thoroughness with which NHTSA developed the proposed rule should be commended. This analysis, however, suggests that NHTSA should reconsider some aspects of the proposed rule. One consideration should be the possibility of technological lock-in: widespread adoption of the gasoline-electric hybrid might hinder the achievement of the ultimate goal of reduce oil dependence and CO_2 emissions, if such adoption delays or prevents other superior technologies from becoming mainstream.

NHTSA should also recalculate its benefit-cost analysis with the following in mind:

1. NHTSA should estimate gas savings to consumers relative to a more realistic baseline. One such baseline could be the predicted average fuel economy in the U.S., which would almost certainly be higher than the present average fuel economy and almost definitely would be higher than the current CAFE standard. Alternatively, NHTSA could use the observed CAFE in year 2007 as the baseline, even though the observed CAFE will likely increase in MY 2008-2010. Either one would improve NHTSA's benefit-cost analysis of the impact of the proposed rule.

2. NHTSA should consider the possible safety consequences of adding fuel-economizing technologies to vehicle models.

3. NHTSA should estimate the marginal cost of the congestion component of the rebound effect in a manner that reflects likely increasing marginal cost as total congestion increases.

This analysis also proposes the following alternatives or modifications to the rule.

B. Proposal 1: No Frontloading

NHTSA proposes making the largest changes in average CAFE standards in the first model year, MY 2011; subsequent changes diminish in percentage terms as the MY approaches 2020. Frontloading creates a risk of technological lock-in, and it is possible that this could result in the widespread adoption of an inherently inferior technology.

Rather than frontload the series of changes to the CAFE standard, NHTSA should consider the following alternatives:

1. Backloaded Changes

Manufacturers are already exploring alternative fuel vehicles and in some locations investing in new infrastructure to allow for their adoption. A backloaded series of changes to the CAFE standard would assign the largest increases in the CAFE standard to the latest possible years—in this case, to model years 2019 and 2020. Increased gas prices and other market forces alone will likely be enough to make the observed CAFE continue increasing rapidly—perhaps even more rapidly than NHTSA proposed in the rule. NHTSA should only require that the largest changes in the CAFE standard occur in the last years prior to 2020; such a backloaded plan would allow manufacturers to develop alternative fuel vehicles. This would minimize the risk of technological lock-in while still meeting the requirement of 35 mpg by 2020. Furthermore, manufacturers would have incentive to invest in alternative fuel technologies (in addition to the profit incentive created by market demand for fuel economy) because they would know that the deadline for compliance with the 35 mpg CAFE standard is the year 2020.

2. Linear changes

Spreading the changes in the CAFE standard equally across the model years 2011 through 2020 would also decrease the risk of technological lock-in, although not as much as backloaded changes. Either backloaded changes or linear changes would dramatically decrease the risk of technological lock-in vis-à-vis the NPRM's frontloaded proposal.

C. Proposal 2: Alternative Fuel Vehicle Technology Development Grace Period

Under this proposal, manufacturers who are working to develop alternative fuel vehicles could be exempted from complying with the new CAFE standards until MY 2018 or even later. Rather than invest in plants that produce cars with presently existing technology, manufacturers should be allowed to choose to invest in research into other technologies to increase fuel economy. Perhaps NHTSA could allow a manufacturer to be exempt from the new standard in a given model year so long as the manufacturer invested whatever the estimated costs of compliance with the new CAFE standard would have been in alternative fuel vehicle technology. Model years 2011 through 2016 then would be an "alternative fuel vehicle technology development grace period" and manufacturers could choose to either comply with the new CAFE standards or to spend whatever those compliance costs would have been on alternative fuel vehicle technology development. NHTSA could implement policies allowing it to monitor manufacturers' alternative fuel technology investments, to ensure that manufacturers that are not complying with the new CAFE standards are instead investing in alternative fuel technologies.

D. Proposal 3: Voluntary Compliance with CAFE Standards

NHTSA could create a voluntary CAFE standards program, something like the Energy Star program. The Energy Star program allows manufacturers of many household and business products to advertise that their products are Energy Star compliant if they meet certain environmental and energy efficiency standards set by the EPA and the Department of Energy. NHTSA could adopt a similar program for the CAFE standards, under which manufacturers who comply get to market their cars as CAFE compliant. Considering the willingness to pay for acting green that seems to be prevalent in the U.S. today, marketing vehicles as CAFE compliant might be enough incentive for some manufacturers to increase average fuel economy.

These proposals are not exclusive of each other: They could easily be mixed together. For example, NHTSA could adopt a backloaded change schedule combined with an alternative fuel vehicle technology development grace period. In this particular example, manufacturers could either comply with the original frontloaded rule, or they could comply with a backloaded rule so long as they invest the amount that compliance with the frontloaded rule would have cost in alternative fuel vehicle technology.

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Appendix I
RSP Checklist

Element	Agency Approach	RSP Comments
1. Has the agency identified a significant market failure?	NHTSA identifies two market failures: the externality cost of tailpipe CO_2 emissions and the externality cost of dependence upon oil for energy. Grade: C	Although NHTSA does provide monetized estimates of these externality costs, NHTSA does not consider whether increasing gas prices and environmental awareness alone might lead to the same results as the proposed rule, without any restriction of consumer choice.
2. Has the agency identified an appropriate federal role?	The Energy Independence and Security Act of 2007 (EISA) requires that NHTSA sets national fuel economy standards equal to or in excess of 35 mpg by the year 2020. Grade: B-	NHTSA sets attribute-based fuel economy standards in years 2011 – 2015 such that the most rapid technological changes occur in the first years. NHTSA does not consider whether this “frontloading” might induce technological lock-in.
3. Has the agency examined alternative approaches	The agency considered various vehicle attributes for the EISA-required attribute-based standard and also considered alternative different average fuel economy standards. Grade: B	NHTSA considered many alternative required CAFE levels, but it did not consider any “backloaded” options. If frontloading could lead to technological lock-in, backloaded changes should be considered.
4. Does the agency attempt to maximize net benefits?	NHTSA has conducted a benefit-cost analysis of this proposed rule and several alternatives. The analysis seems rigorous, but some important details appear to have been overlooked. Grade: C	Technological lock-in has not been considered at all by NHTSA. Including it as a cost might shift the net benefits to negative. Other possible errors include attributing gas savings to the proposed rule even though consumers would likely have reaped those gas savings without a rule and including a constant marginal cost of congestion as a component of the rebound effect.

Element	Agency Approach	RSP Comments
5. Does the proposal have a strong scientific or technical basis?	The proposal includes a strong technical analysis of most of costs and benefits that NHTSA includes in its model. Grade: C	NHTSA does not include a possibly very important cost, technological lock-in, or consider ways of avoiding it.
6. Are distributional effects clearly understood?	NHTSA neglects to address the income distribution effects of the proposed rule. Grade: D-	NHTSA has performed the analysis using a 7% discount rate. As individuals like have varying individual discount rates, and low-income consumers likely have the high discount rates, the proposed rule would be particularly burdensome to them.
7. Are individual choices and property impacts understood?	The NPRM assumes that NHTSA and other government agents can correct a market failure arising from externality costs. Grade: C	The analysis does not consider whether market forces alone would achieve the same results as the proposed rule, without restricting the choice set of consumers.