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THE ECONOMIC CONSEQUENCES OF FUEL ECONOMY STANDARDS

by Julian Morris and Baruch Feigenbaum
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PART 1

INTRODUCTION

Since 1978, the National Highway Traffic Safety Administration has promulgated “corporate average fuel economy” (CAFE) standards.[1] Meanwhile, the California Air Resources Board (CARB) has, since 1990, employed its own low emission vehicle (LEV) standards, including Zero Emission Vehicle (ZEV) standards.[2] Twelve other states and the District of Columbia subsequently adopted California’s LEV standards, and nine of those adopted its ZEV standards.[3]

The original CAFE standards sought to reduce U.S. dependence on foreign oil. While that remains one accepted purpose of current standards, the rationale has now largely shifted to reductions of emissions—especially those associated with climate change.

In 2012, NHTSA and the Environmental Protection Agency (EPA) issued a joint rulemaking for CAFE and GHG emission standards covering the period 2017–2021 and describing

1 “Vehicle Fuel Efficiency (CAFE) Requirements by Year.” Alternative Fuels Data Center. U.S. Department of Energy, Sept. 2013. Web. < https://afdc.energy.gov/data/10562 > 3 Feb. 2020.

2 “Low-Emission Vehicle Program.” California Air Resources Board. *www2.arb.ca.gov*. Web. < https://ww2.arb.ca. gov/our-work/programs/low-emission-vehicle-program/about > 3 Feb. 2020.

3 Edelstein, Stephen. “Which states follows California’s emission and zero-emission vehicle rules?” *GreenCarReports.com*, Green Car Reports. 7 Mar. 2017. Web. < https://www.greencarreports.com/news/110921 7_which-states-follow-californias-emission-and-zero-emission-vehicle-rules > 3 Feb. 2020.

"augural" (i.e. intended) standards for 2022–2025.[4] In 2018, EPA and NHTSA issued a proposal for revised standards for 2021 and new standards for 2022–2025 under the auspices of the proposed Safer Affordable Fuel-Efficient Vehicles rule ("SAFE" rule).[5]

This is the fourth in a series of briefs published by Reason Foundation explaining and evaluating CAFE and ZEV standards.[6] It incorporates lessons from those briefs and other studies that consider the overall effect of CAFE standards, as well as more recent work looking at revisions to federal CAFE and GHG standards under the proposed SAFE rule.[7]

4 "2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards." *Federal Register* Vol. 77 (99) (15 Oct. 2012). 62624-63200. Web. < https://www.gov info.gov/content/pkg/FR-2012-10-15/pdf/2012-21972.pdf > 3 Feb. 2020.

5 "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks." *Federal Register* Vol. 83 (165) (24 Aug. 2018). 42986-43500. Web. < https://www.federalregis ter.gov/documents/2018/08/24/2018-16820/the-safer-affordable-fuel-efficient-safe-vehicles-rule-for-model-years-2021-2026-passenger-cars-and > 3 Feb. 2020,

On September 19, 2019, the EPA and NHTSA issued a final rule relating only to the withdrawal of EPA's waiver for California and federal pre-emption of NHTSA's rule. See: 49 CFR Parts 531 and 533. https://www.epa.gov/sites/production/files/2019-09/documents/safe-vehicles-fr-part1-2019-09-19.pdf.

6 Feigenbaum, Baruch and Julian Morris. *CAFE Standards in Plain English*. Reason Foundation, 2017. Web. < https://reason.org/wp-content/uploads/2017/01/pb137_cafe_standards.pdf > 3 Feb. 2020.

Morris, Julian. *The Effect of Corporate Average Fuel Economy Standards on Consumers*. Reason Foundation, 2018. Web. < https://reason.org/wp-content/uploads/2018/03/corporate-average-fuel-economy-standards-consumers.pdf > 3 Feb. 2020.

7 In particular, it draws heavily on this author's comment on the SAFE NPRM; Morris, Julian. *Public Interest Comment on The National Highway Traffic Safety Administration and The Environmental Protection Agency Proposed Rule The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks Docket ID Nos. EPA-HQ-OAR-2018-0283 and NHTSA-2018-0067 RIN: 2060-AU09 and 2127-AL76*. The George Washington University Regulatory Studies Center, October 25, 2018. Web. < https://reg ulatorystudies.columbian.gwu.edu/sites/g/files/zaxdzs1866/f/downloads/GW%20Reg %20Studies%20-%20SAFE %20Vehicles%20Rule%20-%20Public%20Interest%20Comment%20-%20Julian%20Morris.pdf > 3 Feb. 2020.

PART 2

COMPETITION, CHOICE, INNOVATION AND FUEL ECONOMY STANDARDS

Competition motivates automobile manufacturers to improve their vehicles incrementally so that they better meet consumer preferences. Among other things, this has led to consistent improvements in engine performance and efficiency. But fuel economy per se, as contrasted with engine performance, has rarely been the only or even main goal of manufacturers; power, safety, and comfort have always been important considerations—because these are things that consumers value. Fuel economy standards distort this process by mandating that manufacturers achieve minimum fleetwide goals for fuel economy regardless of consumer preferences. Since they were first introduced in 1978, CAFE standards have likely contributed to increases in the fuel efficiency of vehicles in the U.S. But the extent of this effect is difficult to determine because it is impossible to know precisely what would have developed in the absence of such standards.

Rising fuel prices during the 1970s and early 1980s resulted in increased demand for and supply of vehicles that were more fuel-efficient than required under the CAFE standards of the day.[8] However, the subsequent decline in fuel prices, combined with rising incomes and

8 Crandall, Robert W. "Policy Watch: Corporate Average Fuel Economy Standards." *Journal of Economic Perspectives* Vol. 6 (2) (Spring 1992), 171-180. Print.

changing tastes, led to increased demand for larger, more powerful vehicles.[9] This effect was exaggerated by the lower CAFE-mandated fuel economy requirements imposed on vehicles classified as "light trucks." Under the CAFE standards of the 1970s and 1980s, "light duty vehicles" (all vehicles with a gross vehicle weight rating up to 8,500 pounds)[10] were segmented into "passenger cars" (vehicles designed specifically for the transportation of 10 or fewer passengers) and "light trucks" (vehicles that could be classified as "non-passenger vehicles" by meeting the criteria).[11] Manufacturers developed numerous consumer-oriented vehicles, including SUVs, minivans and luxury pickups that fell into the category of "light truck". Because of the less onerous fuel economy requirements for such vehicles, they were relatively less expensive (per pound of vehicle) than passenger cars.[12]

In general, the effect of fuel economy standards very much depends on how manufacturers and consumers respond to them. By requiring manufacturers to produce fleets of vehicles with, on average, higher fuel economy than would otherwise be the case, fuel economy standards impose costs on manufacturers, which must invest in the development and implementation of technologies that are able to deliver fuel economy improvements. These additional costs are passed on to consumers through increases in the price of new vehicles.

"*...the requirement to invest in fuel economy improvements may lead manufacturers to reduce their investments in some other kinds of vehicle improvements...*"

Sivak, Michael and Omer Tsimhoni. "Fuel efficiency of vehicles on US roads 1923-2006." *Energy Policy* Vol. 37 (8) (2009). 3168-3170. Print.

9 "The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax." Congressional Budget Office. *CBO.gov*. Dec. 2003. Web. < https://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/49xx/doc4917/12-24-03_cafe.pdf > 3 Feb. 2020.

10 Gross vehicle weight rating (GWVR) is the weight of a vehicle when fully laden. Until 1980, CAFE only applied to vehicles with a GWVR up to 6,000 lbs.

11 The criteria for being designated a "non-passenger vehicle" are set out in 49 CFR 523.5; "49 CFR § 523.5 – Non-passenger automobile." *Law.Cornell.edu*, Legal Information Institute. Web. <https://www.law.cornell.edu/ cfr/text/49/523.5> 3 Feb. 2020.

12 BenDor, Todd K. "The System Dynamics of U.S. Automobile Fuel Economy." *Sustainability*. Vol. 4 (2012). 1013-42. Print; Sivak, "Fuel efficiency of vehicles on US roads." 3168-3170.

In addition, the requirement to invest in fuel economy improvements may lead manufacturers to reduce their investments in some other kinds of vehicle improvements, either due to capital constraints or in order to keep down the final purchase price of vehicles, or both. Examples of such forgone investment might include: safety enhancements, improvements in comfort, and investments in the development of connected and autonomous vehicles.

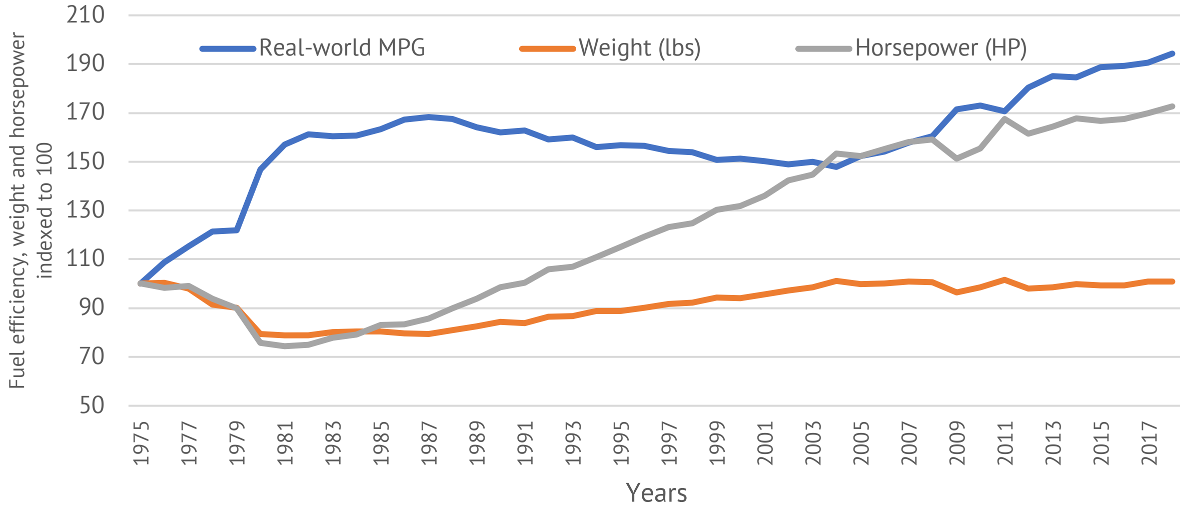
While it is impossible to know precisely what tradeoffs manufacturers might make in the future, it is possible to look at what they did historically and contrast that with what they might have attempted in the absence of CAFE standards. In a 2011 paper published in the *American Economic Review*, Christian Knittel considered the trade-offs manufacturers made between vehicle power and comfort on the one hand and fuel economy on the other. He noted that:

> *From 1980 to 2004 the average fuel economy of the US new passenger automobile fleet increased by less than 6.5 percent. During this time, the average horsepower of new passenger cars increased by 80 percent, while the average curb weight increased by 12 percent. Changes in light-duty trucks have been even more pronounced. Average horsepower increased by 99 percent and average weight increased by 26 percent from 1984 to 2004.*

Knittel found that "if weight, horsepower, and torque were held at their 1980 levels, fuel economy for both passenger cars and light trucks could have increased by nearly 60 percent from 1980 to 2006. This is in stark contrast to the 15 percent by which fuel economy actually increased." The fact that manufacturers chose to invest resources in improvements in power and comfort strongly suggests that consumers value these attributes more than they value fuel economy.

These effects can be seen in Figure 1, which shows how both weight and power increased dramatically when CAFE standards remained constant through most of the 1990s and early 2000s (see Figure 2), contributing to a decline in average real-world fuel economy. Then, as fuel economy standards began to rise again in 2005 (starting with light trucks), average weight stopped increasing and the rate of increase in power fell, while real world fuel economy began to rise once more. From the consumer's perspective, this led to an increase in the price charged for a vehicle with the specific characteristics (power, weight, safety, comfort) that they wanted.

FIGURE 1: ESTIMATED REAL-WORLD FUEL ECONOMY, HORSEPOWER AND WEIGHT SINCE MODEL YEAR 1975

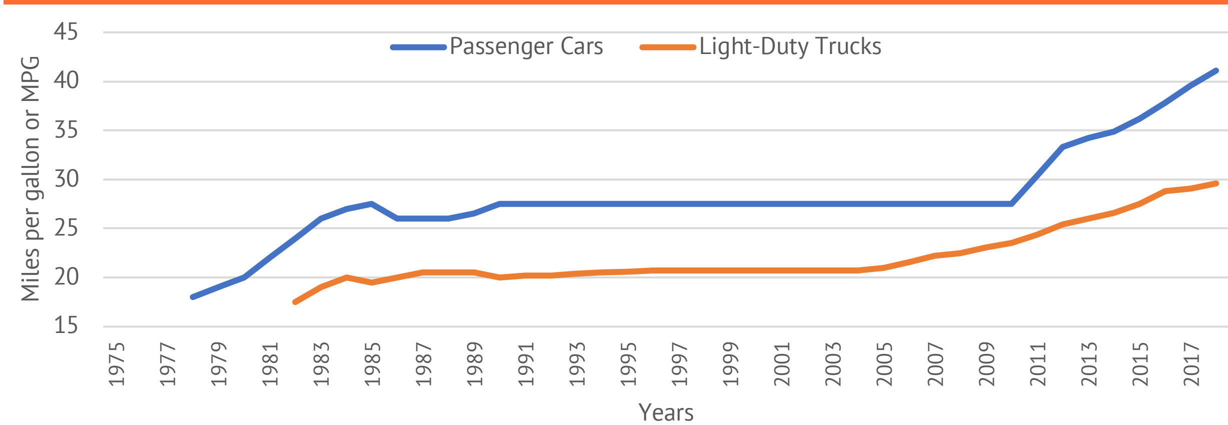


Source: Data from Environmental Protection Agency (https://www.epa.gov/automotive-trends/explore-automotive-trends-data)
NOTE: 1975 average value equals 100

Consumers may respond to increasing prices of vehicles in one of several ways, including:

1. spending more on their new vehicle with all or most of the features they desire;
2. choosing vehicles with lower specifications (e.g. less powerful, fewer advanced features);
3. deferring the purchase of a new vehicle;
4. purchasing a used vehicle instead of a new one.

FIGURE 2: CORPORATE AVERAGE FUEL ECONOMY STANDARDS



Source: Department of Energy, Alternative Fuels Data Center (https://afdc.energy.gov/data/)

2.1 THE REBOUND AND SCRAPPAGE EFFECTS

As CAFE standards have promoted fuel economy over consumer desires for power and comfort, consumers have responded in ways that were not accounted for by the proponents of the standards. Economists have identified at least two perverse effects that result from fuel economy standards: the rebound effect and the scrappage effect.

The **rebound effect** refers to the response by drivers to a reduction in the cost of driving as a result of higher fuel economy (the cost of each mile traveled is lower because their vehicles consume less gasoline). Put simply: when driving costs less, people tend to drive more—all other things being equal. This comes partly from people driving instead of using other modes of transport (bus, train, airplane, etc.) and partly from an increase in trips taken and/or trip length.

The **Scrappage—or Gruenspecht—effect** occurs when vehicle owners respond to the higher price of new vehicles resulting from mandated fuel efficiency increases by keeping existing vehicles longer. This phenomenon decreases the supply of used vehicles, raising their price and reducing the rate at which they are scrapped.[13] Moreover, because fleet-based fuel economy standards incentivize manufacturers to produce fewer gas guzzlers (i.e., vehicles with larger, more powerful engines), demand for used gas guzzlers rises disproportionately—and scrappage rates of such vehicles therefore fall disproportionately.[14]

Estimates of the economic consequences of fuel economy standards have been affected by the assumed extent of these two effects. For example, in their 2016 draft Technical Assessment Report (hereinafter, "draft TAR"), NHTSA, EPA and the California Air Resources Board (CARB) used a rebound effect of 10%.[15] This low value was used in spite of ample evidence from a wide range of studies that estimated much higher rebound effects. In the Preliminary Regulatory Impact Analysis (PRIA) for the proposed SAFE rule, NHTSA undertook a more comprehensive review of available studies and concluded that a rebound

13 Gruenspecht, Howard K. "Differentiated Regulation: The Case of Auto Emissions Standards." *American Economic Review* Vol. 72 (2) (May 1982). 328–331. Print.

14 Jacobsen, Mark R. and Arthur van Benthem. "Vehicle Scrappage and Gasoline Policy." *American Economic Review* Vol. 105 (3) (Mar. 2015). 1312–1338. Print.

15 "Notice of Availability of Midterm Evaluation Draft Technical Assessment Report for Model Year 2022-2025 Light Duty Vehicle GHG Emissions and CAFE Standards." *Federal Register* Vol. 81 (144) (27 Jul. 2016). 49217-49220. Web. <https://www.federalregister.gov/citation/81-FR-49217 > 3 Feb. 2020.

effect of 20% was more appropriate for use in estimating the effect of the rule and alternatives.[16] From our own review of the evidence, this seems reasonable.[17]

Even more remarkably, in the original rulemaking and in the draft TAR, the agencies chose not to include any value for the scrappage effect, arguing that it was not able to do so because it had not undertaken the necessary modeling. This led to a significant bias in the estimates of costs and benefits of the rule.[18] In its analysis of the proposed SAFE rule, NHTSA explicitly modeled the scrappage effect. By incorporating a more realistic estimate of the rebound effect and by explicitly modeling the scrappage effect in its assessment of the proposed SAFE rule, NHTSA was able to develop better assessments of the effects of different standards on fuel use, emissions and safety.

16 "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal* Register. 43104.

17 Morris, Julian and Arthur Wardle. "CAFE and ZEV Standards: Environmental Effects and Alternatives." Reason Foundation, 2017. Web. < https://reason.org/wp-content/uploads/2017/08/cafe_zev_standards_environment_alter natives.pdf > 4 Feb. 2020.

18 Ibid.

PART 3

PRIVATE CONSUMER BENEFITS AND COSTS

The consequences of higher new vehicle prices are widespread, including effects on the age distribution of the vehicle cohort (the scrappage effect, discussed in Part 1) and consequent effects on vehicle-related fatalities (discussed in Part 4). The most direct effects, however, are on vehicle affordability and total cost of ownership.

3.1 CALCULATING NET PRIVATE BENEFITS

In the 2012 rulemaking, the EPA estimated that the combination of final 2017–2021 and augural 2022–2025 GHG standards would result in an increase in average new vehicle prices of $1,800.[19] Including higher lifetime maintenance and insurance costs, as well as taxes and markup, the EPA estimated the additional implied discounted cost of a 2025 vehicle would be $2,300 to $2,400 more than an equivalent 2016 vehicle.[20]

For the SAFE Notice of Proposed Rulemaking (NPRM), NHTSA estimated that the increase in average new vehicle prices attributable to those same standards would be slightly higher,

19 "2017 and Later Model Year Light-Duty Vehicle." *Federal Register*, 62633.

20 Ibid. 62775.

$2,100, resulting in a discounted lifetime increase in costs of $2,700 for new vehicles purchased in 2025 relative to those purchased in 2016.[21]

In their 2012 rulemaking for the 2017–2021 standards and 2022–2025 augural standards, NHTSA and EPA found that in spite of the higher costs of buying, insuring and maintaining new vehicles sold by manufacturers subject to the escalating CAFE standards, consumers would obtain substantial net benefits.[22] The bulk of those alleged net benefits arose from a presumption that consumers do not fully incorporate savings from higher fuel economy when making vehicle purchasing decisions. Thus, according to the earlier analysis by NHTSA and EPA, consumers were essentially leaving dollars on the table by choosing vehicles that were less efficient than those they would have chosen had they fully included the lower fuel expenditures available from such vehicles.

> *In the 2012 rulemaking, the EPA estimated that the combination of final 2017-2021 and augural 2022-2025 GHG standards would result in an increase in average new vehicle prices of $1,800.*

Both in the original rulemaking and the draft TAR, NHTSA and the EPA (and CARB in the TAR) presumed that consumers significantly undervalue the future benefits of more fuel-efficient vehicles. As a result, they were able to claim that, by mandating higher efficiency, consumers would benefit from reduced expenditures on fuel. These claims were made in spite of substantial evidence—available at the time the draft TAR was produced—that consumers do in fact take into consideration much if not all the cost savings accruing to more fuel-efficient vehicles.

21 "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal Register*, 42994.

22 "2017 and Later Model Year Light-Duty Vehicle." *Federal Register*, 62627; "Although the agencies estimate that technologies used to meet the standards will add, on average, about $1,800 to the cost of a new light duty vehicle in MY 2025, consumers who drive their MY 2025 vehicle for its entire lifetime will save, on average, $5,700 to $7,400 (7% and 3% discount rates, respectively) in fuel, for a net lifetime savings of $3,400 to $5,000."

In a 2013 paper published in the *American Economic Review*, Meghan Busse, Christian Knitttel and Florian Zettelmeyer investigated the effect of a change in the price of gasoline on prices of and demand for new and used cars with different fuel economy ratings.[23] They found that a $1 per gallon change in gas prices increased the differential between the highest and lowest fuel economy quartiles of used cars by $1,945. For new cars, the effect on price differentials was smaller, at $354, however they found that when gas rose by $1 in price, the market share of the most fuel-efficient quartile rose by 21.1%, while the market share of the least fuel-efficient quartile fell by 27.1%. Based on these findings, the authors then estimated the implicit discount rates applied by vehicle purchasers to the cost of gas usage and concluded that they "correspond reasonably closely to interest rates that customers pay when they finance their car purchases." In other words, they find little evidence that consumers are selectively myopic with regard to vehicle fuel economy.

In a 2014 paper published in the *Review of Economics and Statistics*, Hunt Alcott and Nathan Wozny used data from 86 million sales of used vehicles at auto dealerships and wholesale auctions to evaluate the relationship between expected changes in gas prices (using the price of oil futures contracts as a proxy) and changes in the price of vehicles of different fuel economy. [24] They found that "vehicle prices move as if consumers are indifferent between one dollar in discounted future gas costs and only 76 cents in vehicle purchase price." In other words, consumers seem to show mild myopia regarding the prospective savings from purchasing more fuel-efficient vehicles.

However, the authors found that most of this myopia was a result of consumers who purchased much older vehicles. As they note: "We show that the result that consumers undervalue gas costs is largely driven by older vehicles: prices for vehicles aged 11–15 years appear to be highly insensitive to gasoline prices, while prices for relatively-new used vehicles move much more closely to the theoretical prediction." (The "theoretical prediction" being that prices of vehicles would move one-to-one with the present discounted cost of future gas purchases.) This is not surprising, for two reasons: first, there are far fewer vehicles older than 10 years on the road, so consumers would be less able to make direct comparisons between such vehicles based on fuel economy. Second, purchasers of older vehicles are more likely to face financial constraints that effectively raise their discount rate above the 6% rate assumed by the authors: for lower-income

[23] Busse, Meghan R., Christopher R. Knittel, and Florian Zettelmeyer. "Are Consumers Myopic? Evidence from New and Used Car Purchases." *American Economic Review* Vol. 103(1) (2013). 220–256. Print.

[24] Allcott, Hunt and Nathan Wozny. "Gasoline prices, fuel economy, and the energy paradox." *Review of Economics and Statistics* Vol. 96 (5) (2014). 779–795. Print.

consumers, low-cost car loans may not be available, so the relevant discount rate would be the cost of financing using a credit card or other higher-cost form of financing, such as a payday loan.

In a 2016 paper published in the *Journal of Public Economics*, James Sallee, Sarah West and Wei Fan used data from wholesale used car auctions, comparing prices of vehicles of identical types and vintages but different mileage (and hence different life expectancies), at various points in time. This enabled the authors to evaluate the effects of changes in gas prices on the sale prices of vehicles with different fuel economy characteristics. The authors conclude, “Our data suggest that used automobile prices move one for one with changes in present discounted future fuel costs, which implies that consumers fully value fuel economy.”

“*...there is little reason to believe that the majority of consumers are myopic when it comes to evaluating the relative costs of future gasoline expenditures.*”

Based on these carefully constructed studies, there is little reason to believe that the majority of consumers are myopic when it comes to evaluating the relative costs of future gasoline expenditures. In their midterm review, the agencies acknowledge the conclusions of these studies and note: “Thus, consumers appear to take fuel economy into account when buying vehicles, but how precisely they do it is not yet clear.”[25] But the agencies then went on to cite an analysis of surveys referenced in a National Academy of Sciences report, which found that “consumer willingness to pay for fuel savings implies average payback periods of 2-3 years.”[26] However, this survey evidence is at odds with the studies cited earlier, which indicate that consumers apply similar discount rates—and hence payback

25 “Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025.” U.S. Environmental Protection Agency, California Air Resources Board and the National Highway Traffic Safety Administration. *NEPIS.EPA.gov*. Jul. 2016. Section 6-7. Web. < https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey =P100OXEO.PDF > 4 Feb. 2020.

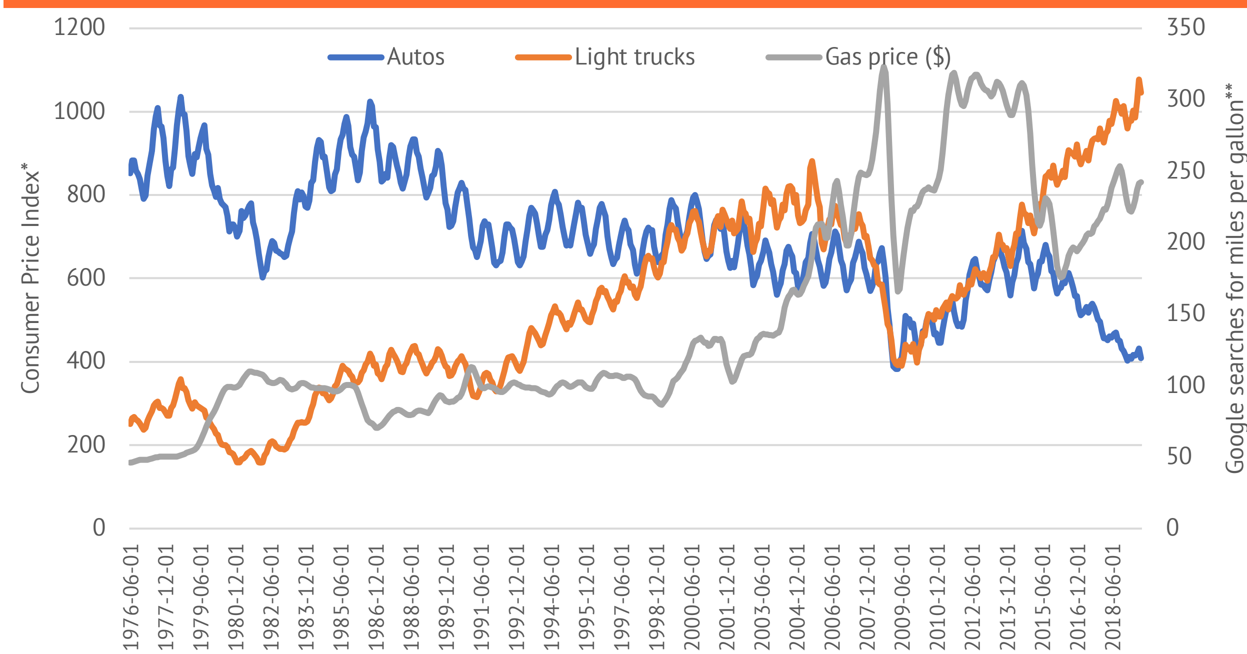
26 Ibid.

periods—to vehicle purchases and fuel savings. It is unclear why the agencies would choose to give prominence to these surveys, which are based on stated preferences, i.e. what people *say* they are willing to pay, and are thus less reliable and relevant than the other studies described above (i.e. Busse et al, Alcott and Wozny, and Sallee et al), which relied on revealed preferences, i.e. what consumers are *actually* willing to pay.

In its SAFE Proposed Regulatory Impact Analysis (PRIA), NHTSA reviews these newer studies and concludes that they “call into question any analysis that claims to show large private net benefits for vehicle buyers.”[27]

In addition to these empirical studies, an analysis of Google Trend data suggests that consumer interest in fuel economy is strongly related to gas prices, as can be seen in Figure 3.

FIGURE 3: RELATIONSHIP BETWEEN GAS PRICES (CPI, LEFT AXIS) AND GOOGLE SEARCHES FOR “MPG” (RIGHT AXIS)



Source: FRED (https://fred.stlouisfed.org/series/CUUR0000SETB01) and Google Trends (https:/ /trends.google.com/trends/explore?date=all&geo=US&q=MPG)
*** 1982–1984 average price equals 100. **0-100 indicates popularity of search term**

27 “Preliminary Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021-2026 Passenger Cars and Light Trucks.” National Highway Traffic Safety Administration and the U.S. Environmental Protection Agency. *NHTSA.gov*. 23 Aug. 2018. Section 8.3.3, p. 939. Web. < https://www.nh tsa.gov/sites/nhtsa.dot.gov/files/documents/ld-cafe-co2-nhtsa-2127-al76-epa-pria-180823.pdf > 4 Feb. 2020.

Given the evidence that consumers tend to take into account the discounted value of future fuel expenditures—especially when buying newer vehicles—it is appropriate to assume that buyers choose vehicles based on their expected total cost of ownership, including the full discounted costs of future fuel expenditures. Thus, the net private costs or benefits of the rule can be calculated based on a comparison of the total costs of ownership with and without the rule.

3.2 COMPARING THE EFFECTS OF THE SAFE RULE WITH PREVIOUSLY ANNOUNCED CAFE STANDARDS

Using various simplifying assumptions, it is possible to make a quick back-of-the-envelope calculation of the likely net effects of the changes to fuel economy standards under the proposed SAFE rule. We will compare two vehicles: one, A, meets the new mandated fleet average fuel economy for light duty vehicles (LDVs) (i.e., averaging across vehicle types subject to the rule) under the proposed SAFE rule of 37 mpg in 2025; the other, B, meets the minimum fuel economy for LDVs implied by the augural standards for 2025 of 49.7 mpg in 2025. We further assume that A is driven for 12,000 miles (about average).[28] However, we assume that the driver of B responds to the reduction in cost per mile of gas usage by using some of the gasoline "saved" to drive more (the rebound effect described above).

We look at three different scenarios:

1. Scenario #1: Gas costs $3/gallon, the rebound effect is 20% (i.e. an additional 824 miles/year), and the discount rate is 6%
2. Scenario #2: Gas costs $4/gallon, the rebound effect is 20% (i.e. an additional 824 miles/year), and the discount rate is 5%
3. Scenario #3: Gas costs $4/gallon, the rebound effect is 10% (i.e. an additional 412 miles/year), and the discount rate is 4%

In each scenario, "discount rate" refers to the rate at which the consumer discounts the future. The presumption is that all consumers prefer money now to money in the future. The discount rate can be seen as the rate at which a consumer would have to be

28 "U.S. households with more vehicles travel more but use additional vehicles less." U.S. Energy Information Administration. *EIA.gov*. 7 Jun. 2018. Web. < https://www.eia.gov/todayinenergy/detail.php?id=36414 > 4 Feb. 2020.

compensated for forgoing income today. Thus, at a 6% discount rate, a consumer is willing to forgo $100 today in return for $106 in a year's time.

Under Scenario 1, even if a consumer were to use the vehicle for 12 years, the net present value (NPV) of savings in gas expenditure in 2025 from car B over car A is only $1,737. (The NPV of such savings over a more typical six-year period would be $1,028.)

In Scenario 2, the NPV of savings in gas expenditure in 2025 is $2,438 over 12 years ($1,405 over six years).

In Scenario 3, the NPV of savings in gas expenditure in 2025 is $2,889 over 12 years ($1,620 over six years).

If our archetypal vehicles roughly approximate the average vehicle discussed in the SAFE rule, then we can assume that the total incremental NPV of non-fuel purchase and operating costs of vehicle B in 2025 would be $2,700 greater than vehicle A.

Another factor that affects total cost of ownership is the NPV of the vehicle when sold or exchanged. It might seem reasonable to assume that the resale value of B would be higher than A. But that might not be the case. Using Kelly Blue Book's online tool, I calculated the difference in value between a 12-year-old (2007 model) Toyota Camry XLE (4 cylinder, 2.4 L, 5 speed automatic transmission; rated 24 mpg combined) in good condition with 70,000 miles and a similar 12-year-old Camry Hybrid with 70,000 miles (so, not taking account of additional miles that would likely have been driven due to the rebound effect). The Kelly Blue Book trade-in value for the 12-year-old Camry XLE was estimated at $4,259,[29] while the Camry Hybrid was estimated at $3,595.[30] Even if the resale value of B were higher than that of A, it seems unlikely to be *much* higher, especially on older vehicles.

29 "Used 2007 Toyota Camry XLE Sedan 4D: Pricing." Kelley Blue Book (Aug.2018). Web. < https://www.kbb. com/toyota/camry/2007/xle-sedan-4d/ > Aug. 2018.

30 "Used 2007 Toyota Camry Hybrid Sedan 4D: Pricing." Kelley Blue Book (Aug.2018). Web. < https://www.kbb. com/toyota/camry/2007/hybrid-sedan-4d/?intent=buy-used&mileage=137457&pricetype=retail&condition=good &persistedcondition=good > Aug. 2018.

TABLE 1: CUMULATIVE EFFECTS OF PREVIOUSLY ANNOUNCED (AUGURAL) CAFE STANDARDS ON THE PURCHASER OF A TYPICAL LIGHT DUTY VEHICLE IN 2025

Scenario	**1**	**2**	**3**
Total miles traveled/year	12,824	12,824	12,412
Fuel used (gallons)/year	258	258	250
Price of fuel/gallon	$3	$4	$4
Discount rate	6%	5%	4%
Net benefit (loss) over 6 years	-$1,672	-$1,295	-$1,080
Net benefit (loss) over 12 years	-$963	-$262	$189

Thus, as can be seen in Table 1, in Scenario 1, the typical consumer almost certainly suffers a substantial financial loss by purchasing vehicle B instead of vehicle A. In Scenario 2, the typical consumer also very likely suffers a financial loss by purchasing B rather than A, although the loss would be less than in Scenario 1. Only in Scenario 3 would a typical consumer be better off purchasing B over A—and then only marginally so and only if the consumer keeps the vehicle for 12 years. Since the assumptions underlying Scenario 3 are arguably the least plausible, it seems fair to conclude that there would be substantial consumer welfare gains arising from keeping the mandated fuel economy at the level set for 2020 rather than increasing it.

Indeed, if Scenario 1 is broadly accurate, and new vehicle sales remain at around 17 million per year, and if we take a six-year time horizon, the consumer welfare gains from the SAFE rule would be over $28 billion from 2025 new vehicle sales alone.

Of course, this analysis is inherently simplistic. Nonetheless, it provides a quick gut-check to NHTSA's more sophisticated analysis, which comes to similar conclusions. In any event, a proper respect for consumers' judgment of their own preferences leads to the conclusion that the SAFE rule must necessarily improve consumer welfare.[31]

In addition, by reducing prices of new vehicles relative to the prices under the augural standards, the proposed SAFE standard would increase effective demand for new vehicles,

[31] Mannix, Brian and Susan Dudley. "The Limits of Irrationality as a Rationale for Regulation." *Journal of Policy Analysis and Management* Vol. 34, (3) (May 2015). Print; Mannix, Brian and Susan Dudley. "Please Don't Regulate my Internalities." *Journal of Policy Analysis and Management* Vol. 34 (3) (May 2015). Print.

reduce demand for older vehicles and, as discussed below, increase scrappage rates. Of particular relevance in terms of consumer welfare, the reduced demand for older vehicles will result in lower prices of such vehicles, which will especially benefit lower income consumers. Thus, SAFE is effectively progressive in the distribution of its benefits.

3.3 THE VALUE OF ATTRIBUTES OTHER THAN FUEL ECONOMY

One challenge for estimating the consumer welfare effects of CAFE standards in this way is that consumers do not make vehicle purchasing decisions *only* on the basis of the total cost of ownership. They also value attributes such as acceleration, size, comfort and safety. As noted above, when manufacturers are forced to increase vehicle fleet fuel economy, they likely reduce investment in improvements to other vehicle features, thereby harming consumers who might have purchased vehicles with those desirable attributes. However, attempting to disaggregate these effects in order to calculate net private costs and benefits is practically impossible. Nonetheless, it is reasonable to assume that less onerous fuel economy and GHG emission rules would lead manufacturers to invest more in other vehicle attributes that consumers want to buy, so the above estimates reflect a lower bound on the potential benefits to consumers of the SAFE rule relative to the augural standards.

3.4 EFFECTS ON INNOVATION

Another related effect of CAFE standards that is practically impossible to estimate is the consequence of resources diverted away from the development of innovative technologies, such as automation. Such technologies offer potentially enormous benefits, ranging from reductions in collisions to improved productivity. While it is likely that resources expended on compliance with CAFE standards reduce the amount of capital available to spend on such innovations, it is not possible to know with any degree of precision the extent of this effect or its consequences for consumers.

PART 4

ROAD SAFETY

An important component to any benefit-cost analysis relating to the regulation of automobiles is the effect on safety. This has been long recognized by NHTSA and upheld by the courts.[32] The EPA has likewise long incorporated the effects of its rules on safety.[33]

An ongoing debate in academic circles concerns the effects of fuel economy standards on fatalities. Early studies suggested that by incentivizing manufacturers to produce lighter weight vehicles, CAFE standards resulted in an increase in mortality—because lighter vehicles generally provide less protection during crashes, especially when they collide with heavier vehicles.[34]

Some more-recent studies have questioned whether this effect has continued. One recent study even suggested that CAFE standards *reduced* fatalities over the period 1989–2005, finding that reductions in mean vehicle weight (which reduces fatality) outweighed the effect of increased weight dispersion (which increases fatalities).[35]

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32 *Competitive Enterprise Institute* v. *NHTSA,* 901 F.2d 107, 120 n. 11 (D.C. Cir. 1990), *Competitive Enterprise Institute* v. *NHTSA,* 956 F.2d 321, 322 (D.C. Cir. 1992).

33 "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal Register*. 43231.

34 Crandall, Robert W. and John D. Graham. "The Effect of Fuel Economy on Auto Safety." *The Journal of Law & Economics* 32(1) (1989) 97–118. Print.

35 Bento, Antonio, Kenneth Gillingham, and Kevin Roth. "The Effect of Fuel Economy Standards on Vehicle Weight Dispersion and Accident Fatalities." The National Bureau of Economic Research. *NBER.org*. Apr. 2017. Web. < https://www.nber.org/papers/w23340 > 6 Feb. 2020.

In the proposed SAFE rule and PRIA, NHTSA analyzed the effects of fuel economy standards on road safety in great detail. In its new analyses, NHTSA better accounts for the effects of the likely increase in the price of new vehicles, the consequent effect on scrappage, the rebound effect for consumers purchasing new, more fuel-efficient vehicles, and the new footprint-based standard that reduces the incentives to sell lighter vehicle models (as opposed to reducing the weight of existing models, while maintaining their strength). As NHTSA notes, these factors were not accounted for in the aforementioned study.[36]

In their PRIA, NHTSA and EPA find that the changes to CAFE and GHG standards in the proposed SAFE rule would substantially reduce the number of road fatalities (by as many as 12,700 in total for the CAFE rule change and 15,680 for the GHG rule change),[37] as a result of a combination of:

1. an increase in the proportion of newer vehicles on the road (since newer vehicles tend to be safer);
2. an increase in the average weight of newer cars relative to light trucks (i.e. a reduction in weight dispersion); and
3. a small reduction in the total number of vehicle-miles traveled, due to a lower rebound effect.

Unfortunately, these estimates seem to have been marred by some calculation errors. Notably, the PRIA appears to assume that lower standards would result in a reduction in vehicle sales, which is contrary to what one would expect.[38] Moreover, the sizes of the effects were subject to considerable uncertainty.[39] So the asserted magnitudes should be treated with caution. That said, the direction of the effect seems plausible. In particular, numerous studies have shown that newer vehicles are less likely to be involved in a fatal

36 "NHTSA identified factors in the analysis limiting the inference that can be drawn with respect to CAFE rulemaking going forward. The temporal range of the analysis does not include current footprint-based standards that incentivize light-weighting existing models rather than switching to lighter models. The statistical approach in the analysis does not account for the rebound effect or effects of CAFE on vehicle sales (which affect per mile fatality risk), and Bento et al. also represented annual CAFE compliance costs at a level substantially less than expected costs for model years in this rulemaking;" "Preliminary Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." NHTSA and EPA. *NHTSA.gov*. 1343.

37 "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal Register*. 42996, 43231.

38 Bento, Antonio M. et al. "Flawed analyses of U.S. auto fuel economy standards." *Science* 362(6149) (Dec. 2018) 1119-21. Web. < https://science.sciencemag.org/content/362/6419/1119 > 6 Feb. 2020.

39 Morris, *Public Interest Comment on The National Highway Traffic Safety Administration*.

crash due to technologies such as electronic stability control (ESC). Indeed, estimates suggest that ESC alone reduces the risk of a rollover by about 40% on average (more for SUVs).[40] NHTSA estimates that in 2015 ESC saved 1,949 lives—reducing road fatalities by approximately 20%.[41] Since ESC has only been fitted as standard in most models since about 2010 (and mandated since 2012),[42] a policy such as more-stringent fuel economy standards that encourages consumers to keep older vehicles on the roads effectively increases the number of rollover crashes. Conversely, a policy such as the proposed SAFE rule that would reduce the incentives to keep older vehicles on the road would have the opposite effect. So, the agencies may still be correct in concluding that any of the more-stringent alternative standards would result in higher fatalities, with the extent of those fatalities being directly proportional to the stringency of the standard.

Perhaps more important than the lower standards' short-term effects on fatalities is the chance to use those resources to invest in technologies that may reduce future collisions and fatalities. NHTSA estimates that a switch to fully autonomous vehicles, for example, could reduce fatalities by 94%.[43] Such a dramatic reduction is unlikely in the near future, not least because the switch to fully autonomous vehicles is likely to take many years. Nonetheless, in the medium term (20 to 30 years), widespread use of autonomous vehicles could plausibly be expected to reduce fatalities by perhaps 50%.

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40 MacLennan, P.A., T. Marshall, R. Griffin, M. Purcell, G. McGwin, and L.W. Rose. "Vehicle rollover risk and electronic stability control systems." *Injury Prevention* 14 (3) (Mar. 2017) 154-158. *BMJ Journal*. Web. < https://injuryprevention.bmj.com/content/14/3/154.long > 6 Feb. 2020.

41 "Estimating Lives Saved by Electronic Stability Control, 2011-2015." National Highway Traffic Safety Administration. *CrashStats.NHTSA.DOT.gov*. Mar. 2017. Web. < https://crashstats.nhtsa.dot.gov/Api/Public/V iewPublication/812391 > 5 Feb. 2020.

42 "Facts + Statistics: Highway Safety." Insurance Information Institute. Web. < https://www.iii.org/fact-statistic/facts-statistics-highway-safety > 5 Feb. 2020.

43 "Automated Driving Systems 2.0: A Vision for Safety." U.S. Department of Transportation and the National Highway Traffic Safety Administration. *NHTSA.gov*. 2017. Web. < https://www.nhtsa.gov/sites/nhtsa.dot.go v/files/documents/13069a-ads2.0_090617_v9a_tag.pdf > 5 Feb. 2020.

PART 5

ENVIRONMENTAL EFFECTS

Since their inception, fuel economy standards have sought to promote conservation of resources. However, when including the rebound and scrappage effect, the cost per barrel of oil "saved" by the current and augural CAFE standards would likely be well over $100—and could be closer to $500.[44] By lowering the mandated increase in fuel economy, the proposed SAFE rule would dramatically reduce this cost.

Moreover, as NHTSA notes in the PRIA:

> *When the U.S. becomes self-sufficient in petroleum supply—which is now anticipated to occur within a decade—the entire value of increased payments by U.S. petroleum users that results from relaxing CAFE and CO_2 standards will become a transfer within the U.S. economy.*[45]

At that point, the initial purpose of CAFE standards is entirely obviated.

44 Morris. "CAFE and ZEV Standards."

45 "Preliminary Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." NHTSA and EPA. *NHTSA.gov*. 1068.

More recently, that purpose has been extended to the reduction of harmful emissions, especially of greenhouse gases (GHGs). However, even assuming that it is desirable to increase vehicle fuel efficiency and/or reduce GHG emissions at a rate higher than would be achieved through innovation in a competitive market, fuel economy standards are a very inefficient way to achieve those goals. Numerous researchers have compared the efficiency of CAFE standards with alternatives such as higher gasoline and diesel taxes and find that taxes are far more efficient.[46] Fuel taxes incentivize consumers to buy more-efficient vehicles and thereby incentivize manufacturers to produce more-efficient vehicles in ways that match consumer preferences, rather than by seeking to comply with footprint-based fuel economy standards. By increasing the effective cost per mile traveled, fuel taxes reduce any rebound effect resulting from the purchase of more-fuel-efficient vehicles. Fuel taxes also result in higher scrappage rates for less-efficient vehicles—in other words, they reverse the negative effect created by fuel economy standards. In total, fuel economy standards such as CAFE likely cost three to four times as much to achieve similar gains in fuel economy and emissions reduction as a fuel tax.[47]

While gas taxes are clearly superior to fuel economy standards for reducing fuel use and greenhouse gas emissions, an even better alternative would be to charge drivers per mile traveled.[48] Such mileage-based user fees (MBUFs) have the advantage that prices could be

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46 "The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax." Congressional Budget Office. *CBO.gov*.

Austin, David and Terry Dinan. "Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increases in Gasoline Taxes." *Journal of Environmental Economics and Management* 50(3) (2005) 562-582. Print.

Jacobsen, Mark R. "Evaluating U.S. Fuel Economy Standards in a Model with Producer and Household Heterogeneity." *American Economic Journal: Economic Policy* 5(2) (2013) 148-87. Print.

Anderson, Soren T. and James M. Sallee. "Designing Policies to Make Cars Greener: A Review of the Literature." The National Bureau of Economic Research. *NBER.org*. May 2017. Web. < https://www.nber.org/papers/w22242 > 6 Feb. 2020.

47 Jacobsen, Mark R., Christopher R. Knittel, James M. Sallee, and Arthur A. van Benthem. "Sufficient Statistics for Imperfect Externality-Correcting Policies." Manuscript: University of California at Berkeley. Web. https://pdfs.semanticscholar.org 25 Feb. 2016. https://pdfs.semanticscholar.org/99e7/21635e6e99e43c87908c935c677255b6b4db.pdf

48 Poole, Jr., Robert W. and Adrian T. Moore. *Ten Reasons Why Per-Mile Tolling Is a Better Highway User Fee than Fuel Taxes*. Policy Brief 114. Los Angeles: Reason Foundation, 2014. Print; Fleming, D. S. *Dispelling the Myths: Toll and Fuel Tax Collection Costs in the 21st Century*. Policy Study 409. Los Angeles: Reason Foundation, 2012. Print.

DeGood, Kevin and Michael Madowitz. *Switching from a Gas Tax to a Mileage-Based User Fee: How Embracing New Technology Will Reduce Roadway Congestion, Provide Long-Term Funding, and Advance Transportation Equity*. Washington, DC: Center for American Progress, 2014. Print.

varied according to the number of vehicles on the road, or at least according to the time of day—with higher prices during peak periods. This would reduce congestion, which results in additional unnecessary fuel use and emissions. MBUFs could also vary according to the weight of vehicle, thereby more accurately accounting for the damage the vehicle causes to the road.

> *…even assuming that it is desirable to increase vehicle fuel efficiency and/or reduce GHG emissions at a rate higher than would be achieved through innovation in a competitive market, fuel economy standards are a very inefficient way to achieve those goals.*

Resources expended on improving fuel economy and reducing GHG emissions from vehicles through fuel standards—rather than more cost-effective alternatives such as fuel taxes or MBUFs—are not available for investment elsewhere. If these resources were not wasted on compliance with inefficient fuel economy standards, there would be more resources available to spend on other environmental amenities, such as improvements in local air or water quality or conservation of species. Thus, requiring manufacturers to comply with fuel economy standards, rather than using a more cost-effective alternative policy tool to achieve the same goals, likely harms the environment.

PART 6

THE EFFECTS OF FUEL ECONOMY STANDARDS ON MANUFACTURERS

As already noted, a defining feature of CAFE standards is their effects on manufacturers. These have significant economic consequences.

6.1 FUEL ECONOMY STANDARDS DISTORT MANUFACTURERS' INVESTMENT DECISIONS

Fuel economy standards effectively require many automobile manufacturers to achieve higher fleetwide average fuel economy for the vehicles they sell than would be the case in the absence of those standards. As a result, they are forced to develop and manufacture vehicles they would otherwise not produce. As already noted, it is difficult to calculate the precise consequences of this distortion on investment decisions. However, the scale of such distortions should not be underestimated. NHTSA estimated the annualized cost of implementation of the 2017-21 standards and 2022–25 augural standards at between $5.4 billion and $7.6 billion.[49]

[49] Total discounted costs were estimated to be $146.8 billion to $155.7 billion. See: "Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY 2025; Passenger Cars and Light Trucks." National Highway and Transportation Safety Administration, Office of Regulatory Analysis and

Other studies estimated much higher costs; in a review and extension of several estimates, Salim Furth and David Kreutzer of the Heritage Foundation found that the costs of meeting the new standards could range from $61.2 billion to $186.1 billion per year.[50] The higher figure would put the cost of meeting the more stringent CAFE and GHG standards at approximately 1% of U.S. GDP. NHTSA and EPA estimate that even the SAFE rule fuel economy standards would cost between $12.4 billion and $14.7 billion per year, while the SAFE rule GHG standards would cost between $13.9 billion and $16.3 billion per year.[51]

6.2 FINES IMPOSED ON MANUFACTURERS FOR NON-COMPLIANCE

In addition to the diversion of investment resources toward R&D, fuel economy standards typically result in many manufacturers forfeiting sums to the federal government for non-compliance. CAFE standards are based on the average fuel economy for each manufacturer's fleet. Manufacturers typically produce a range of vehicles of differing fuel economy, some of which do not meet the CAFE standards. Until 2011, if a manufacturer was unable to persuade consumers to buy a sufficient proportion of high fuel economy vehicles from their fleetwide sales, they were required to pay a fine in proportion to the number of vehicles sold in breach of the standards. Since 2011, manufacturers have had the option of being able to purchase credits from manufacturers who exceeded the standards, or to use their own credits earned in previous years. Manufacturers unable to use or procure sufficient credits must pay a fine.

In 2016, NHTSA issued an interim final rule that would increase the penalty for each non-compliant vehicle sold from $5.50 to $14.[52] In March 2018, NHTSA proposed to retain the existing fine of $5.50.[53] While the credit trading system has reduced the burden of

Evaluation, National Center for Statistics and Analysis. *NHTSA.gov*. Aug. 2012. Web. < https://www.nhtsa.g ov/sites/nhtsa.dot.gov/files/fria_2017-2025.pdf > 7 Feb. 2020.

50 Furth, Salim and David W. Kreutzer. *Fuel Economy Standards are a Costly Mistake*. Backgrounder No. 3096. Washington DC: Heritage Foundation, 2016. Print.

51 "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal Register*. 42998.

52 "Civil Penalties: Interim final rule." *Federal Register* Vol. 49 (578) (5 Jul. 2016). 43524. Web. < https://www.fed eralregister.gov/documents/2016/07/05/2016-15800/civil-penalties > 7 Feb. 2020.

53 "49 CFR Part 578, Docket No. NHTSA-2018-0017, RIN 2121-AL94, Civil Penalties." National highway Traffic Safety Administration. *NHTSA.gov*. 2018. Web. < https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/npr m_cafe-fines-03262018_0.pdf > 7 Feb, 2020.

compliance with CAFE standards, NHTSA notes that this burden is likely to increase in coming years:

> *Prior to trading and transferring, on average, manufacturers paid $29,075,899 in civil penalty payments annually (a total of $814,125,176 from model years 1982 to 2010). Since trading and transferring, manufacturers now pay an annual average of $15,260,480 each model year. The agency notes that five manufacturers have paid civil penalties since 2011 totaling $76,302,402, and no civil penalty payments were made in 2015. However, over the next several years, as stringency increases, manufacturers are expected to have challenges with CAFE standard compliance.*[54]

The reason manufacturers will have 'challenges with CAFE standard compliance' is simple: the more stringent standards make it increasingly difficult for manufacturers to produce vehicles that consumers actually want to buy at a price they can afford.

The reason manufacturers will have "challenges with CAFE standard compliance" is simple: the more stringent standards make it increasingly difficult for manufacturers to produce vehicles that consumers actually want to buy at a price they can afford. As a result, more manufacturers will fail to meet the standards—because they are producing vehicles that people *do* want to buy. And, with fewer credits available (because most manufacturers will not be in compliance), they will pay higher fines. Indeed, a few months after NHTSA made this statement, in December 2018, Fiat-Chrysler alone paid a penalty of over $77 million for breaching standards on its domestic passenger car fleet in 2016.[55] That's more than all the fines paid by all manufacturers between 2011 and 2015.

[54] "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal Register*. 43451.

[55] "CAFE Public Information Center: Civil Penalties Live." National Highway Traffic Safety Administration. *One.NHTSA.gov*. Web. < https://one.nhtsa.gov/cafe_pic/CAFE_PIC_Fines_LIVE.html > 7 Feb. 2020; this was not included in the SAFE PRIA because it happened after that was produced.

The SAFE NPRM finds that manufacturers would avoid fines totaling $2.1 billion (discounted at 7%) relative to the fines that would have been incurred under the 2021 standard and 2022–2025 augural standards.[56] Recent studies indicate that is likely close to the correct figure. Zielinski et al. modeled the effects of implementing the original 2017–2025 standards and found that over time it would become increasingly difficult for manufacturers to comply with the standards, as the introduction of new fuel-saving technologies would become increasingly costly, raising the price of new vehicles and reducing demand for the most fuel-efficient vehicles.[57] As a result, the authors estimated that vehicle manufacturers would incur increasingly large fines. As can be in Figure 4, the fines paid would accelerate rapidly after 2020. By 2025, they estimated that the annual cost of fines could reach $700 million. This would be a truly perverse outcome: not only would the proportion of vehicles meeting CAFE standards fall, but manufacturers would effectively divert hundreds of millions of dollars to paying fines rather than investing those resources in developing better vehicles.

If Zielinski et al's estimates are within the ballpark, application of the current standards for 2020 and augural standards for 2021–2025 would have imposed on manufacturers a double whammy: in addition to the billions of dollars diverted to developing vehicles that are more fuel-efficient than consumers want, billions of dollars would be diverted to the payment of fines. As a result, vehicle manufacturers would have fewer resources available to invest in research and development of new vehicles. This would particularly harm domestic manufacturers, whose domestic market share is much higher than their international market share.[58]

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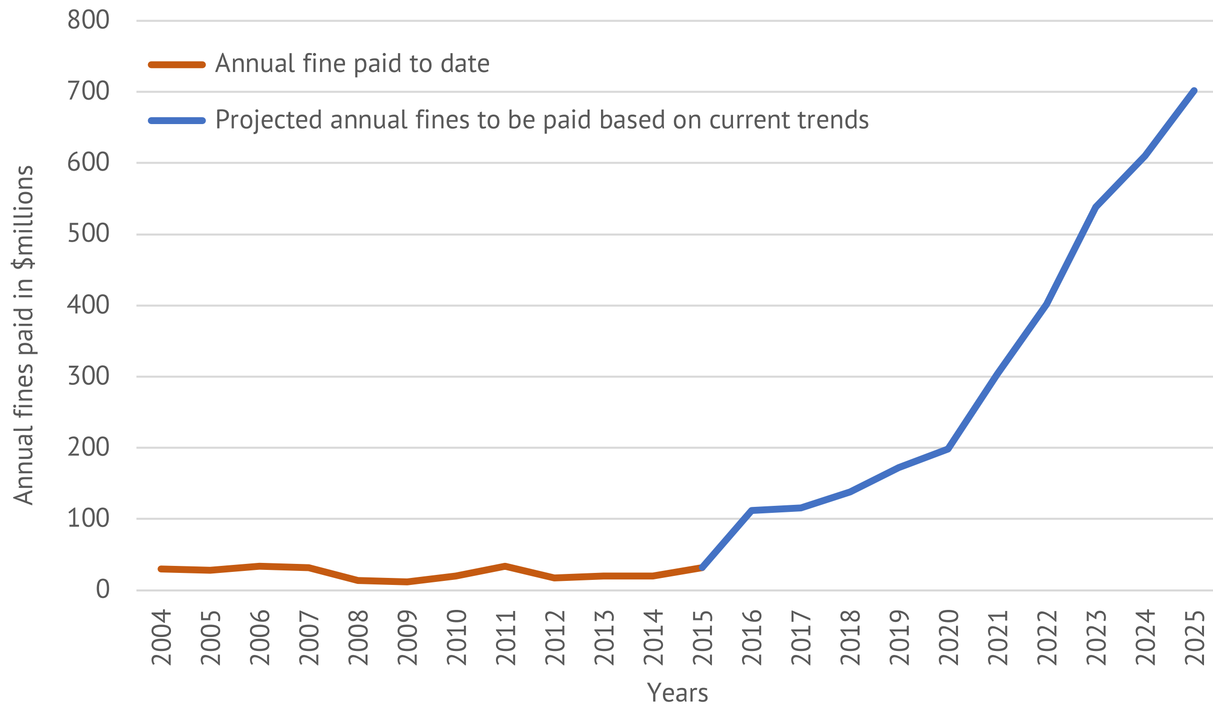
56 "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal Register*. 43064. See Table II-26; while it is not clear from the summary model outputs, this is presumably the majority of the assumed future civil penalties that would have been imposed.

57 Zielinski, Jessica, Rebecca Andreucci, Neethi Rajagopalan, and Can B. Aktasa. "Prospects for meeting the corporate average fuel economy standards in the U.S." *Resources, Conservation and Recycling* 136 (Sept. 2018) 466–472. Print.

58 According to Statista.com, GM and Ford have over 30% of the domestic U.S. auto market but only 11% of the global market. "Estimated U.S. market share held by selected automotive manufacturers in 2019." *Statista.com*, Statista. Web. < https://www.statista.com/statistics/249375/us-market-share-of-selected-automobile-manufacturers/ > 7 Feb. 2020.

"Global automotive market share in 2019, by brand." *Statista.com*, Statista. Web. < https://www.statista.com/statistics/316786/global-market-share-of-the-leading-automakers/ > 7 Feb. 2020.

FIGURE 4: PROJECTED FINES



Source: Zielinski et al. "Prospects for meeting the corporate average fuel economy standards in the U.S."

By contrast, the proposed amendment to the CAFE standards for MY 2021 and the proposed standards for MY 2022–2026, combined with the proposal to keep the per-vehicle fine at $5.50 rather than increase it to $14, would likely result in significantly lower compliance costs. Indeed, it is likely that compliance costs would fall after 2020, as continued innovation and better understanding of actual demand for vehicles with varied emission characteristics enables manufacturers better to adapt to the CAFE standards with minimal penalties. This alone could save auto makers billions of dollars—much of which will be passed on to consumers in the form of better and less expensive vehicles.

PART 7

CONCLUSION: OVERALL ECONOMIC EFFECTS OF THE SAFE RULE

Fuel economy standards undoubtedly result in harmful distortions to markets, undermining choice and competition and leading overall to a reduction in beneficial innovation and economic growth. To the extent that reductions of various emissions (such as NOx and CO_2) are desirable, there are more economically efficient ways to achieve these reductions, such as taxes and, even better, mileage-based user fees (MBUFs).

In terms of its effects on the economy, the SAFE rule thus represents a substantial improvement over the existing CAFE and GHG emission standards for MY 2017–2021 and an enormous improvement over the augural standards for 2022–2025. The rule will likely save consumers and manufacturers tens if not hundreds of billions of dollars, freeing up resources to be spent on innovation that will increase rates of economic growth and result in vehicles that consumers actually prefer.

Looking to the future, it seems likely that vehicle fuel economy will increase even without fuel economy standards, as vehicle manufacturers implement cost-effective improvements and respond to the felt needs of consumers, especially in the face of gas prices that are generally higher than during the late 1980s and 1990s. In a study published in 2017, Kenneth Small used an adapted version of the National Energy Modeling System to estimate that if NHTSA and EPA were to leave the average CAFE requirement for light duty vehicles (LDVs) at 33.7 mpg, the average fuel economy for new cars would rise from 36.7 mpg in 2015 to 41.7 mpg in 2025, while the fuel economy of new light trucks would rise from 27.3 mpg to 35.6 mpg over the same period.[59] In other words, average fuel economy for new LDVs would rise to 38.9 mpg (this is about 2 mpg *more* than the mandated increase in fuel economy under the proposed SAFE rule). Small assumed that the price of a gallon of gasoline would rise to $3.58 by 2025, which is lower than the $3.78 assumed by NHTSA and EPA in their 2012 rulemaking but higher than the $2.93 assumed in the SAFE rulemaking.[60]

TABLE 2: POLICY RESULTS: BASE SCENARIO

	Base Case		
	2015	2025	2035
Inputs			
• Gasoline price (2010$/gallon)	3.16	3.58	3.79
• CAFE standard average (miles/gallon)	31.9	33.7	34.1
Outcomes			
Market Shares			
• Conventional gasoline	67%	55%	52%
• Diesels	5%	3%	3%
• Hybrids (excluding plug-ins)	5%	18%	19%
• Plug-ins and dedicated electrical vehicles	1%	7%	11%
Fuel Efficiency (new vehicles in miles/gallon)			
• Cars	35.7	41.7	45.5
• Trucks	27.3	35.6	39.6
• All LDVs	31.2	38.9	43.0
Fuel efficiency – vehicle stock (miles/gallon)			
• All LDVs	22.2	26.8	31.5
VMT (billions)	2.966	3.518	4.145
Fuel use (billions of gallons)	134	131	132

Source: Small, Kenneth A. "The Elusive Effects of CAFE Standards." August 22, 2017. Table 2. 17. https://www.socsci.uci.edu/~ksmall/Elusive%20Effects%20of%20CAFE.pdf

59 Small, Kenneth A. "The Elusive Effects of CAFE Standards." University of California at Irvine, 22 Aug 2017, Web. <https://www.economics.uci.edu/research/wp/1718/17-18-03.pdf.> 10 Feb. 2020.

60 "2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions." *Federal Register*. 62719, "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule." *Federal Register*. 43070.

These findings are relevant because they suggest that if gas prices are higher than expected in the proposed SAFE rule, the fuel economy standards could cease to be binding, thereby reducing the costs they impose on society. It is difficult to predict the future of gasoline prices, but it seems clear that consumers and manufacturers adjust quickly to unexpected price changes, whereas mandated fuel economy standards run the risk of becoming either ineffectual or seriously harmful.

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