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October 26, 2018

VIA ELECTRONIC SUBMISSION

Attn: Christopher Lieske, Office of Transportation and Air Quality, Assessment and Standards Division, Environmental Protection Agency (EPA)

Re: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, EPA–HQ–OAR–2018–0283; FRL–9981–74–OAR; RIN 2127–AL76; RIN 2060–AU09

The Institute for Policy Integrity ("Policy Integrity") at New York University School of Law[1] submits the following comments on The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 83 Fed. Reg. 42986 (Aug. 24, 2018) ("Proposed Rule").

In the Proposed Rule, the Environmental Protection Agency ("EPA") proposes to reverse course on its final greenhouse gas emissions standards for 2021-2025 ("GHG Standards") and the National Highway Traffic Safety Administration ("NHTSA") proposes to reverse course on the Corporate Average Fuel Economy standards for 2021 as well as the augural standards for 2022-2025 ("CAFE standards") (collectively the "baseline standards").[2]

Policy Integrity is a non-partisan think tank dedicated to improving the quality of government decisionmaking through advocacy and scholarship in the fields of administrative law, economics, and public policy. We write to make the following comments, as more fully described herein:

1. The agencies' approach to weighing their statutory factors is unreasonable.

[1] This document does not purport to present New York University School of Law's views, if any.

[2] In 2012, EPA set standards for cars and light trucks sold in model years 2017 to 2025. 2017 and Later Model Year Light-Duty vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards 77 Fed. Reg. 62,624 (Oct. 12, 2012) [hereafter "baseline standards"]. NHTSA set final fuel economy standards for model years 2017 to 2021 and non-final "augural" standards for model years 2022 to 2025, meaning that those standards represented the agencies' "best estimate" of the appropriate level of stringency for those model years, based on the information available in 2012. *Id.* at 62,627.

2. The agencies have arbitrarily inflated the costs of the baseline standards through several unreasonable assumptions about compliance costs and the extent to which manufacturers pass those costs through to consumers.
3. The agencies have arbitrarily ignored consumer valuation of fuel savings and the welfare benefits of the baseline standards.
4. The agencies' analysis is riddled with econometric errors.
5. The agencies' assumptions about the impact of the baseline standards on fleet composition, vehicle travel, and safety arbitrarily disregard basic economic theory.
6. The agencies' choice of rebound estimate is arbitrary and capricious.
7. Potential changes in the mass of vehicles caused by the baseline standards do not support the Proposed Rule.
8. The agencies' employment analysis is incomplete.
9. The agencies' emissions analysis is inaccurate and incomplete.
10. The agencies' have arbitrarily failed to provide missing information necessary for meaningful public review of the Proposed Rule.

In addition, Policy Integrity is submitting the following three sets of comments under separate cover, which are incorporated herein:[3]

1. Comments explaining that EPA cannot legally withdraw the Clean Air Act preemption waiver granted to California in 2013 for the greenhouse gas and zero emission vehicle requirements of its Advanced Clean Cars program.
2. Comments, submitted together with several other organizations, explaining how the agencies' analysis of the social cost of carbon in the Proposed Rule is inconsistent with best available science, best practices for economic analysis, and legal standards for rational decisionmaking.
3. Comments, submitted together with several other organizations, explaining how NHTSA's analysis of the social cost of carbon in the Draft Environmental Impact Statement for the Safer Affordable Fuel-Efficient Vehicles Rule for Model Year 2022-2026 Passenger Cars and Light Trucks is inconsistent with best available science, best practices for economic analysis, and legal standards for rational decisionmaking.

The references cited herein are provided in a bibliography at the end of these comments.

[3] All three sets of comments are available here: https://policyintegrity.org/what-we-do/update/3190.

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In their justification for the Proposed Rule,[4] the National Highway Traffic Safety Administration ("NHTSA") and the Environmental Protection Agency ("EPA") (collectively the "agencies") rely heavily on the argument that the baseline standards will substantially increase costs which, in turn, will translate into higher prices faced by new car purchasers. NHTSA estimates that vehicle prices will be approximately $2,700 higher by 2029 under the baseline standards.[5] EPA similarly estimates that vehicle prices will be $2,800 higher in 2030, including maintenance and other costs.[6] Discouraged by the price surge, so the agencies argue, used car scrappage will decrease as consumers increasingly rely on used cars for their transportation needs and retain and drive those cars more. This analysis is the core of the agencies' decision to roll back the baseline standards.

In our comments, we show that the agencies' analysis produced biased and irrational results at each of the steps in that causal chain, leading to a Proposed Rule that vastly overstates the benefits of the rollback and understates the benefits society foregoes with the rollback. The agencies should not finalize the Proposed Rule.

I. THE AGENCIES' APPROACH TO WEIGHING THEIR STATUTORY FACTORS IS UNREASONABLE

In attempting to carry out their statutory mandates to conserve energy[7] and protect public welfare,[8] the agencies have unreasonably interpreted their statutory factors, arbitrarily overlooked important parts of the problem, and fixated on a subset of issues in ways that Congress did not intend. They have misidentified the market failures and problems that their proposed rollback intends to address, and have relied on a biased and manipulated cost-benefit analysis to justify their proposal. A full and balanced analysis of all the costs and benefits that the agencies are charged with considering would reveal—as the midterm review recently confirmed—that the baseline standards will deliver massive net social benefits, and the proposed rollback is unjustified.

4 The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 83 Fed. Reg. 42986 (Aug. 24, 2018) [hereafter "Proposed Rule"].

5 83 Fed. Reg. at 42,994; *see also id.* at 43,263-64, Table VII-4 (see last two rows for MY2025).

6 *Id.* at 43,229 (explaining that these costs "could be passed on to consumers").

7 83 Fed. Reg. at 42,995, 43,015, 43,205 (conceding that EPCA ultimately requires NHTSA to set standards to conserve energy).

8 42 U.S.C. § 7521(a)(1).

A. Standards of rationality for regulatory decisionmaking

Agencies are constrained by the standards of rationality both in interpreting statutory factors[9] and in exercising their regulatory decisionmaking.[10] Agencies may not rely on factors that Congress did not intend for them to consider, fail entirely to consider an important aspect of the problem, or offer an explanation for their decision that runs counter to the evidence before them. Additionally, when agencies propose to reverse course from a prior reasoned decisionmaking—as the agencies propose to do here—they must provide a "reasoned explanation" for dismissing the "facts and circumstances that underlay" the original rule.[11] Finally, agencies' regulatory decisions must stay within the overarching bounds of their statutory mandate.[12]

B. NHTSA's approach to its statutory factors is unreasonable

The Energy Policy and Conservation Act (EPCA) requires NHTSA to set the maximum feasible fuel economy standards after considering technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy.[13] NHTSA admits that the overarching mandate under EPCA is to conserve energy.[14]

Need to Conserve Energy: NHTSA has unreasonably defined the "need . . . to conserve energy" factor and has unreasonably ignored aspects of this issue.

To start, the agencies falsely and inconsistently argue that the need to conserve energy has diminished because U.S. reliance on foreign oil has decreased.[15] At the most extreme, the agencies claim that the rollback will result in zero monopsony costs and zero national security costs because the United States is so close to self-sufficiency in its petroleum supply that it is

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9 Chevron U.S.A. Inc. v. NRDC, 467 U.S. 837 (1984).

10 Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Ins. Co., 463 U.S. 29, 43, 48 (1983).

11 *F.C.C. v. Fox Television Stations*, 556 U.S. 502, 515-16 (2009).

12 *See, e.g., Center for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1195 (9th Cir. 2008) (noting that NHTSA's balancing of statutory factors cannot undermine the "fundamental purpose" of the EPCA); *Clean Air Council v. Pruitt*, 862 F.3d 1, 9 (D.C. Cir. 2017) ("It is 'axiomatic' that 'administrative agencies may act only pursuant to authority delegated to them by Congress.'") (quoting *Verizon v. FCC*, 740 F.3d623, 632 (D.C. Cir. 2014)).

13 49 U.S.C. § 32902(f).

14 83 Fed. Reg. at 42,995, 43,015, 43,205 (conceding that EPCA ultimately requires NHTSA to set standards to conserve energy).

15 83 Fed. Reg. at 43,214-15.

“unlikely” that imports would increase as a consequence of the proposed rollback.[16] That assumption is wrong for several reasons, and is inconsistent with other parts of the analysis:

- The latest *Annual Energy Outlook* from the Energy Information Administration projects that the United States will continue to import crude oil through 2050 and “remains a net importer of petroleum and other liquids on an energy basis.”[17]
- But even assuming that the United States will soon become a net exporter of petroleum, there are still foreign suppliers in the meantime, and there would continue to be foreign suppliers even after the United States achieves net-export status.[18] Petroleum prices are set in a global market. And because oil is a global market, how much we produce is irrelevant to U.S. exposure to price shocks; the United States will remain vulnerable.[19]
- Moreover, the assumption that the increased petroleum consumption caused by the proposed rollback will be met through 0% imports[20] is also wildly inconsistent with the assumptions made elsewhere in the analysis. For the purposes of calculating the energy price shock effect, the agencies assume that—through the year 2050—75% of the increase in fuel consumption resulting from lower CAFE and CO_2 emissions standards will be reflected in increased U.S. imports.”[21] For calculating upstream emissions effects, the agencies assume that—through the year 2050—50% of increased gasoline consumption would be supplied by increased domestic refining and that 90% of this additional refining would use imported crude petroleum.”[22] In total, the upstream emission calculations assume that 95%[23] of increased consumption will either be from foreign refining or from foreign crude imports. The agencies inconsistently and opportunistically assume 0% imports when it serves their purposes, but

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16 NHTSA & EPA, Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021-2026 Passenger Cars and Light Trucks Preliminary Regulatory Impact Analysis 1068, 1077 (Aug. 23, 2018) [hereafter “PRIA”].

17 EIA (2018a), at 24 (showing projections for the reference case); *cf. id.* at 53-54 (showing that the United States is a “modest net export of petroleum *on a volume basis* from 2029 to 20245,” as compared to on an energy basis; and showing that under certain oil price scenarios, the United States remains a net importer even on a volume basis; and showing that in the reference case, “the United States returns to being a net petroleum importer in 2045 on a volume basis”). Notably, the AEO2018 assumes that all “current laws and regulations . . . are unchanged throughout the projection period,” *id.* at 8, meaning it assumes that the current standards under the 2012 rule will stay in force. Under the proposed rollback, as U.S. demand for petroleum increases, projections for imports could change. *See* EIA (2018b), at 26 (“CAFE standards are increased . . . to meet augural CAFE standards for model year 2022 to 2025,” after which “CAFE standards are held constant” at MY2025 levels “through the end of the projection.”).

18 EIA (2018a), at 24 (2018) (explaining that even if the United States becomes a net energy exporter, “both imports and exports continue through the projection period”).

19 *See* Letter to the Agencies from Jason Bordoff (Oct. 22, 208), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-3906

20 PRIA at 1068, 1077

21 PRIA at 1073.

22 PRIA at 1291.

23 50% + (50% * 90%) = 95%.

elsewhere in the Proposed Rule, when a different estimate suits them, they instead assume 95% imports. This is patently arbitrary.

- The agencies wrongly conclude that national security costs are zero based on the fact that the "size" of the Strategic Petroleum Reserve (SPR) has not historically varied in response to the level of U.S. petroleum consumption or imports.[24] However, "the budgetary costs for maintaining [the size of] the SPR" is only one possible effect of changes in the level of petroleum consumption or imports. Regardless of whether the United States actually changes the *size* of the SPR in real time to respond to changing levels of U.S. petroleum consumption, the *protective value* that the SPR offers given its size does automatically change as total U.S. petroleum consumption changes.[25] The agencies have failed to assess how much the relative protective value of the SPR will change as total U.S. consumption rises following the proposed rollback, and therefore have failed entirely to consider one important element of the national need to conserve energy.

The agencies also wrongly argue that assessing how environmental considerations create a need to conserve energy is "complicated,"[26] that the 2012 standards may not "sufficiently address climate change to merit their costs,"[27] and that increasing the standards is not "necessary to avoid destructive or wasteful use of energy."[28] The agencies attempt to belittle the standards' effect on climate as "small" by focusing on temperature degree effects rather than on economic impacts.[29] In fact—as detailed in separate comments that Policy Integrity submitted jointly with other organizations—assessing the climate effects of the proposed rollback versus the 2012 standards is not "complicated"; it is quite easily accomplished by monetizing climate damages using the social cost of greenhouse gas metrics. Once climate damages are more fully monetized (as the agencies are required to do[30]), it will become apparent that the proposed rollback will cause billions of dollars in climate damages. Billions of dollars lost to avoidable climate damages is not a small effect, and it very clearly is a "destructive and wasteful" effect. This approach in no way

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24 PRIA at 1077.

25 Dept. of Energy, *Long-Term Strategic Review of the U.S. Strategic Petroleum Reserve: Report to Congress* 64 (2016), https://www.energy.gov/sites/prod/files/2016/09/f33/Long-Term%20Strategic%20Review%20of%20the%20U.%20S.%20Strategic%20Petroleum%20Reserve%20Report%20to%20Congress_0.pdf ("The value of the SPR over the coming decades will be affected by the evolution of future world crude oil markets in terms of future oil price levels and quantities of oil produced and consumed globally.").

26 83 Fed. Reg. at 43,215.

27 *Id.*

28 *Id.*

29 *Id.* at 43,216.

30 See our separate Joint Comments on the Social Cost of Greenhouse Gases, available at https://policyintegrity.org/what-we-do/update/3190 (explaining how the agencies have improperly manipulated and undervalued the climate damage calculations).

places "an outsized emphasis"[31] on this consideration; to the contrary, it simply uses monetization to translate effects into the same metric of dollars that the agencies use to value all other costs and benefits in the proposed rollback. As the agencies explained in the 2012 rule, monetization is an "appropriate[ ]" tool to put climate benefits "in context in the rule."[32] An apples-to-apples comparison of more fully monetized costs and benefits would show—just as the agencies concluded in the 2012 rule—that the climate benefits of the 2012 standards alone offset a significant portion of the technology costs, and together with the other significant private and social benefits, the benefits well justify the costs of the 2012 standards.[33] In addition, if anything, the need to conserve energy to prevent climate and other environmental externalities is only more urgent now than it was during the 2012 rulemaking.[34]

NHTSA's discussion of the "need to conserve" factor also gives short shrift to non-climate environmental externalities, only briefly mentioning the possible effects on other emissions without detailing any of the myriad non-climate public health and welfare consequences from pollution associated with petroleum production and combustion for motor vehicles.[35]

The agencies also wrongly concludes that consumers' need to save money is now "less urgent" and no longer supports a strong overall need to conserve energy.[36] The agencies assert that past

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[31] 83 Fed. Reg. at 43,216.

[32] 77 Fed. Reg. at 62,898. Far from giving monetized climate benefits outsized weight in the 2012 rule, the agencies did not select more stringent standards that would have had even larger net benefit figures. If anything, the agencies gave "outsized" weight in the 2012 rule to economic practicability in selecting a standard that did not maximize net benefits. *Id.* at 63,055 ("We recognize that higher standards would help the need of the nation to conserve more energy . . . [but] [w]e conclude that the correct balancing recognizes economic practicability concerns . . . and sets standards at the [less stringent] levels that the agency is promulgating.").

[33] NHTSA, *Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY 2025 Passenger Cars and Light Trucks* at 51 (2012) [hereafter "NHTSA 2012 FRIA"] (showing cost and benefit estimates at a 7% discount). Note that even these monetizations of climate damages are almost certainly a severe underestimate. Consideration of unquantified benefits further justifies the 2012 standards. *See* 77 Fed. Reg. at 63,079-80 ("Similarly, the agency's estimate of the value of reduced climate-related economic damages from lower emissions of GHGs excludes many sources of potential benefits from reducing the pace and extent of global climate change. For example, none of the three models used to value climate-related economic damages includes those resulting from ocean acidification or loss of species and wildlife. The models also may not adequately capture certain other impacts, including potentially abrupt changes in climate associated with thresholds that govern climate system responses, interregional interactions such as global security impacts of extreme warming, or limited near-term substitutability between damage to natural systems and increased consumption. Including monetized estimates of benefits from reducing the extent of climate change and these associated impacts would increase the agency's estimates of benefits from adopting higher CAFE standards.").

[34] *See* Intergovernmental Panel on Climate Change, *Global Warming of 1.5ºC: Summary for Policymakers* at SPM-4, SPM-11 (2018), http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf (reporting with high confidence that warming could likely reach 1.5 degrees by 2030, and detailing the associated risks to health, livelihoods, food security, water supply, human security, and economic growth).

[35] 83 Fed. Reg. at 43,211.

[36] 83 Fed. Reg. at 43,216.

rulemakings were overly and paternalistically focused on "myopia."[37] This statement ignores all the other pathways through which the 2012 standards benefit consumers' need to save money, including by correcting informational asymmetries, attention costs, and other informational failures; positional externalities; and various other supply-side and demand-side explanations for consumers' inability to achieve in an unregulated market the level of fuel economy that they desire. These components of the national need to conserve energy are discussed at length throughout these comments, and were specifically considered by the agencies in the 2012 rule.[38]

Indeed, more broadly, NHTSA has failed to adequately explain its shift since 2012 in its interpretation and application of the need to conserve energy factor. In the 2012 Clean Car Standards, NHTSA noted that the fuel savings of the rule allowed it to comply with the purposes of the statute, estimating that the rule's "fuel economy increases would lead to fuel savings totaling a range from 180 billion to 184 billion gallons."[39] Actual fuel savings, and the associated benefits to consumers, the environment, and society, were at the heart of NHTSA's analysis of the need to conserve energy factor back in 2012.[40] Now the agency ignores those conclusions from 2012 and relies on mistaken and inconsistent interpretations of petroleum import projections and the urgency of climate change to justify ignoring this statutory factor and giving primacy instead to economic practicability and safety effects. The failure to explain this shift in approach is arbitrary.

Economic Practicability: NHTSA discusses consumer valuation, price effects, sales effects, and job impacts in the context of its economic practicability factor. These comments discuss at length how NHTSA has inappropriately analyzed many of these elements of the economic practicability test.

NHTSA additionally claims that economic practicability also encompasses "harm to the nation's economy caused by highway fatalities,"[41] even as the agency also counts safety as its own separate factor.[42] First, NHTSA has miscalculated the safety impacts, as discussed throughout these comments. But second, it is arbitrary to fully include the alleged "harm to the nation's economy caused by highway fatalities" as part of economic practicability even while the agency ignores and undercounts various harms to the nation's economy caused by climate- and pollution-related fatalities, illnesses, and other welfare impacts. Neither under the need to

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[37] Id.

[38] 77 Fed. Reg. at 62,914.

[39] 77 Fed. Reg. at 63,059.

[40] *E.g.*, 77 Fed. Reg. 63,077 (stating that the rule's fuel economy savings offset any rebound-related costs of the rule, producing "significant benefits to society.").

[41] 83 Fed. Reg. at 43,209.

[42] 83 Fed. Reg. at 43,226.

conserve energy factor, as noted above, nor under the economic practicability factor does NHTSA fully weigh the monetized damages associated with such climate impacts[43] as:

- property lost or damaged by sea-level rise, coastal storms, flooding, and other extreme weather events, as well as the cost of protecting vulnerable property and the cost of resettlement following property losses;
- changes in energy demand, from temperature-related changes to the demand for cooling and heating;
- lost productivity and other impacts to agriculture, forestry, and fisheries, due to alterations in temperature, precipitation, CO_2 fertilization, and other climate effects;
- human health impacts, including cardiovascular and respiratory mortality from heat-related illnesses, changing disease vectors like malaria and dengue fever, increased diarrhea, and changes in associated pollution;
- changes in fresh water availability;
- ecosystem service impacts;
- impacts to outdoor recreation and other non-market amenities; and
- catastrophic impacts, including potentially rapid sea-level rise, damages at very high temperatures, or unknown events.

It is arbitrary for NHTSA to count alleged safety costs as support for its propose rollback both under the economic practicability factor and as its own separate "bolster[ing]" factor,[44] and yet never fully monetize climate- and pollution-related deaths and other welfare impacts under either the need to conserve energy factor nor under the economic practicability factor.[45]

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43 These impacts are all included to some degree in the three integrated assessment models (IAMs) used by the IWG (namely, the DICE, FUND, and PAGE models), though some impacts are modeled incompletely, and many other important damage categories are currently omitted from these IAMs. *Compare* Interagency Working Group on the Social Cost of Carbon (2010), at 6-8, 29-33; *with* Howard (2014). For other lists of actual climate effects, including air quality mortality, extreme temperature mortality, lost labor productivity, harmful algal blooms, spread of west nile virus, damage to roads and other infrastructure, effects on urban drainage, damage to coastal property, electricity demand and supply effects, water supply and quality effects, inland flooding, lost winter recreation, effects on agriculture and fish, lost ecosystem services from coral reefs, and wildfires, *see* EPA, *Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment* (2017); U.S. Global Change Research Program, *Climate Science Special Report: Fourth National Climate Assessment* (2017); EPA, *Climate Change in the United States: Benefits of Global Action* (2015); Union of Concerned Scientists, *Underwater: Rising Seas, Chronic Floods, and the Implications for U.S. Coastal Real Estate* (2018).

44 83 Fed. Reg. at 43,226.

45 See our separate comments on NHTSA's failure to fully monetize the social cost of greenhouse gases. https://policyintegrity.org/what-we-do/update/3190.

C. EPA's approach to its statutory factors is unreasonable

EPA acknowledges that it must consider public health and welfare under Section 202 of the Clean Air Act,[46] and yet claims authority to give "particular consideration" to costs and safety.[47] EPA never explains why it may give outsized consideration to costs and safety, even as it devalues important climate and pollution effects. After all, the "primary goal" of the entire Clean Air Act is to advance "pollution prevention."[48] It is therefore arbitrary and inconsistent with the statute for EPA to instead give primacy to cost and safety factors in justifying the proposed rollback, to fixate on alleged traffic deaths avoided without also clearly reporting the climate- and pollution-related deaths, illnesses, and welfare losses that the proposed rollbacks will cause. In its discussion of its statutory factors, EPA specifically highlights the alleged avoided highway fatalities,[49] and yet only reports volume estimates for greenhouse gas changes, without detailing any of the real-world impacts from the increase in greenhouse gas emissions, criteria pollutant emissions, and toxic pollutant emissions, which will include: climate-related deaths and illnesses from excessive heat, excessive cold, extreme weather events, diarrhea, vector-borne diseases, food- and water-borne diseases, cardiovascular and respiratory effects, food scarcity, water scarcity, and conflict;[50] as well as mortalities and morbidities from increases in particulate matter and other pollutants, including premature adult and infant mortality, acute bronchitis, respiratory emergency room visits, non-fatal heart attacks, asthma exacerbations, strokes, reproductive and developmental effects, cancer and genotoxicity effects, and work-loss days.[51] EPA never sufficiently discusses these important aspects of the regulatory problem, and does not explain their connection to its statutory factors. EPA certainly may consider a range of effects, including

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[46] 83 Fed. Reg. at 43,228.

[47] 83 Fed. Reg. at 43,231.

[48] 42 U.S.C. § 7401(c) (defining the goal for "this chapter," which includes § 7521 in subchapter II); *Air Alliance Houston v. EPA*, No. 17-1155 (D.C. Cir., Aug. 17, 2018), 2018 WL 4000490 (citing § 7401(c) as describing congressional intent in enacting the Clean Air Act). "Pollution prevention" is often distinguished from strictly technologically-based end-of-pipe pollution controls, to include process changes that reduce the amount of pollution generated in the first place. S. Rep. No. 101-228, pt. 2, at 168 (1989), 1990 U.S.C.C.A.N. 3385, 3553 ("The technologies, practices or strategies which are to be considered . . . go beyond the traditional end-of-the-stack treatment or abatement system. The Administrator is to give priority to technologies or strategies which reduce the amount of pollution generated through process changes or the substitution of materials less hazardous. Pollution prevention is to be the preferred strategy wherever possible."). Increasing fuel economy of vehicles is precisely the kind of pollution prevention strategy that Congress had in mind.

[49] 83 Fed. Reg. at 43,231.

[50] Carleton et al. (2018); Howard (2014); NHTSA, Draft Environmental Impact Statement at S-21 (2018) [hereafter "SAFE Rule Draft EIS"].

[51] SAFE Rule Draft EIS at S-9, 2-27, 4-24 (listing the human health and welfare impacts from the increased particulate matter emissions under the proposed rollbacks).

safety, energy security, and national security, but there is no statutory basis for giving safety more attention than other important effects such as public "health" and "welfare."[52]

In the 2012 rulemaking, EPA focused on its charge to protect public health and welfare, and spoke at length about the standards' effects on "atmospheric concentrations of CO2, global climate warming, ocean acidification, and sea level rise."[53] The agency also devoted in 2012 a long discussion to the health and air-quality effects of non-GHG pollutants.[54] The Proposed Rule meanwhile, notably lacks any meaningful reference to ocean acidification or sea level rise.[55] EPA now fails to explain its lack of attention to important parts of the problem that the agency previously assessed under its statutory mandate back in 2012.

D. The agencies define the market failure too narrowly

The regulatory impact analysis far too narrowly defines the market failures that fuel economy and greenhouse gas emission standards are intended to address. The regulatory impact analysis claims that, "in the case of the CAFE standards," the market failure is limited to protecting consumers who do not "voluntarily purchase enough fuel economy" to protect themselves "if gasoline prices suddenly rise significantly."[56] With the CO2 standards, the market failure is to protect "the planet from the risks of unchecked climate change."[57]

Under both the statutory mandate from EPCA and best practices for economic analysis,[58] the problems that NHTSA is charged with addressing are not so restricted to only protecting consumers from gas price spikes. As explained above in this section as well as throughout these comments, NHTSA is more broadly charged to address: externalities relating to energy security, national security, positional goods, global climate change, and air and water pollution associated with fuel production and consumption; asymmetric information, attention costs, and other

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52 42 U.S.C.A. § 7521(a)(1) ("The Administrator shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare."); *Massachusetts v. E.P.A.*, 549 U.S. 497, 528-29 (2007).

53 77 Fed. Reg. at 62,895.

54 *See* 77 Fed. Reg. at 62,899, 62,910-12.

55 The lone exceptions occur in footnote 477, where the agencies note that the 2012 rule measured sea level rise, but does not mention any sea level effects from this proposed rollback, 83 Fed. Reg. at 43,230; and at page 43,248, discussing California's reasons for a waiver. EPA also mentions that it has estimated sea-level rise under the Executive Order on environmental justice, *id.* at 43,474, but fails to connect such climate impacts to its statutory mandate.

56 PRIA at 110.

57 *Id.*

58 *See* Office of Mgmt. & Budget, *Circular A-4* (2003) [hereafter "OMB Circular A-4"] (defining various market failures, including environmental externalities and informational failures).

information failures; internalities, including myopia; and various supply-side market failures, including first-mover disadvantage.

Similarly, while EPA's primary focus when regulating greenhouse gas emissions should remain the need to protect the planet from unchecked climate change, EPA must not ignore other related market failures that cause harm to public health and welfare, including the issues and market failures listed in the previous paragraph.

In defining the market failures too narrowly, the agencies not only violate the instructions of Executive Order 12,866,[59] but also evince their fundamental misunderstanding of the purposes of the original 2012 standards. The proposed rollback fails to consider important aspects of the problem set before the agencies by Congress, and also fails to consider discussions of these market failures from the 2012 rulemaking, and so the proposed rollback is arbitrary and capricious.

E. The agencies should balance their statutory factors using a full and balanced cost-benefit analysis, not a biased and manipulated cost-benefit analysis

In the past, the agencies have relied on cost-benefit analysis to inform their balancing of their statutory factors. And the agencies should do the same here, after conducting a full, balanced cost-benefit analysis. As we have explained throughout these comments, such as analysis would not support the Proposed Rule.

Past Reliance on Cost-Benefit Analysis: Both agencies have relied on cost-benefit analysis in previous rulemakings to provide an explanation and context for their chosen standards. For example, in the 2012 rule, both NHTSA and EPA cited the costs and benefits in discussing the statutory balancing process. EPA stated that "given the technical feasibility of the standard, the cost per vehicle in light of the savings in fuel costs over the lifetime of the vehicle, the very significant reductions in emissions and in oil usage, and the *significantly greater quantified benefits compared to quantified costs*, EPA is confident that the standards are an appropriate and reasonable balance of the factors to consider under section 202(a)."[60] NHTSA similarly used a marginal cost-benefit analysis to set the 2012 CAFE standards. The agency explained that while the agency is not required to conduct a cost-benefit analysis, "[r]egardless of what type of analysis is or is not used, considerations relating to costs and benefits remain an important part of CAFE standard setting."[61] Similarly, in setting the CAFE standards for MY 2008-2011, NHTSA used a marginal cost-benefit analysis to determine the maximum feasible standards.[62] The U.S.

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[59] Exec. Order 12,866 § 1(b)(1) (1993).

[60] 77 Fed. Reg. at 62,777 (emphasis added).

[61] 77 Fed. Reg. at 62,623, 63,020.

[62] *Center for Biological Diversity*, 538 F.3d at 1186.

Court of Appeals for the Ninth Circuit affirmed the agency's use of cost-benefit analysis to balance the statutory factors of EPCA, explaining that the balancing was appropriate so long as the agency does not balance the factors in such a way that conflicts with the statute's energy conservation mandate, and so long as the agency does not "put a thumb on the scale" by undervaluing or overvaluing particular effects.[63]

In the current rule, the agencies turned their back on these principles and their prior practice without providing a reasoned explanation. Instead, the agencies have balanced the factors in a way that conflicts with their controlling statutes and weighed the statutory factors without regard for the accuracy of the accompanying cost-benefit analysis.

Errors and Oversights in Balancing the Factors: The agencies acknowledges that the proposed rollback will increase fuel usage by about 500,000 barrels per day by the early 2030s.[64] The agencies nonetheless claim that the increased consumption and emissions are justified by the cost savings and safety concerns (in rebound, fleet composition, and mass).[65] But that analysis is severely flawed.[66] First, the increased emissions that will result from the proposed action need to be properly incorporated into the cost-benefit analysis. There are significant health and safety issues associated with the increased greenhouse gas emissions which the agencies are ignoring. See Sections I and IX of these comments, and our separate comments on the social cost of greenhouse gases, for a discussion of the treatment of emissions in the agencies' cost-benefit analysis. Second, the safety considerations have been incorrectly calculated in the cost-benefit analysis. See sections V-VII of these comments for an in-depth discussion of the treatment of scrappage, rebound, and mass effects. The agencies cannot duck their requirements to conserve energy and protect public health and safety by citing automobile safety without an adequate discussion of the health and safety impacts of the Proposed Rule's increased emissions or without an accurate estimate of the actual safety impact of the rollback versus the 2012 standards.

NHTSA claims that it is allowed to use feasibility concerns to deviate from the regulatory standards that would maximize net benefits.[67] Yet if a standard truly were not feasible, then its costs would be prohibitively high, and a full and fair cost-benefit analysis would reflect that. After correcting their currently inaccurate estimations of costs and benefits, in the ways we have laid out in these comments, the agencies should rely on a full and balanced cost-benefit analysis. Such a full and fair analysis will reveal that the proposed rollback is not justified, that the 2012

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[63] *Id.* at 1197.

[64] 83 Fed. Reg. at 42,995, 43,254.

[65] 83 Fed. Reg. 42,995-96, 43,067, 43,230.

[66] *National Ass'n of Home Builders v. EPA*, 682 F.3d 1032, 1040 (D.C. Cir. 2012).

[67] 83 Fed. Reg. at 43,209.

standards remain massively benefit-cost justified, and that, if anything, an increase in stringency is warranted.

Misleading Fatalities Statistics: The agencies' reliance on fatality statistics that include alleged rebound-related traffic fatalities to justify its proposed rollback is arbitrary because the agency's own cost-benefit analysis finds that the rebound effect will have no net welfare impact.[68] The agencies repeatedly cite as justification for the proposed rollback that it will allegedly "reduce highway fatalities by 12,700 lives."[69] Half of this figure comes from fatalities allegedly attributed to the rebound effect.[70] Yet the agencies acknowledge that the increase in driving is "freely chosen" and not "imposed by" the standards,[71] and their analysis reflects this fact by showing that the private welfare gained by consumers from driving more due to the rebound effect will offset any fatalities allegedly caused by the rebound effect. As a result, the agencies are misrepresenting the effects of the proposed rollback by claiming 12,700 lives saved. Compounding this error, the accident related costs associated with the increase in driving that results from the scrappage and dynamic fleet share models—which is also "freely chosen"—are inexplicably and unjustifiably not offset by countervailing mobility benefits in the benefit cost analysis—and the agencies inappropriately claim that these traffic fatalities—which comprise the other half of the 12,700 projection[72]—also justify the roll back. Indeed, the agencies entire "safety" justification for the roll back rests solely on their prediction that by rolling back the standards, people will drive less and this will reduce traffic fatalities. The agencies discussion of the "safety" effects of the standards is thus deeply misleading. Furthermore, the projected traffic fatalities figure is never offset by the significant increase in climate- and pollution-related fatalities from the proposed rollback's increase in greenhouse gas emissions and other pollution. Consequently, the agencies' justification for the proposed rollback runs counter to the evidence before the agencies.

Inconsistent Claims on Net External Costs versus Net External Benefits: In Tables II-25 through II-28, the agencies list positive sums for "net external benefits."[73] Yet, immediately following those tables, the agencies instead report that the proposed rollback will generate net external *costs*: "less stringent . . . standards will produce *net external economic costs*, as the increase in environmental and energy security externalities outweighs external benefits from

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[68] 83 Fed. Reg. at 43, 212, 43, 231; *Id.* at 43,105 (discussion of mobility benefits accompanying the rebound effect).

[69] 83 Fed. Reg. at 42,986, 42,995, 43,152; *see also id.* at 43,231-43,232 (where EPA inconsistently refers instead to either 15,680 fatalities or 12,903 fatalities).

[70] *See id.* at 43,153, tbl. II-74.

[71] *Id.* at 43,148.

[72] Leaving aside the small number of mass reduction related fatalities, which the agencies concede are not statistically significant. NPRM at 43,111

[73] *E.g.*, 83 Fed. Reg. at 43,065.

reduced driving and higher fuel tax revenue (line 19)."[74] Adding to the inconsistency, the regulatory impact analysis reports on the exact same figures from line 19 but instead writes "the reduction in external costs imposed by vehicle use combines with higher fuel tax revenue to more than offset the increase in environmental and energy security externalities (line 19)."[75] The summaries from the Proposed Rule and the PRIA are mirror opposites. Given the wording, this discrepancy cannot have resulted from a mere typographical error. Rather, it seems more likely that, at some point in the agencies' analysis of the proposed rollback, the agencies had calculated that the rollback would result in a net external economic cost, but then different numbers were used for the tables. Tellingly, EPA's June 18, 2018 review of the proposed rollback, as shared with OIRA, found that the proposed rollback would cause $83 billion in net social costs.[76] If the agencies do calculate a net external cost for the proposed rollback, then the agencies have not explained why the proposed rollback is justified; if the agencies do not calculate a net external cost despite the statement in the Proposed Rule, the agencies have failed to explain what changed in their analysis to completely switch the sign and magnitude of the calculation of net external effects, from a significant cost to an alleged benefit. Either way, as presented currently, the Proposed Rule and its justification are arbitrary.

II. THE AGENCIES HAVE ARBITRARILY INFLATED THE COSTS OF THE BASELINE STANDARDS

The agencies' estimates of the relative effects on vehicle buyers of the Proposed Rule versus the baseline standards is riddled with errors. First, the agencies have overestimated compliance costs by failing to appropriately model how manufacturers will efficiently deploy flexible compliance options and make fuel economy improvements to reduce their costs. Second, the agencies have overstated the share of vehicle prices that will be passed on to consumers—in particular, to consumers of lower-price vehicles. And third, the agencies have arbitrarily relied on "relatively low" fuel prices to justify the need for the Proposed Rule.

The premise of the Proposed Rule is that, under the baseline standards, vehicle prices will otherwise increase enough to cause a substantial drop in sales, thus allegedly affecting the ability of manufacturers to comply with the standards as well as the relative safety of the cars driven by consumers.[77] That price analysis rests on the assumption that manufactures will pass all of their

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[74] 83 Fed. Reg. at 43,067 (emphasis added).

[75] PRIA at 1085.

[76] EPA, *Further Review of CAFE Model & Inputs* at 2 (June 18, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (see Email 5, page 11 of PDF).

[77] 83 Fed. Reg. at 42,993-994

compliance costs on to buyers, a feature known as full "pass-through."[78] Thanks to this pass-through assumption, NHTSA estimates that vehicles will be approximately $2,700 higher by 2029 under the baseline standards.[79] EPA similarly estimates that vehicle prices will be higher by $2,260 in 2030.[80] Additional costs from maintenance, financing, insurance, taxes, and other fees brings the agencies' estimates to a total of $2,810.[81] But those price estimates are inflated, because the agencies incompletely model the use of cost-saving flexibilities, wrongly model the decisions about fuel economy improvements and unreasonably assume a full pass-through of costs to consumers, among other reasons. Additionally, those estimates are offset by the lifetime fuel savings of the baseline standards, which the agencies have underestimated.

Correcting these mistakes, together with other errors in calculating the Proposed Rule's costs and benefits, will show that the baseline standards continue to be benefit-cost justified, and that the Proposed Rule is not justified.

A. The agencies fail to model efficient deployment of all compliance options, including flexibilities, and thus overestimate the baseline standards' costs

The baseline standards incorporate a number of cost-minimizing flexible compliance options. Manufacturers can reduce their costs of compliance by averaging the efficiency levels of vehicles within a fleet, by generating excess compliance credits in one year and banking them for future use, by promising to over-comply in future years and borrowing those credits to make up for an existing deficit, by transferring credits between fleets, by trading credits with other manufacturers, by generating offset credits (or "adjustments" as NHTSA calls them) through off-cycle technologies and other opportunities, and by efficiently relying on penalties as an upper-bound safety valve on compliance costs, among other things.

Studies show that for both fuel economy standards and EPA's history with averaging, banking, and trading (ABT) programs, the expected cost savings from employing these kinds of market-based flexible compliance options relative to uniform standards can be as high as 50%.[82] These compliance flexibilities are especially beneficial given how heterogeneous the car manufacturers

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[78] *Id.* at 43,071; *see also id.* at 43,135 ("CAFE standards force manufacturers to apply fuel saving technologies to offered vehicles and then pass along the cost of those technologies (to the extent possible) to buyers of new vehicles.").

[79] 83 Fed. Reg. at 42,994; *see also id.* at 43,263-64, Table VII-4 (see last two rows for MY2025).

[80] *Id.* at 43,229

[81] *Id.* at 43,229.

[82] *See* Rubin et al. (2009), at 315–328 (2009) (showing the huge potential of cost savings associated with credit trading between firms for the CAFE program); Newell & Stavins (2003), at 56 (estimating the potential cost savings associated with market-based policies); Carlson et al. (2000) (showing gains from trade in transferable sulfur dioxide emission allowances among electric utilities).

are and how diverse individual manufacturers' product lines are.[83] And indeed, with companies as different in their fuel efficiency profiles as Tesla and Porsche, one can expect substantial cost savings from credit trading and other flexible compliance options.[84] The agencies are well aware of the cost-minimizing potentially of these flexibilities.[85] In the proposal, the agencies explain that, "well-functioning banking and trading provisions increase market efficiency and reduce the overall costs of compliance with regulatory objectives."[86] Moreover, as the agencies acknowledge, the introduction of trading has changed the decisions made by manufacturers: "Since NHTSA introduced trading and transferring, manufacturers have largely traded or transferred credits in lieu of paying civil penalties."[87] The agencies also acknowledge "that buying and selling credits is a more cost-effective strategy for manufacturers than paying civil penalties" and quote the decrease in civil penalties paid annually.[88]

By failing to model the most efficient deployment of all these cost-minimizing compliance flexibilities, both NHTSA and EPA have overestimated the costs of complying with the baseline standards.

1. Manufacturers would not automatically apply all technologies defined by the agencies as "cost-effective"

Figure 9 below, copied from NHTSA's Draft CAFE Model Documentation, illustrates how the agencies simulate the manufacturer's compliance decisions in every model year.[89] As shown in Figure 9, the agencies assume that manufacturers apply all technologies considered "cost-effective" in the first step, regardless of how much compliance is needed or how many credits

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[83] More formally, the more the marginal costs of compliance differ between the producers, the more costs are saved when trade is introduced. *See* Administrative Conference of the United States, *Recommendations 2017-4 on Marketable Permits* 3 (2017), *available at* 82 Fed. Reg. 61,728, 61,730 (Dec. 29, 2017) (reporting that marketable permit programs are more beneficial when "Regulated parties have sufficiently differing compliance costs, such that the savings from trading are likely to be greater than transaction costs.").

[84] *See, e.g.*, Stranlund (2017); 74 Fed. Reg. 14,196, 14206 (Mar. 30, 2009) ("Under Part 536, credit holders . . . will have credit accounts with NHTSA, and will be able to hold credits, apply them to compliance with CAFE standards, transfer them to another 'compliance category' for application to compliance there, or trade them."); *id.* at 14,218 ("In the event that a manufacturer does not comply with a CAFE standard, even after the consideration of credits, EPCA provides for the assessing of civil penalties."); 81 Fed. Reg. at 95,489 ("[S]ince the introduction of credit trading and transfers for MY 2011 and after, many manufacturers have taken advantage of those flexibilities rather than paying civil penalties for non-compliance.").

[85] 83 Fed. Reg. at 43,231.

[86] *Id.* at 42,999.

[87] *Id.* at 43,451.

[88] *Id.* at 43,451.

[89] Draft CAFE Model Documentation, July 2018, Figure 9, at 69, available at ftp://ftp.nhtsa.dot.gov/CAFE/2021-2026_CAFE_NPRM/CAFE_Model/CAFE_Model/CAFE_Model_Documentation_NPRM_2018.pdf (last accessed 10/19/2018) [hereafter "CAFE Model Documentation"]; see also 83 Fed. Reg. at 43,161, 43,174.

they have available. The problem with this assumption lies in the definition of "cost-effective technologies." According to the agencies, cost-effective technologies are the technologies that cost less than the sum of compliance costs that the technology avoids[90] plus the value of 2.5 years of fuel savings achieved by the technology.[91] Given those numbers, some manufacturers could be predicted to over-comply in every year on a technological basis, even as available credits are left to expire.

If consumers are demanding these cost-effective technologies such that manufacturers can earn a profit by including them, that assumption may make some sense. However, the assumption clashes directly with the contradictory assumption that the agencies rely on in the model's sales module, where they implicitly assume that customers entirely disregard fuel efficiency in their purchasing decisions.[92] In that model, the failure to include any estimate for consumer valuation leads the agencies to overestimate how the baseline standard's alleged price increases will depress sales of new vehicles (The problematic assumptions of the sales module, and the inconsistency with the agencies' other assumptions on consumer valuation of fuel economy, are discussed in Section III.)

At the same time, the agencies' schematic of manufacturers' compliance decisions in Figure 9 assumes that manufacturers think that consumers value fuel economy enough that they will demand every technological option with a 2.5-year payback period, even if it causes the manufacturer to over-comply with the standards year after year.

Those positions are inconsistent. The agencies cannot have it both ways. Like under Figure 9's 2.5-year payback assumptions, the agencies' sales module should also assume that consumers do value fuel savings, as explained in Section III, thus changing the estimates of new vehicle sales under the baseline standards.

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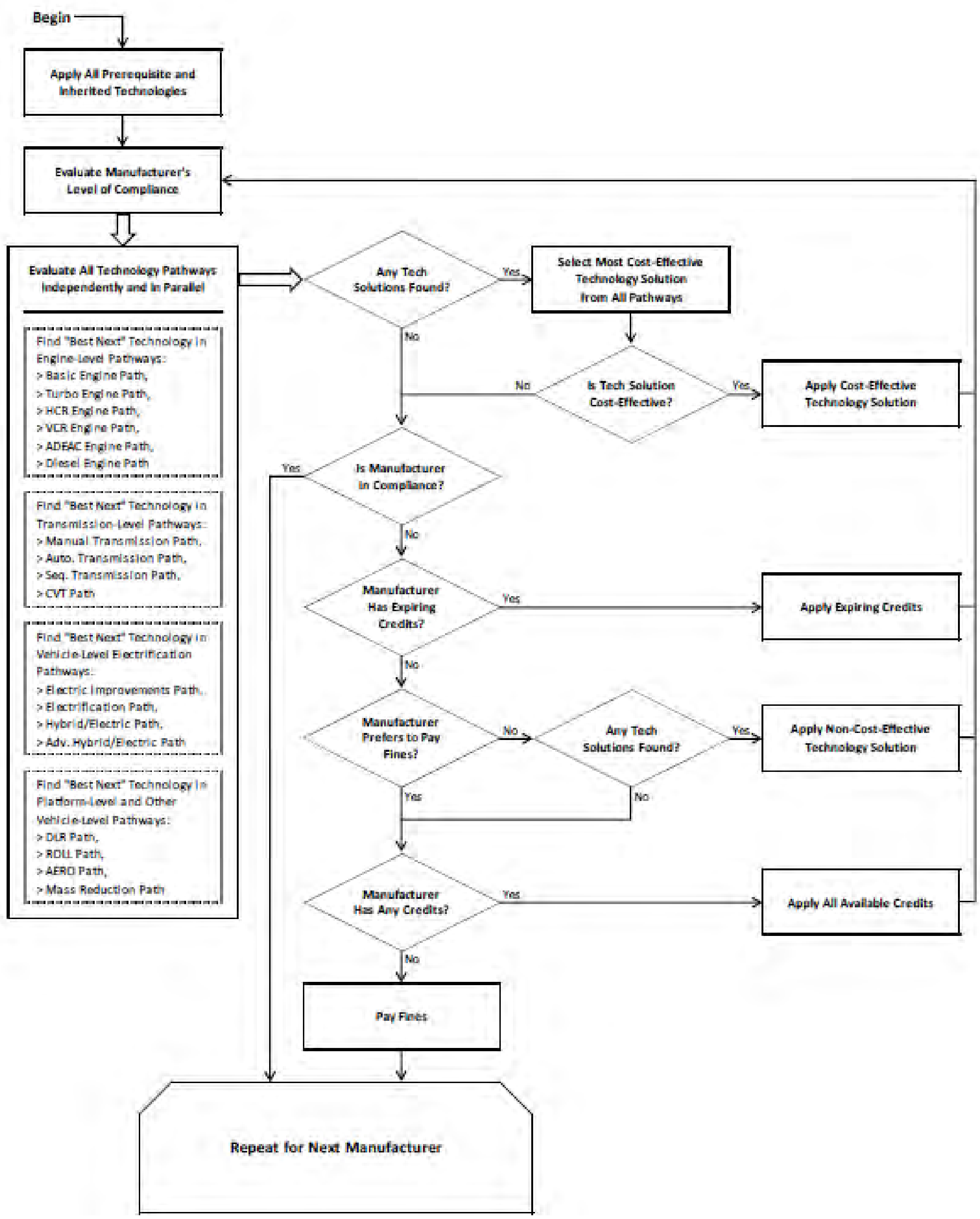
[90] In the case of the CAFE program, this value represents the change in CAFE civil penalties (or fines).

[91] *See* CAFE Model Documentation at 72-75 (explaining cost-effective technologies); 83 Fed. Reg. at 43,179, 43,225.

[92] The assumption that customers do not value fuel efficiency is irrational. *See* Section III.

Figure 9. Compliance Simulation Algorithm



Furthermore, it is unreasonable to assume, that manufacturers will only use their expiring credits or other compliance flexibilities after they have applied all cost-effective technologies, as seen in Figure 9. A manufacturer would not let a credit expire while using costly fuel efficiency technologies. They would be even less likely to do that if customers did not value the technology, as the agencies assume in the sales model. These unreasonable assumptions lead to an overestimation of fuel economy costs and thus bias the findings.

Perhaps a manufacturer would apply cost-effective technologies before using all available credits if the manufacturer is able to transfer or trade any credits about to expire. Yet, as explained more below, the agencies have not fully modeled the trading of excess credits, even when permitted to by statute. This failure further leads to a biased overestimate of total compliance costs for the entire industry.

2. Many of the agencies' failures to consider efficient deployment of banking, borrowing, trading, and offsets are not mandated by the statute

The proposed rollback explains that the agencies' model reflects banking as well as transfers between car and truck fleets, but not borrowing or trading.[93] Yet banking and transferring are not accurately modeled. While NHTSA has some limits on what flexibilities it can consider when setting standards, many of the omissions of compliance flexibilities from the model are not dictated by limits in NHTSA's statutory authority; moreover, EPA does not even face such limits.

Banking: The model's default assumption is that manufacturers will hold on to banked credits "for as long as possible," applying credits only after all technological options have been exhausted, and even applying expiring credits only after all "cost-effective" technological options have been exhausted.[94] The model also does not fully capture that manufacturers may strategically over-comply in some years to bank more credits. These assumptions are incorrect and will lead to an overestimation of costs. In reality, manufacturers will take a long-range view to planning their compliance and will identify the most cost-efficient times to generate credits, bank credits, and use credits. Sometimes a manufacturer will be able to save money by over-complying in early years when standards are less stringent, banking those credits, and then applying those credits in later years before installing costlier technologies. The model ignores these potential cost savings.

The model also only incompletely counts credits banked in years before the Proposed Rule would take effect. NHTSA claims that its statutory instructions prohibit it from considering credit availability in setting standards, and so only models credits that are already banked or will be banked and used through "the last year for which new standards are not being considered (MY 2019 in this analysis)."[95] First of all, because the Proposed Rule starts in MY 2021, that means MY 2020—not MY 2019—is the last year for which new standards are not being considered. This difference matters, especially because ignoring a full year of early banked credits will make it seem like manufacturers are further behind in meeting their compliance than they really are, which will affect the agencies' assumptions about the compliance costs

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[93] 83 Fed. Reg. at 43,181.

[94] *Id.* at 43,181.

[95] *Id.* at 43,183.

manufacturers will face from MY 2021 and on. Second, it is not clear that the statutory prohibition on considering credit availability was intended to apply to banked credits. The statutory limit on considering "trading, transferring, or availability of credits," 42 U.S.C. § 32902(h)(3), was added in 2007 as a "conforming amendment" to the Energy Independence and Security Act, which was the statute that gave NHTSA authority to allow credit trading and transferring;[96] meanwhile, banking and borrowing have been part of NHTSA's authority since the original Energy Policy and Conservation Act of 1975.[97] In 1989, for example, NHTSA explicitly relied on the availability of "credit banks" to justify maintaining the MY 1990 standard at 27.5 mpg instead of lowering its stringency.[98] NHTSA has not explained why it now believes it may not more fully consider banking. Third, whatever statutory limit may apply to NHTSA does not apply to EPA under the Clean Air Act. And yet, not only has EPA not separately modeled the cost-saving potential of banking more thoroughly, but the model does not even fully reflect the availability of already-banked CO_2 credits, because the "CAFE model was not modified to allow exceptions to the [assumed five-year] life-span of compliance credits" even though EPA credits for MY 2009-2011 may be used through MY 2021.[99]

All of these errors and unnecessary omissions result in the agencies overestimating total compliance costs, by failing to capture the full cost-saving potentials of banking. The agencies have made similar errors and omissions for all the other flexible compliance options: borrowing, transferring, trading, offsets, and penalties.

Borrowing: The agencies acknowledge that manufacturers have, in the past, sometimes made use of the cost-savings afforded by borrowing, but they chose not to include borrowing in the model because they assume manufacturers would not want to accept the "risk" of this flexible compliance strategy.[100] The agencies do not explain why they believe manufacturers would be particularly risk averse to the use of this compliance flexibility. The fact that manufacturers have, in fact, used borrowing in the past to help save on compliance costs indicates that the agencies should not be so quick to omit borrowing from the model. The result of that omission is likely an overestimation of compliance costs.

Transferring: Just as the model does not fully capture how manufacturers will strategically over-comply in order to bank credits, the model also does not fully capture how manufacturers may

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[96] Pub. L. 110-140 § 104, 121 Stat. 1503 (Dec. 19, 2007).

[97] Pub. L. 94-163 § 301 (amending the Motor Vehicle Information and Cost Savings Act §§ 503(a)(1) (on averaging) and § 508 (on banking)).

[98] 54 Fed Reg. 21,985, 21,994 (May 22, 1989) ("given their credit banks, both GM and Ford can easily comply with the MY 1990 standard of 27.5 mpg by use of carryforward credits, i.e., ones that have already been earned").

[99] 83 Fed. Reg. at 43,183.

[100] Id.

save on total costs by over-complying in one fleet to transfer credits to another fleet.[101] Furthermore, "[t]he model prefers to hold on to earned compliance credits within a given fleet," because that is the behavior the agencies have observed from the manufacturers going back to 2009.[102] Yet historical compliance behavior under less stringent standards is not necessarily a useful template for how manufacturers would respond in the future under more stringent standards. As the agencies acknowledge, under the CO_2 standards, given the availability of more early compliance credits, manufacturers have been more strategic about transferring credits between fleets to minimize their costs.[103] The agencies' failure to more realistically model the efficient use of transferring results in an overestimation of total compliance costs.

Trading: The agencies say they have "not attempted" to model trading.[104] Though NHTSA may have some statutory limits on its ability to consider the cost-saving potentials of credit trading, EPA does not face any such statutory limits under the Clean Air Act. The agencies do include a sensitivity analysis that, by pretending all cars and trucks were manufactured by a single company, imperfectly approximates the conditions of trading.[105] Even this imperfect exercise suggests the cost savings afforded by trading could be substantial: by the agencies' own estimates, costs drop by over 12%.[106] Yet in relegating this consideration to a single scenario in the sensitivity analysis, EPA has failed to consider how a model of the cost-savings of trading—combined with other necessary corrections to misestimates of costs and benefits and with other plausible assumptions also buried in sensitivity analysis—could further confirm what the agencies already know from the 2016 midterm evaluation: that compliance with the baseline standards is feasible and affordable, especially compared to the baseline standard's massive benefits. Instead, by relegating any consideration of trading to an imperfect sensitivity analysis, EPA has overestimated compliance costs.

Air-Conditioning and Off-Cycle Credits/Adjustments: The model "does not attempt to project how future off-cycle and A/C efficiency technology use will evolve . . . . Rather, this analysis uses the off-cycle credits submitted by each manufacturer for MY 2017 compliance and carries these forward to future years with a few exceptions."[107] For some manufacturers, that means the agencies assume zero or low[108] use of off-cycle adjustments in perpetuity, just because of their

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[101] *Id.*

[102] *Id.* at 43,185.

[103] *Id.*

[104] *Id.* at 43,181.

[105] *Id.* at 43,367.

[106] Id.

[107] *Id.* at 43,159.

[108] *Id.* at 43,160, tbl. II-79.

compliance choices for MY 2017. That is an illogical and arbitrary assumption. Rather, the agencies should assume that manufacturers will efficiently deploy all cost-saving offset opportunities, especially in the face of increasingly stringent standards.

EPA Is Not Constrained by EPCA: To whatever extent EPCA may limit NHTSA's ability to consider credit trading and transferring, such limits do not extend to EPA. EPA is *not* statutorily prohibited from taking credit trading and transferring into account in setting its standards, and it thus has no excuse not to consider them in analyzing the costs of the standards. To the contrary, EPA is required to "giv[e] appropriate consideration to the cost of compliance,"[109] and by failing to consider the availability of a cost-minimizing compliance strategy, the agency fails to consider an important element of its statutory factors.

If EPA fully models the rational use of credits while NHTSA does not, it is possible that the two agencies would reach somewhat different conclusions about what level of standards are justified. EPA might be tempted to ignore such analytical results and, instead of adopting the standards shown to be cost-benefit justified, just continue to match NHTSA's standards. Yet EPA is not allowed to set lower standards just for the sake of harmonization; to the contrary, full harmonization may be inconsistent with EPA's statutory responsibilities. Harmonization would have very real costs in terms of forgone emissions reductions and consumer savings and would go against EPA's statutory mandate. In addition, EPA would have to assess those costs and explain why the alleged benefits of harmonization would justify those very real costs. The Proposed Rule fails to satisfy this standard.

How the Agencies Considered Compliance Flexibilities in 2012: In prior rules, the agencies discussed and analyzed the impact of various compliance flexibilities when assessing whether new standards were feasible.[110] For example, in 2012, EPA embraced credit trading as a mechanism that allows manufacturers to comply with the standards in the most cost-effective way and took compliance flexibilities such as trading into account.[111] And despite NHTSA's statutory restriction, NHTSA acknowledged in 2012 that credit trading would reduce the cost of complying with the standards to a meaningful extent."[112] In fact, in 2012 NHTSA provided an estimate of the impact that those flexibilities have on the costs and found that compliance flexibilities would reduce the cost of additional technology needed for compliance by $20 billion, or about 15% of the total estimate.[113]

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[109] 42 U.S.C. § 7521(a)(2).

[110] 77 Fed. Reg. at 62,776.

[111] *Id.* at 62,649, 62,776.

[112] *Id.* at 63,082-83.

[113] *Id.* at 63,084.

Importantly, the 2012 analysis found the standards were beneficial even without these savings. Currently, since the agencies now assert that the costs of the original standards exceed their benefits, accounting for credit trading might change the outcome of the analysis and show that the proposed rollback is not justified.

In order to satisfy the requirement to provide a reasoned explanation, this issue must be addressed. When an agency reverses course through a repeal, it must provide a "reasoned explanation" for dismissing the "facts and circumstances that underlay" the original rule.[114] EPA has given no reason for not taking these flexibilities into account now in deciding to roll back its standards. And both NHTSA and EPA have failed to provide a reasoned explanation for ignoring the impact of credits and trading on compliance costs. At minimum, EPA needs to fully incorporate credit trading into its model for the years 2016-2030.

Risk Aversion: As a justification for disregarding credit trading, the agencies claim that "long-term planning is an important consideration for automakers," and that "firms may be reluctant to base their future product strategy on an uncertain future credit availability."[115] But the industry has a well-known track record of using trading and it is unlikely that the market would dry up. The manufacturers face uncertainty that will affect any compliance strategy: uncertainty from steel tariffs and technological innovation and so forth. There is no reason to think that vehicle manufacturers would be particularly risk averse to these particular types of compliance flexibilities. Averaging, banking, and borrowing have been part of the CAFE program since 1975.[116] While trading and transferring were added to the CAFE program later, vehicle manufacturers have been familiar with trading since EPA finalized rules for heavy-duty truck emissions in 1990.[117] Vehicle manufacturers have been comfortable with these compliance flexibilities for decades, and activity in the credit trading markets has increased in recent years.[118] The assumption that industry would be reluctant to use a proven tool that could save it money is arbitrary.

Additionally, there are a variety of ways to structure a credit market, through futures and liability schemes and banking, which can minimize many potential uncertainties.[119] Not only have manufacturers not been calling for such tools, suggesting perhaps a lack of particularized risk here, but also the agencies have failed to explore such tools if they do indeed perceive a risk. In

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[114] *Fox Television Stations*, 556 U.S. at 515-16.

[115] 83 Fed. Reg. at 43,231.

[116] Energy Policy and Conservation Act of 1975, Pub. L. 94-163 § 301 (amending the Motor Vehicle Information and Cost Savings Act §§ 503(a)(1) (on averaging) and 508 (on banking)).

[117] 55 Fed. Reg. 30,584 (July 26, 1990).

[118] Leard & McConnell (2017).

[119] Schwartz (2017).

any event, uncertainty applies to almost all businesses and there is no reason to believe that the vehicle industry is particularly risk averse. For instance, the supply of many "rare earth elements," rare minerals or elements needed to build products in the high tech industry, is legitimately uncertain.[120] But many high tech companies nonetheless operate under on the assumption that those materials will be available in developing their technologies.[121] The availability of trading here is much more certain than the availability of rare earths, and manufacturers are very likely to assume that trading will continue to be available.

3. NHTSA's assumption about which manufacturers are willing to pay penalties leads to an overestimate of compliance costs

The CAFE penalties work like safety valves because they allow car manufacturers to either comply with the standards or pay the penalty if compliance costs are too high.[122] Consequently, when the marginal cost of compliance is lower than the penalty, companies comply with the standards. But when the marginal costs of compliance with the standards exceed the penalty, companies tend to choose to pay penalties.

In assessing the costs of the baseline standards, NHTSA assumes that manufacturers consider paying penalties as a form of compliance only when all cost-effective technologies have already been deployed, and even then assumes that any manufacturer without historic evidence of willingness to pay penalties will instead opt for any non-cost-effective technologies before using any available credits. Ultimately, NHTSA assumes that most manufacturers are not willing to pay penalties beginning in 2020.[123] This effectively inflates the aggregate compliance costs. Combined with NHTSA's disregard for usage of credits after 2020, this assumption implies that each fleet needs to reach at least the fuel efficiency level prescribed by the standards in the given year through technology alone. Such modeling is equivalent to modeling a command-and-control regulation without any flexibilities and, by definition, will result in overstated compliance costs.

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[120] See for instance http://www.airforcemag.com/MagazineArchive/Pages/2018/February%202018/Rare-Earth-Uncertainty.aspx; https://www.wsj.com/articles/SB10001424052748704049904575553792429346772

[121] https://www.osa-opn.org/home/articles/volume_22/issue_7/features/rare_earth_elements_high_demand,_uncertain_supply

[122] NHTSA, CAFE Pub. Info. Ctr., Civil Penalties, https://one.nhtsa.gov/cafe_pic/CAFE_PIC_Fines_LIVE.html ("Manufacturers that do not meet the applicable standards in a given model year can pay a civil penalty."); NHTSA, CAFE Overview, https://one.nhtsa.gov/cafe_pic/CAFE_PIC_home.htm (describing the penalties as one option among several "compliance flexibilities"); *See also* Stranlund (2017), at 238 (describing the economics of compliance); Jacoby & Ellerman (2004) (describing the use of the safety valve principle to limit the cost of emissions restrictions); Roberts & Spence (1976) (describing the benefits of a penalty system enhancing the emission licensing when the abatement costs are unknown; Pizer, (2002) (describing the welfare benefits of enhancing quantity controls by using price controls like penalties when the compliance costs are unknown to the regulator).

[123] The assumptions regarding manufacturer behavior with respect to civil penalties is presented in Table–II–86, 83 Fed. Reg. at 43,180.

The assumptions NHTSA makes about which manufacturers are unwilling to pay penalties are arbitrary. NTHSA claims to base them on the historic data, but that data comes from a time when regulation stringency was much lower as compared to future standards.[124] Under such circumstances, there is no reason to assume—and NHTSA has not explained—that past compliance behavior provides enough relevant information to reliably predict manufacturers' future compliance strategies. With an increased penalty and more stringent fuel economy standard, historic compliance levels are likely to change going forward.[125]

Historical observations cannot explain all of the assumptions made by the agencies. The arbitrariness of NHTSA's penalty assumption is visible in its treatment of FCA (Fiat Chrysler Automobiles), for which NHTSA assumes willingness to pay penalties until year 2025 but never afterwards. NHTSA provides no justification for that arbitrary assumption.[126]

NHTSA assumes that most manufacturers will be unwilling to pay penalties based in part on the fact that most manufacturers have not paid penalties in recent years. The Proposed Rule cites the statutory prohibition on NHTSA considering credit trading as a reason to assume manufacturers without a history of paying penalties will comply through technology alone, whatever the cost.[127] But this is an arbitrary assumption and is in no way dictated by the statute. NHTSA knows as much, since elsewhere in the proposed rollback, the agency explains "EPCA is very clear as to which flexibilities are not to be considered" and NHTSA is allowed to consider off-cycle adjustments because they are not specifically mentioned.[128] But considering penalties are not mentioned as off-limits for NHTSA in setting the standards either. Instead, the prohibition focuses on credit trading and transferring. The penalty safety valve has existed in EPCA for decades, and Congress clearly would have known how to add penalties to the list of trading and transferring. The fact that Congress did not bar NHTSA from considering penalties as a safety valve means that NHTSA must consider manufacturer's efficient use of penalties as a cost-minimizing compliance option. Besides, NHTSA does consider penalties for some of the manufacturers making its statutory justification even less rational.

The agencies also explain that, since the Clean Air Act does not contain a specific civil penalty provision, the model does not assume that manufacturers will choose non-compliance with the CO_2 standards. To the extent it may be true that few manufacturers have a history of failing to comply with EPA's CO_2 standards, it is only because of the existence of useful compliance

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[124] *See* Union of Concerned Scientists, Response to Automaker Comments Regarding Raising CAFE Fines at 5 (Dec. 21, 2017), https://www.regulations.gov/document?D=NHTSA-2017-0059-0019.

[125] *See id.*

[126] "The notable exception to this is FCA, who we expect will still satisfy the requirements of the program through a combination of credit application and civil penalties through MY 2025 before eventually complying exclusively through fuel economy improvements in MY 2026." 83 Fed. Reg. at 43,181.

[127] *Id.* at 43,181.

[128] *Id.* at 43,212.

flexibilities like trading and borrowing. And yet the model does not capture trading and borrowing for CO_2 credits, nor does it accurately model other compliance flexibilities. The lack of a civil penalty provision in the Clean Air Act only highlights the need for EPA to fully model all available compliance flexibilities. Otherwise, EPA will overestimate compliance costs, as it has done in the proposed rollback.

4. Credit use does not show that the baseline standards are unaffordable

The agencies' justification for the Proposed Rule also misrepresents how manufacturers make their compliance credit decisions. According to the agencies, further proof that consumers do not sufficiently value fuel efficient vehicles lies in the fact that manufacturers have begun using credits to comply with the baseline standards.[129] This conclusion, however, gets the logic of credit use wrong.

Though automakers have indeed used banked credits to meet some of their compliance obligations under the baseline standards in the last couple of years,[130] there are at least two other reasons to explain that use, which are more likely than the argument that manufactures think they will not be able to comply with the standards in the future.

First, automakers have an incentive to use their banked credits if they are about to expire.[131] Credits earned in a given year can be banked for only a limited number of years,[132] and it would be a waste of money on the part of automakers to fail to use banked credits (or sell for usage) before they expire.

Second, automakers have an incentive to use banked credits when they expect that the future standards will be easier to achieve—not when they expect future standards to be more costly, as EPA asserts. A bank of credits is similar to a "rainy day fund." With a rainy day fund, if a person expects to need the fund in the near future, it would be foolish to use it today. If that person were to use the funds in such a case, the funds would be unavailable when they are really needed in the future. Similarly, if automakers expected compliance to be even more costly in the future, it would not make sense for them to use up their bank of credits right now.

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[129] *Id.* at 43,217; *id.* at 16,079.

[130] EPA, Manufacturer Performance Report for the 2016 Model Year iv (2018) [hereafter "EPA (2018) Manufacturer Performance Report"], available at https://www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-ghg-emission-standards-light-duty-vehicles#2016MY; see also 83 Fed. Reg. at 16,079.

[131] Credits can be banked and carried forward for up to five years. NHTSA, CAFE 2017-2015 Fact Sheet at 8, https://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2017-25_Fact_Sheet.pdf.

[132] Credits are usually available for five years, but some credits are available for different periods of time. See 40 CFR § 86.1865-12(k)(6)(ii).

Given this logic, the use of credits over the last couple of years (starting before the election of President Donald Trump, and so starting before promises began to be made about a rollback),[133] indicates that automakers may believe compliance will be less costly in the future than now. Given that the standards are scheduled to go up from 2022 through 2025, why might automakers expect compliance to be easier in the future? Three factors likely explain this belief.

First, rising consumer demand for fuel efficient vehicles caused by increasing fuel prices, as discussed in Section II.C. below, will make compliance easier. Second, increasing availability—and the lower cost—of low-emission vehicle technology will also make compliance less costly. An industry group released a recent analysis of electrified vehicle sales,[134] showing that sales of electrified vehicles have grown for the last two years, both in absolute terms and as a fraction of overall new vehicle sales.[135] This continues a long-running trend of growth in electrified vehicle sales that began when mass-market hybrid vehicles were released in the late 1990s.

Focusing in particular on sales of fully electric cars and trucks, sales growth is even stronger: 2017 was a record year for sales of fully electric vehicles. There were 199,826 fully electric vehicles sold in 2017, an increase of 25% relative to 2016, substantially outpacing growth in sales of vehicles overall.[136] In 2017, fully electric vehicles constituted just over 1% of all new vehicles sold in the United States.[137] In 2016, EPA found that the 2022–2025 standards would be achievable if even 2% of new vehicle sales are electric by 2025.[138] If sales continue to grow at their current rate, then fully electric vehicle sales will be at least double this amount by 2025. Current projections from the EIA show that fully electric vehicles are predicted to be 5.5% of new car sales by 2025.[139]

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[133] *See* EPA (2018) Manufacturer Performance Report at iv (reporting that "[u]nlike the previous four years, in which generating credits was the norm, most large manufacturers (with sales greater than 150,000 vehicles) generated deficits in the 2016 model year" and reported sufficient credits available from prior model years to be able to offset that deficit).

[134] This figure appeared as early as December 2017 in a Center for Automotive Research presentation. Chen (2017), at 18.

[135] Bailo et al. (2018), at 9.

[136] Jonathan M. Gitlin, *2017 was the best year ever for electric vehicle sales in the US*, ARSTECHNICA (Jan. 4, 2018), https://arstechnica.com/cars/2018/01/2017-was-the-best-year-ever-for-electric-vehicle-sales-in-the-us/.

[137] *Id*.

[138] EPA, NHTSA, & California Air Resources Board ("CARB"), 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 at 12-22 (2016), at https://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/Draft-TAR-Final.pdf [hereafter "Draft TAR"].

[139] EIA, Light-Duty Vehicle Sales by Technology Type (thousands), United States, https://www.eia.gov/opendata/qb.php?category=2642004 (last visited Apr. 26, 2018) (data found at "Light-Duty Vehicle Sales: Alternative-Fuel Cars: 100 Mile Electric Vehicle," "Light-Duty Vehicle Sales: Alternative-Fuel Cars: 200 Mile Electric Vehicle," and "Light-Duty Vehicle Sales: Alternative-Fuel Cars: 300 Mile Electric Vehicle").

Third, the generous electric vehicle credits available under the baseline standards may explain why automakers have expected compliance to be less costly. Since 2017, electric vehicles have allowed automakers to earn credits that can be used to meet compliance shortfalls due to sales of less-efficient vehicles. The credits earned by electric vehicles are especially valuable, because they also earn a "multiplier incentive" from EPA. Any credit earned for sale of an electric vehicle in 2017 through 2019 is doubled. Credits earned in 2020 are worth 1.75 traditional credits, and in 2021, they will be worth 1.5 traditional credits.[140] In addition to using these credits to meet their own compliance obligations, automakers can also sell these credits to other automakers or bank them (for up to five years) for use in the future.[141] The electric-vehicle credits give automakers substantial flexibility when meeting the standards. Given the significant benefits that electric-vehicle sales provide to manufacturers seeking to comply with the standards, the recent high projections of sales of electric vehicles indicate that automakers will have an easier time meeting the standards than EPA could have expected in 2012 or even when analyzing the Final Determination in 2016 and 2017.

B. The agencies' assumption that manufacturers will pass all compliance costs through to consumers is unreasonable

The agencies' full pass-through assumption[142] is unreasonable for two further reasons having to do with the structure of the vehicle markets.

1. Market power

First, the existing level of market power in the vehicle industry means that firms may not pass on all of their costs to consumers. When an industry is perfectly competitive, manufacturers cannot charge consumers more than their marginal cost of production, because competitors are ready and waiting to lure away their customers. Thus, with perfect competition, prices equal the marginal costs of production. In such a case, if production costs increase, the prices rise correspondingly. But the vehicle industry is still characterized by some degree of market power,[143] which means that manufacturers are less constrained in what they chose to pass on to consumers. In other words, firms in a market that is not perfectly competitive likely have a profit margin that is bigger than their marginal cost of production, and they can choose not to pass the

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[140] Draft TAR at 11-6. The multiplier for fully electric vehicles ends in 2021, but the credits earned until that point will be available for use for five years after the year in which they were earned.

[141] *Id.* at 11-4.

[142] 83 Fed. Reg. at 43,071.

[143] The market has become increasingly competitive. But strong product differentiation and huge fixed costs of entry have shielded the industry from becoming fully competitive. As a result, only four firms hold 58.1% of the market. Calculations of CR4 based on data from https://www.statista.com/statistics/249375/us-market-share-of-selected-automobile-manufacturers/. Because of this consolidation, the sector has some monopolistic competition, if not an oligopolistic structure.

full cost increases on to consumers through price increases, because they have the ability to absorb costs into their profit margin.[144] The agencies acknowledge that manufacturers have some ability to absorb costs into their profit margin,[145] thus supporting the assumption that manufacturers may choose to do so.

2. Mix shifting

Second, in their pursuit of profits, manufacturers can be expected to use any available means of reducing compliance costs.[146] And as the agencies acknowledge in the proposal, when deciding how to meet the standards, vehicle manufacturers can and do take into account consumers' demand for individual vehicle models and their attributes.[147] Using that information, manufacturers adjust prices across their fleet to optimally attract customers toward more fuel-efficient vehicles—a practice called *mix-shifting*.[148] As the agencies admit, this practice allows manufacturers to cross-subsidize the prices of entry-level vehicles to keep monthly payments low and attract new and young consumers to their brand.[149] It also allows manufacturers to shift the cost of fuel efficiency and emissions control improvements to categories of vehicles where consumers are less price-sensitive, such as luxury vehicles. This approach minimizes the total compliance cost, and in particular minimizes the pass through of costs to consumers of lower-price vehicles. As a result, economic studies tend to point to less than 100% pass though.[150]

While the agencies acknowledge cross-subsidization in the Proposed Rule,[151] in their price analysis, the agencies claim that "it is reasonable to assume that all incremental technology costs

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[144] *See* Hourcade et al. (2007).

[145] 83 Fed. Reg. at 43,085.

[146] *See* Anne C. Mulkern, *Economists see errors in government claims on pricing*, E&E NEWS (August 6, 2018), https://www.eenews.net/climatewire/2018/08/06/stories/1060092785 (quoting economist Mark Jacobsen, associate professor of economics at the University of California, San Diego as saying that "'Automakers don't always raise the price of cars relative to the costs of meeting fuel economy standards" but that instead automakers have "price points they're trying to meet for specific markets.").

[147] 83 Fed. Reg. at 43,186.

[148] *See* Luk et al. (2016), at 154–171; *see also* Goldberg (1998); Austin & Dinan (2005).

[149] 83 Fed. Reg. at 43,224; *see also id.* at 43,083 (acknowledging that technology costs could, among other options, be paid for by manufacturers or dealers rather than be passed onto consumers in their entirety).

[150] Gron & Swenson, (2000), at 316 (rejecting the hypothesis of full cost pass-through and constant markup).

[151] "All of this is paid for through cross subsidization by increasing prices of other vehicles not just in California and other States that have adopted California's ZEV mandate, but throughout the country." 83 Fed. Reg. at 42,999. In addition: "If the body-style level average price change is used, then the assumption is manufacturers do not cross-subsidize across body styles, whereas if the average price change is used then the assumption is they would proportion costs equally for each vehicle. These are implementation questions to be worked out once NHTSA has a historical data source separating price series by body styles, but these do not matter in the current model which only considers the average price of all light-duty vehicles. 83 Fed. Reg. at 43,095.

can be captured by the average price of a new vehicle."[152] This approach completely overlooks vehicle and customer heterogeneity and ignores the profit-maximization idea behind mix-shifting.[153]

In 2012, the agencies acknowledged mix-shifting and pointed to its importance going forward.[154] However, because mix-shifting can only decrease costs compared to baseline standards and the agencies had already found the rule to be beneficial, there was no need for mix-shifting modeling in 2012. But now, the agencies claim that the benefits of the baseline standards no longer outweigh the costs.[155] Yet the agencies cannot possibly reach such a conclusion before they have considered the impact of mix-shifting. Given that the agencies currently find the baseline standards to be detracting from welfare, they should ensure that their results are not driven by biased methodology that inflates the costs of the regulation.

Moreover, evidence of the industry's recent performance, cited in the Proposed Rule, shows that manufacturers have been able to comply with the standards over the past ten years without detriment to their fleets.[156] For example, the agencies explain that manufactures have been able to reduce fleet-wide CO2 emissions while continuing to produce a diverse fleet.[157] This was likely helped in part by the ability to shift any increase in costs due to the standards to models, such as luxury vehicles, where consumers are less likely to react to the price difference and thus continue to keep prices at a competitive level. The agencies now argue that the Proposed Rule is justified on the ground that something different "may" happen with compliance levels than was assumed in the baseline standards.[158] But that conjecture is insufficient to show that "there are good reasons for the new policy."[159]

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[152] 83 Fed. Reg. at 43,186.

[153] *See* Anne C. Mulkern, *Economists see errors in government claims on pricing*, E&E NEWS (August 6, 2018), https://www.eenews.net/climatewire/2018/08/06/stories/1060092785 (quoting economist Christopher R. Knittel, professor of economics at MIT as saying in the context of mix-shifting that "They [the agencies] add up what those technologies would cost, and then that is the change in prices of the vehicles. The EPA and NHTSA analysis, I think, is missing a major part of how the markets operate in the presence of fuel economy standards,").

[154] 77 Fed. Reg. at 63,068 ("We recognize, however, that many manufacturers do in fact cross-subsidize to some extent, and take losses on some vehicles while continuing to make profits from others. NHTSA has no evidence to indicate that manufacturers will inevitably shift production plans in response to these final standards, but nevertheless believes that this issue is worth monitoring in the market going forward.").

[155] As these comments explain, the agencies' analysis is fundamentally flawed.

[156] 83 Fed. Reg. at 43,231.

[157] *Id.* at 43,230.

[158] *Id.* at 43,231.

[159] *Fox Television Stations, Inc.*, 556 U.S. at 515; *see also NetCoalition v. SEC*, 615 F.3d 525, 539 (D.C. Cir. 2013) (holding that the court would not "defer to the agency's conclusory or unsupported suppositions" (internal quotation marks omitted)).

3. The agencies provide no evidence for their claim of past price increases due to the baseline standards

The agencies' suggestions that evidence of full pass-through lies in recent vehicle price increases are also incorrect.

According to the agencies, there have been "tremendous increases" in vehicle prices over the last decade, making vehicles "increasingly unaffordable."[160] But historical prices do not support the agencies' conclusions. As independent surveys show, over the last ten years, the price of lower-cost vehicles has remained constant despite recent increases in the stringency of standards. A study by Synapse Economics shows that the range of prices of new vehicles has increased, but those increases occurred because the price of high-end vehicles has gone up as more features have been added.[161] The price of more affordable vehicles, on the other hand, has not changed in real terms.

Moreover, the agencies' narrative about the average vehicle becoming unaffordable for the median household is ill-conceived and misleading.[162] By definition, the median household does not buy an average vehicle, but rather a median vehicle. To illustrate why that matters, assume that the price of only the most expensive makes (e.g., only Mclaren vehicles) increases. For the median household, this will have no implications: as the median household never buys the most expensive makes, the price of the vehicles it buys has not changed. However, the average price would increase, so using the agencies' logic, we would deduce that the increase of Mclaren car price would make the cars less affordable for the median household. That is obviously unreasonable.

In addition, in its discussion of affordability, the agencies also disregard the fact that the recent changes in average vehicle price can be, and in fact are, demand-driven and thus reflect the shift in consumer preferences, and not a financial burden for customers. For example, the agencies claim that "new vehicles become increasingly unaffordable—with the average new vehicle transaction price recently exceeding $36,000—up by more than $3,000 since 2014 alone."[163]

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[160] 83 Fed. Reg. at 42,993-94 (citing Average New-Car Prices Rise Nearly 4 Percent for January 2018 On Shifting Sales Mix, According To Kelley Blue Book, https://mediaroom.kbb.com/2018-02-01-Average-New-Car-Prices-Rise-Nearly-4-Percent-For-January-2018-On-Shifting-Sales-Mix-According-To-Kelley-Blue-Book (last accessed Jun. 15, 2018).

[161] Tyler Comings & Avi Allison, Synapse Energy Economics, Inc., *More Mileage for Your Money: Fuel Economy Increases While Vehicle Prices Remain Stable* 5 (2017), https://consumersunion.org/wp-content/uploads/2017/03/Synapse-CU-Affordability-Report-3-15-corrected-1.pdf.

[162] ("In fact, a recent independent study indicated that the average new car price is unaffordable to median-income families in every metropolitan region in the United States except one: Washington, DC. Figure I-2 with the average new vehicle transaction price recently exceeding $36,000—up by more than $3,000 since 2014 alone. 83 Fed. Reg. 42,993-42,994.

[163] *Id.* at 42,993.

However, as the quoted article explains: "shifting sales mix to trucks and SUVs has been particularly extreme lately, and as volume shifts away from cars, the average vehicle price ticks up."[164] Clearly, in that context, the agencies' concern about decreasing affordability is misplaced—it is the consumers that have been choosing, on average, the more expensive types of cars.

C. The agencies' reliance on "relatively low" fuel prices is arbitrary and capricious

The agencies' conclusions about the need for the Proposed Repeal also rest on the claim that fuel prices are "relatively low" when compared to fuel prices in 2012.[165] According to the agencies, because of these lower prices, consumers have chosen to buy vehicles that do not improve manufacturers' compliance positions.[166] For example, according to the agencies, because of the new fuel prices, consumers are not interested in hybrids.[167] And according to the agencies, because of these "new facts and circumstances," the agencies are justified in rejecting the 2012 facts and analyses.[168]

But the agencies have arbitrarily ignored EPA's analysis in 2016 and the 2017 Final Determination, which show that the baseline standards were still achievable and justified even though fuel prices had dropped since 2012. For the 2017 Final Determination, EPA's central analysis used the EIA Annual Energy Outlook 2016 ("2016 AEO") forecast of gasoline prices, and analyzed scenarios that included a low estimate of $1.97, up to a high estimate of $4.94. After analyzing those scenarios, EPA found that even with the lowest prices projected in AEO 2016 of close to $2, the "lifetime fuel savings significantly outweigh the increased lifetime costs" of the GHG Standards.[169] In ignoring the 2017 analysis, the Proposed Rule has failed to provide a "reasoned explanation" for dismissing the "facts and circumstances that underlay" the original rule rendering its analysis arbitrary and capricious.[170]

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[164] *Average New-Car Prices Rise Nearly 4 Percent for January 2018 On Shifting Sales Mix, According To Kelley Blue Book*, Kelley Blue Book https://mediaroom.kbb.com/2018-02-01-Average-New-Car-Prices-Rise-Nearly-4-Percent-For-January-2018-On-Shifting-Sales-Mix-According-To-Kelley-Blue-Book.

[165] 83 Fed. Reg. at 42,993; *id.* at 43,069 (explaining that both the high and low fuel prices from 2017 are lower than they were in 2011); *id.* at 42,993 ("Things have changed significantly since 2012, with fuel prices significantly lower than anticipated, and projected to remain low through 2050.").

[166] *Id.* at 43,217.

[167] *Id.* at 43,222.

[168] *Id.* at 43,226.

[169] EPA, Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation at 8 (2017, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100QQ91.pdf [hereafter "Final Determination"].

[170] *Fox Television Stations*, 556 U.S. at 515-16.

Moreover, even if fuel prices are slightly lower than in 2012, for the last several years, fuel prices have been rising again. Fuel prices have been rising steadily since 2016, and as of October 6, 2018, are at $2.866.[171] In the last year, fuel prices have risen by more than 10%.[172] With oil prices reaching currently around $83 per barrel of Brent crude, some analysts and commodity traders predict that 2019 might see prices above $100 per barrel.[173]

If fuel prices rise in line with these forecasts, those rising fuel prices will give consumers an increased incentive to buy fuel-efficient cars, raising demand for fuel efficient vehicles and making it easier for automakers to comply with the standards.[174] Indeed, even if fuel prices do not actually rise, a 2013 study shows that consumers believe future prices will be the same as current prices (stated more formally, average consumer beliefs are typically indistinguishable from a no-change forecast).[175] So the fact that prices are currently rising will motivate consumers to buy more fuel-efficient vehicles. In other words, even if consumers just expect fuel prices to rise (whether or not they actually rise), consumers will have the incentive to buy fuel-efficient cars.

In any event, fuel prices change very quickly and the accuracy of the forecast tends to be very low. As such, the agencies should recognize that the value of fuel efficiency provides an insurance value against future and unpredictable developments in gasoline markets. The agencies should not relegate any consideration of different, realistic gas prices to the sensitivity analysis, but instead should more systematically incorporate various gasoline price scenarios into their main analysis.

III. THE AGENCIES HAVE ARBITRARILY IGNORED CONSUMER VALUATION OF FUEL SAVINGS AND THE WELFARE BENEFITS OF THE BASELINE STANDARDS

The agencies' incomplete and inaccurate estimations of the fuel savings and time savings from increasing vehicle efficiency render its cost-benefit analysis arbitrary. Moreover, much of the proposed rollback's justification undercuts even those partial estimations, alleging that the private benefits of fuel economy standards must be illusory and will be offset by lost welfare from other vehicle attributes. Elsewhere, the agencies' model and the proposed rule's justification depend on inconsistent assumptions that either consumers do not value fuel economy at all, or else that consumers very strongly value fuel economy. The agencies have

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[171] Current gas prices from EIA are available here: https://www.eia.gov/petroleum/gasdiesel/

[172] *Id.*

[173] See https://oilprice.com/Energy/Oil-Prices/100-Oil-Is-A-Distinct-Possibility.html, https://www.aljazeera.com/news/2018/09/oil-prices-hit-year-high-81-looming-iran-sanctions-180925060509728.html and https://www.wsj.com/articles/opecs-wildcards-could-push-oil-to-100-1538737295

[174] EIA (2018A), at 113 (2018) (showing that sales of cars and other high-efficiency automobiles are expected to increase relative to sales of other vehicles starting in 2020 as gas prices motivate consumers to adopt more fuel-efficient vehicles).

[175] Anderson et al. (2013).

failed to consider important economic theories and evidence—both from new literature and from the agencies' own past rulemakings—that explain why fuel economy standards can deliver significant net private welfare gains. One such important concept is that many vehicle attributes, like horsepower and size, are positional goods, and so regulation of fuel economy can help correct the positional externality. The agencies also fail to consider the distributional aspect of consumer valuation of fuel economy and the health effects associated with refueling.

A. The myriad problems with the scrappage, rebound, and sales modules cause the agencies to underestimate the net forgone private savings from fuel economy

In their various tables summarizing the costs and benefits of the proposed rollback, the agencies present the forgone private savings from the proposed rollback as a net calculation. For example, the estimate of "higher fuel costs from lower fuel economy" includes "lost fuel savings from lowered fuel economy of MY's 2017-2029 *and gained fuel savings from more quickly replacing* MY's 1997 to 2029 with newer vehicles."[176] All the myriad problems with the agencies' scrappage, rebound, and sales modules (detailed throughout these comments) have therefore once again infected their calculation of costs and benefits. In this case, by overestimating the effect of the proposed rollback on the replacement of older vehicles with newer vehicles, the agencies have overestimated "gained fuel savings" that will allegedly offset lost fuel savings under the proposed rollback. If the agencies correct the problems with their scrappage, rebound, and sales modules, the estimates of net forgone private savings will increase, showing that the proposed rollback will be more detrimental to the personal welfare of vehicle owners than the agencies currently calculate.

B. The agencies' position on consumer valuation of fuel economy is internally inconsistent and provides false support for the rollback

Much of the Proposed Rule's justification and models depend on the incorrect and unsupported assumption that consumers do not value fuel economy. Nowhere is that wrong assumption more apparent or more problematic than in the agencies' sales module.

When purchasing a vehicle, an individual pays the upfront cost of the vehicle, and the consumer will also need to pay for fuel for the vehicle over time. The degree to which consumers value fuel economy relative to the objective, present discounted value of fuel savings, generally expressed as a ratio or a percentage of full valuation, is a key parameter for assessing how vehicle sales will react to fuel efficiency standards. If consumers have a valuation of less than 100%, that suggests that consumers undervalue fuel efficiency, implying that increases in fuel efficiency will not lead to as large of an increase in automobile demand as a standard economic

[176] *E.g.*, 83 Fed. Reg. at 43,065 (emphasis added).

model would suggest.[177] An undervaluation likely reflects a market failure, such as an informational failure, myopia, supply side failures, positional externalities, or so forth—as discussed below, and as discussed by the agencies at length in the 2012 rulemaking. Fuel economy regulations, therefore, can correct the market failure and so deliver net private welfare gains.[178] If consumers instead have greater than 100% valuation of fuel economy, then emissions standards will increase demand for more fuel-efficient vehicles by *more* than a standard economic model would predict.[179]

Despite the centrality of this parameter to accurate estimation of the demand response to the proposed rollback, the agencies arbitrarily omit the parameter from their sales module, thus implicitly assuming that consumers have a 0% valuation of fuel economy. To derive estimates for how the baseline standards would affect sales (which ultimately leads to the agencies' inflated fatality numbers), the agencies use a model that connects claimed price changes (attributed to the baseline standards) with sales.[180] That sales module ignores consumer valuation of fuel economy and so effectively treats consumers as having zero valuation of fuel economy.[181] Ignoring the amount that consumers value fuel economy in the sales module allows the agency to significantly boost the sales drop that it attributes to the baseline standards.[182] This drop in sales then drives the agencies' inflated estimates about the effect of the baseline standards on fleet size and fatalities.

Similarly, at various points throughout the proposed rule, the agencies assume that consumers' low valuation of fuel economy creates compliance "challenges for achieving increased fuel economy levels and lower CO_2 emission rates" and offer these challenges as a justification for the proposed rollback.[183] Thus, an assumed very low or zero valuation of fuel economy is central to the proposed rollback's justification.

But neither the literature the agencies cite nor any of the literature they ignore supports such an extreme and arbitrary assumption as a very low or zero valuation. The agencies' failure to estimate consumer valuation of fuel economy in their sales module results in their gross

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177 Steven Berry et al. (1995).

178 *E.g.*, Alcott & Sunstein (2015) (explaining that CAFE standards can correct internalities).

179 *See, e.g.* Busse et al. (2013).

180 *See* 83 Fed. Reg. at 43,074.

181 *Id.* at 43,075. The agencies claim that their model operates at "too high a level of aggregation to capture" consumer preference for fuel efficiency. *Id.*

182 The agencies conclude that, because of their assumptions, including their implicit assumption that consumers do not value fuel economy, it is "reasonable to assume" that lowering the standards will "increase total sales of new cars and light trucks during future model years." *Id.*

183 *E.g.*, *id.* at 42,993; *see also id.* at 43,217 (blaming "consumers not being interested in better fuel economy" for manufacturers' alleged need to "manag[e] their CAFE compliance obligations through use of credits").

overestimation of the alleged safety benefits of this proposed rollback, as explained throughout our comments. In fact, because EPA's 2017 *Final Determination* confirmed that "[e]ven with the lowest fuel prices projected by AEO 2016 . . . the lifetime fuel savings significantly outweigh the increased lifetime costs,"[184] there is good reason to believe that the original standards would raise consumer demand and hasten adoption of new vehicles, while the proposed rollback will have the opposite effect.

Moreover, the 0% valuation conflicts with agencies' own analysis. The agencies conclude—after reviewing only a very narrow set of literature (see next subsection critiquing the agencies' literature review)—that consumers instead value "at least half—and perhaps all—of the savings in future fuel costs."[185] The agencies' rebound module also implicitly assumes that consumers will have an extremely strong reaction to changes in fuel economy, indicating a strong valuation of fuel economy, and the scrappage module incorporates a cost-per-mile factor that assumes consumers value both absolute and relative fuel economy.[186] Elsewhere, the agencies rely on a payback assumption that consumers are willing to pay for fuel economy technology that returns the investment within 30 months.[187]

The agencies' inconsistent positions on consumer valuation of fuel economy are arbitrary and capricious. On the one hand, the agencies argue that consumers value fuel economy so fully that there can be no private welfare benefits to increasing fuel economy by regulation.[188] And on the other hand, the agencies argue the exact opposite, that consumers have so little regard for fuel economy that manufacturers cannot sell efficient vehicles.[189] In fact, neither extreme position is supported either by the literature that the agencies cite nor by the important additional literature that the agencies ignore.

C. The agencies fail to consider important theoretical and empirical literature

The Agencies' Three Preferred Studies: The proposed rollback's discussion of consumer valuation of fuel economy relies almost entirely on three sources: Sallee et al. (2016), Busse et al. (2013), and Allcott & Wozny (2014).[190] Before critiquing the agencies' reason for focusing only on these studies and the agencies' failure to look at other important literature, it is worth

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[184] Final Determination at 7.

[185] 83 Fed. Reg. at 43,073; *see also id.* at 43,075.

[186] See the sections of our comments on new vehicle sales, scrappage, and rebound for more details on all these inconsistent assumptions.

[187] *Id.* at 43,217.

[188] *See, e.g.*, *id.* at 43,072, 43,075.

[189] *Id.* at 42,993.

[190] *Id.* at 43,072-73.

noting that these three sources in no way support either the proposition that consumers do not value fuel economy at all (as the agencies implicitly assume in their sales model), nor the position that consumers already so perfectly value fuel economy that there is no possible benefit to efficiency standards (as the agencies imply in their literature review). The best read of even just these three studies is that consumers do value fuel economy but are not reliably willing to pay exactly $1 today for a net present expected savings in future fuel costs of just over $1, as classic economic theory would predict. Instead, there is a gap, and that gap creates the potential for a well-designed regulation to deliver net private benefits. Allcott & Wozny estimate that consumers are probably incorporating about 55% of future fuel costs into their vehicle purchase decisions;[191] Busse et al. estimate a very wide range (between 54% and 117%);[192] Sallee et al. find that consumers may "incorporate slightly more than 100% of changes in future fuel costs" into their decisions,[193] but also find "modest undervaluation" of "70 to 86%" among large-scale fleet operators.[194] None of these studies estimates a 0% valuation, as the agencies' sales module implicitly does.

The agencies justify their decision to focus almost exclusively on these three studies by highlighting problems with cross-sectional and discrete choice studies, and by citing those problems as a reason to prefer studies based on panel data.[195] While cross-sectional and discrete choice studies may have limitations, the studies the agencies focus on also have limitations. Most notably, as the agencies acknowledge, only one study they rely on, Busse et al., includes any direct examination of new vehicle sales, and even that estimate "is based on more limited information";[196] the other two studies, Sallee et al. and Allcott & Wozny, both focus exclusively on used vehicles.[197] And each of the three studies has various other limitations and idiosyncrasies with its choice of data and methodology. Sallee et al., for example, excludes data on hybrid vehicles.[198] Just as these various limitations would not necessarily be grounds to completely ignore these three studies, neither should all other literature be ignored outright.

Ignoring All Other Empirical Literature: Even as they admit the limitations of the three studies that they rely on, the agencies assume that the limitations of all other studies are fatal flaws and so essentially ignore all other literature, including literature that helps explain the energy

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[191] *Id.* at 43,072. With different model choices, that number either rises to 76%, *id.* (when using oil future market data) or drops to 55%; *id.* at 43,073 (with greater disaggregation of the MPG groups).

[192] *Id.*

[193] *Id.* at 43,072.

[194] *Id.* at 43,703.

[195] *Id.* at 43,071.

[196] *Id.* at 43,073.

[197] *Id.*

[198] PRIA at 936, n. 487.

efficiency paradox. Such an extreme reaction is not warranted. When a study raises useful and relevant points, it should not be ignored simply because the agencies prefer a different methodological structure, or even just because the study has not been published in a peer-reviewed journal. The agencies should assess the study's quality and relevance, and particularly should have a good reason to ignore studies that the agencies previously relied upon.

For example, the agencies identify in footnote 223 that Kilian & Sims (2006) also used a longitudinal approach to examine consumer valuation, similar to the methodology of the agencies' three preferred studies; yet the agencies exclude the results of this study because it is "unpublished" and so its "empirical results are subject to change."[199] It is true that the quality and finality of unpublished studies should be carefully examined before relying on them, and if they are of insufficient quality or relevance, they will not deserve equal consideration with literature published in peer-reviewed journals. Yet neither should unpublished studies, if otherwise relevant and of sufficient quality, be automatically ignored just because they are unpublished.[200] In this case, for example, the Kilian & Sims paper raises a relevant result and theory worthy of further consideration: specifically, that consumers react more strongly to a potential loss of fuel savings than to a potential gain in fuel savings.[201] Given that the agencies have relied on Killian & Sims in the past,[202] and given the relevance of their finding to the proposed decrease in fuel economy standards, the agencies should review the study's quality to determine its relevance, rather than dismiss it out of hand. The agencies should also more thoroughly search the literature for analysis of whether consumers will react differently to a rollback of fuel economy standards than to an increase in standards, and the agencies should generally review the literature that they had previously examined and relied on during the 2012 rulemaking.[203]

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[199] 83 Fed. Reg. at 43,072 n.223.

[200] *See, e.g.*, EPA (2010a), at 7-45 ("Because peer-reviewed academic journals may be more likely to publish work using novel approaches compared to established techniques, some studies of interest may be found in government reports, working papers, dissertations, unpublished research, and other 'gray literature.' Including studies from the gray literature may also help mitigate 'publication bias' that results from researchers being more likely to present and/or editors being more likely to publish studies that demonstrate statistically significant results, or results that are of an expected sign or magnitude. . . . [T]he analyst should develop an explicit set of selection criteria to evaluate each of the potentially relevant studies for quality and applicability to the policy case.").

[201] Kilian & Sims (2006), at 3 ("[T]he responses of automobile prices to positive changes in the real price of gasoline are far greater in magnitude than in the baseline case, whereas decreases in the price of gasoline have little or no effect on prices.").

[202] EPA (2010b), at 39 (explaining that Kilian & Sims suggests that consumers may be willing to pay more to avoid a decrease in fuel economy than to gain an increase in fuel economy). This literature review was commissioned in support of NHTSA and EPA's earlier rulemakings.

[203] *Id.*

The agencies should also review the most up-to-date literature. For example, the agencies should consider David Greene et al.'s recently published meta-analysis of marginal willingness-to-pay estimates for fuel economy. These authors find a mean estimate for willingness to pay of $853 for a $0.01/mile reduction in fuel costs.[204] The agencies have failed to do a thorough search of the literature and to base their decision on all of the reliable information available to them.

Ignoring Other Explanations for the Efficiency Paradox: The agencies claim that previous rulemakings relied heavily on the belief that consumers' undervaluation of fuel economy was due to "myopia,"[205] and falsely assert that the prior rules could only be justified by assuming that consumers value less than one-third of fuel savings.[206] In the past, the agencies did raise the idea of consumer myopia and various "internalities" among the many reasons why consumers may fail to achieve their welfare-maximizing level of fuel economy in the marketplace without the assistance of regulation. But, the agencies also previously explored many other reasons for the energy efficiency paradox which supported the decision to adopt the baseline standards—reasons which the agencies now ignore. For example, in the 2012 rule, the agencies explained that what seems like an undervaluation of fuel economy could result from consumers "lack[ing] the information necessary to estimate the value of future fuel savings, or not hav[ing] a full understanding of this information even when it is presented," or that "[i]n the face of such a complicated choice, consumers may use simplified decision rules," and may focus on "visible attributes that convey status."[207] Yet, with no analysis of the relevant literature, the agencies now assume that consumers must be perfectly informed about fuel economy[208] and so conclude that "it is reasonable to believe that U.S. consumers value future fuel savings accurately."[209]

In fact, important literature explains why, even with the assistance of somewhat improved—though surely not yet optimized—labels that provide consumers with information on fuel savings, consumers may still face challenges to fully incorporating that information into their decisionmaking. James Sallee, for example, has explained that:

> [A]ccurate valuation of lifetime present discounted fuel costs is challenging, both because the calculation is cognitively difficult and because the information required is hard to obtain. Government labels aid in this task, but they do not resolve all uncertainty because the labels are incomplete and inaccurate and because

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[204] Greene et al. (2018) at 270-71 (finding a range from a mean estimate of $693 in market sales and revealed preference studies, to $1225 in stated-preference studies; meanwhile, NHTSA data would suggest that a $0.01/mile reduction should deliver about $1150 in lifetime fuel savings).

[205] 83 Fed. Reg. at 43,216.

[206] *Id.* at 43,073.

[207] 77 Fed. Reg. 62,624, 62,914 (Oct. 15, 2012).

[208] 83 Fed. Reg. at 42,993.

[209] *Id.* at 43,216.

> heterogeneity in usage patterns implies that labels can resolve only a modest portion of the relevant uncertainty.[210]

Because the variation in fuel costs across automobiles—though "substantial"—is also "dwarfed by variation in prices," and given the costs of obtaining and processing more information about fuel economy, consumers tend to be "inattentive" to fuel economy. The financial loss in future fuel savings to any individual from making a "mistake" in their choice of fuel economy may be less than the costs of the effort to obtain and process more information on fuel economy before the decision—yet, "in the aggregate," the result could be billions of dollars in lost fuel savings across the entire U.S. car market.[211] Because "firms will bring to market only those innovations that garner attention," firms may underprovide important but "shrouded" innovations in fuel economy that may rationally escape consumers' attention.[212] Yet because increased attention "involves real costs" for consumers, policy fixes focused on increasing information and attention may not improve welfare; instead, energy efficiency standards become the optimal policy solution.[213] The agencies have failed to consider the ongoing challenges to information processing that consumers face and so fail to consider how regulation can help consumers overcome these challenges and maximize private welfare.

Similarly, the agencies now ignore explanations of supply-side market failures that helped justify past rulemakings. In the 2012 rule's impact analysis, the agencies explained that imperfect competition in the vehicle market could "reduce[ ] producers' profit incentive to supply the level of fuel economy that buyers are willing to pay for."[214] Asymmetric information between manufacturers and consumers could also cause fuel economy to "remain persistently lower than that demanded by potential buyers."[215] Manufacturers may "deliberately limit the range of fuel economy levels they offer" if manufacturers "mistakenly believe" that consumers are unwilling to pay for improved fuel economy.[216]

Other important literature further explores these supply-side market failures. Manufacturers may face a first-mover disadvantage for developing new fuel-efficiency technologies, and regulation can help overcome that perceived disadvantage as well as bring down costs through economies of scale and learning, and thus may "lead to a more optimal provision of fuel economy in the

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[210] Sallee (2014), at 782. Note also that NHTSA has not fulfilled its statutory obligation to develop a consumer education program on fuel economy and greenhouse gas emissions. 49 U.S.C. § 32908(g).

[211] *Id.* at 783.

[212] *Id.* at 784.

[213] *Id.* at 785. Note that Sallee et al. (2016), which the agencies rely on, cite Sallee (2014) as an important "caveat" to some of the conclusions drawn in Sallee et al. (2016). *See* Sallee et al. (2016), at n. 5.

[214] NHTSA 2012 FRIA at 987-88.

[215] *Id.*

[216] *Id.*

marketplace."[217] As manufacturers offer more fuel-efficiency technology and the technology becomes more widespread in the market, consumer attitudes toward that technology will change.[218] Manufacturers also shape consumer preferences through advertising. Yet now, the agencies assume that it is consumer preferences alone that shape and constrain manufacturers' compliance options,[219] without considering manufacturers' role in shaping the options available in the marketplace and consumers' attitudes toward those options. A review of the broader set of literature, on both supply-side and demand-side obstacles to the efficient provision of fuel economy, demonstrates that the justification for the proposed rollback runs counter to the available evidence.

In Tables II-25 to II-28, the agencies' presentation of costs and benefits seem to count the forgone private savings from the increased fuel economy that the original 2012 standards would provide. Implicit in the calculations in those tables is some theory for why consumers will value fuel savings once a regulatory standard helps deliver increased fuel economy, even though consumers are unable to achieve those fuel savings on their own in an unregulated marketplace. Viable theories supported by the literature include some combination of informational failure, attention costs, myopia, positional externalities, or supply-side failures. Much of the agencies' discussion in the *Federal Register* notice and preliminary regulatory impact analysis either ignores or seems skeptical of these theories, and as already noted, much of their modeling relies on inconsistent assumptions that consumers instead do not value fuel economy. As the agencies redo their analysis in response to these and other public comments, they should preserve the calculation of private savings from fuel economy reported in these tables (corrected so that the mistakes with the scrappage, rebound, and sales modules do not cause an undervaluation of net private savings). By more fully valuing the private fuel savings from the 2012 standards, together with other corrections to the analysis, it will be apparent that the proposed rollback is not justified.

D. Surveys on consumer satisfaction

The proposed rollback insists that consumers value fuel savings accurately,[220] that consumers "generally tend not to be interested in better fuel economy above other attributes,"[221] and that consumers are "unlikely" to "suddenly become more interested in fuel economy over other

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[217] NAS (2015), at 319.

[218] *Id.*

[219] *E.g.*, 83 Fed. Reg. at 43,217 (blaming "consumers not being interested in better fuel economy" for manufacturers' alleged need to "manag[e] their CAFE compliance obligations through use of credits").

[220] *Id.* at 43,216.

[221] *Id.* at 43,217 (citing manufacturer comments and an NAS study; but see *infra* on contradictory evidence from the same NAS study).

attributes" in the "foreseeable future."[222] The agencies rely on these statements to claim there are compliance challenges with the 2012 standards, and so justify the proposed rollback. Yet these conclusions are not supported by extensive data from consumer satisfaction surveys.

National Academy: As reported by a 2015 review of fuel economy standard by the National Academy of Sciences, "the public's perception of the CAFE standards and support for raising the standards has been highly positive for the past 25 years."[223] In one survey, for example, 77% of respondents supported higher fuel economy standards even after being told that it would increase the costs of buying or leasing; in another survey, 82% of respondents supported standards of 56 miles per gallon by 2025.[224] The proposed rollback's various pronouncements on consumer valuation are inconsistent with these findings.

ACSI and J.D. Power Surveys: Two long-running surveys of consumer satisfaction with their motor vehicles provide a good deal of publicly available data: the American Customer Satisfaction Index, and J.D. Power's APEAL survey. The data from these two surveys strongly suggests that consumers at least partly value fuel economy, that they value it even when fuel prices are dropping, that they sometimes value it more than other attributes, that they want more of it and are not satisfied by the levels currently provided, and that fuel economy is among the attributes with the most room for improvement and most potential to contribute to greater customer satisfaction with their vehicles.

This section of our comments will look first at recent evidence from these surveys specifically on fuel economy, before taking a more historical and graphical look at data going back to 1994.

Since 1994, the American Customer Satisfaction Index (ACSI) has conducted annual surveys on consumers' satisfaction with "recent purchases and driving experiences" in both mass-market and luxury cars and trucks.[225] Since 2016, ACSI has included details and scores for individual attributes, including gas mileage. In the 2016, 2017, and 2018 surveys, gas mileage has consistently been the lowest-ranked attribute for consumer satisfaction, in both mass market and luxury vehicles.[226] The results of the 2017 survey confirmed that "[r]egardless of category,

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[222] *Id. see also id.* at 42,993 (assuming that only "a relatively small percentage of buyers" value fuel economy, and citing only a single news report).

[223] NAS (2015), at 317.

[224] *Id.* at 318.

[225] For example, in 2018, they conducted 4,649 interviews about "recent purchases and driving experiences. *See* ACSI, *Automobile Report 2018*, https://www.theacsi.org/news-and-resources/customer-satisfaction-reports/reports-2018/acsi-automobile-report-2018/acsi-automobile-report-2018-download [hereafter "2018 ACSI Report"]. As a result, their data may reflect more than just purchases of new vehicles and may include purchases of used vehicles and driving experiences in vehicles that the interviewee did not directly purchase.

[226] ACSI, *Automobile Report 2016,* https://www.theacsi.org/images/stories/images/reports/16aug_auto-report.pdf [hereafter "2016 ACSI Report"]; ACSI, *Automobile Report 2017*,

everybody wants better gas mileage," and that of all the attributes, gas mileage "shows the most room for improvement."[227] The 2018 report made identical comments, adding that "gas mileage continues to be the low point" among all vehicle attributes.[228]

J.D. Power has conducted the U.S. Automotive Performance, Execution and Layout (APEAL) Study for twenty-three years. Its most recent survey, for example, interviewed nearly 68,000 purchasers and lessees of new Model Year 2018 vehicles within ninety-days of ownership.[229] At various times, the APEAL study has included details and comments on fuel economy specifically, and in more recent years, individual attributes including fuel economy have been scored and ranked separately. In 2007, J.D. Power observed that over half of that year's total drop in overall customer satisfaction with new vehicle performance could be attributed to "a significant decrease in owner delight with fuel economy," noting that "manufacturers that deliver more fuel-efficient vehicles . . . stand a better chance of delighting their customers."[230] In 2008, J.D. Power reported that "fuel economy and practicality are increasingly important in vehicle selection process" and attributed yet another overall dip in consumer satisfaction "primarily due to decline in satisfaction in fuel economy."[231] In 2009, an uptick in overall consumer satisfaction was "driven primarily by increased owner satisfaction with fuel economy," which J.D. Power attributed not just to fuel prices, but also to the fact that more manufacturers were designing--and more consumers were buying--fuel-efficient vehicles.[232] In 2010, the vehicles that scored the best included those with "unexpected fuel economy."[233] In 2011, newly launched vehicle models scored higher than redesigned models, partly due to higher scores for fuel economy.[234] In 2012,

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http://marketing.theacsi.org/acton/attachment/5132/f-0058/1/-/-/-/-/ACSI%20Automobile%20Report%202017.pdf [hereafter "2017 ACSI Report"]; 2018 ACSI Report.

[227] 2017 ACSI Report.

[228] 2018 ACSI Report.

[229] Joseph Dobrian, *2018 New Car Appeal Shows Biggest Improvement in History*, J.D. POWER (July 25, 2018), https://www.jdpower.com/cars/ratings/performance-and-design/2018/2018-us-apeal-study-results.

[230] J.D. Power, *Fuel Price Concerns Lead to Decrease in Vehicle Appeal*, June 26, 2008, https://web.archive.org/web/20090221020855/http://www.jdpower.com/corporate/news/releases/pressrelease.aspx?ID=2008078.

[231] Jeff Youngs, J.D. Power, 2008 APEAL Study Results (Dec. 31, 2007), https://www.jdpower.com/Cars/Ratings/Performance-and-Design/2008/2008-apeal-study-results.

[232] Jeff Youngs, J.D. Power, 2009 APEAL Study Results, Dec. 31, 2008, https://www.jdpower.com/Cars/Ratings/Performance-and-Design/2009/2009-apeal-study-results.

[233] Paul A. Eisenstein, *U.S. Automakers Gain APEAL—and Appeal*, NBC NEWS (July 22, 2010), http://www.nbcnews.com/id/38346050/ns/business-the_driver_seat/t/us-automakers-gain-apeal-appeal/ (reporting on APEAL scores).

[234] J.D. Power, *Automakers Face Up to Tough Market Conditions by Offering the Most Appealing Lineup of New Vehicles in History*, July 27, 2011, https://web.archive.org/web/20120304214343/http://www.jdpower.com:80/content/press-release-auto/7uCb2L3/owner-reported-fuel-economy-from-apeal-study-.htm.

owners shifted toward smaller and more fuel-efficient vehicles, and satisfaction with fuel economy showed the greatest overall increase, helping to drive the total APEAL score up. That year, J.D. power reported that "*47 percent of owners say gas mileage was one of the most important factors in choosing their new vehicle, up from 40 percent in 2011*."[235] In 2014, fuel economy was the only attribute with a year-over-year improvement in owner satisfaction, driven not just by fuel prices but by vehicle efficiency itself. Nevertheless, "fuel economy is still a problem area for automakers . . . [and] *continues to be the lowest-scoring category in the study by a wide margin*."[236] In other words, consumers have not been satisfied with the fuel economy provided by manufacturers, and it drags down their overall satisfaction with their new vehicles. In 2016, an improvement in fuel economy had the largest impact on overall increase in satisfaction; increased satisfaction with the related attribute of driving range was the second-most-important attribute in driving overall gains in consumer happiness.[237] And in 2018, satisfaction with fuel economy rose again slightly (though remained relatively quite low compared to all other attributes), with J.D. Power reporting that "*customers are more satisfied with their fuel economy despite increases in fuel prices*."[238] Driving range rounded out the "top 10 vehicle attributes with the greatest positive effect year over year on overall score."[239] Looking back over J.D. Power's survey results from the last decade, consumers have consistently expressed dissatisfaction with current levels of fuel economy and a desire for greater fuel economy than the market was providing, even during periods when gas prices were falling.

These robust surveys undercut many of the agencies' justifications and conclusions. The upshot from the ACSI and J.D. Power survey is that consumers are not satisfied with the currently available levels of fuel economy, they want greater fuel economy improvements even when gasoline prices fall, and they are unable to obtain in the marketplace the amount of fuel economy they would prefer. Additionally, as the graph in the next subsection suggests, fuel economy could have a relationship to overall customer satisfaction with their vehicles that other attributes, like horsepower and size, in fact might lack.

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[235] J.D. Power, *As Vehicle Appeal Improves, Owners Find that Downsizing Doesn't Necessarily Mean Downgrading*, July 25, 2012, http://www.jdpower.com/press-releases/2012-us-automotive-performance-execution-and-layout-apeal-study.

[236] Jeff Youngs, J.D. Power, 2014 APEAL Study Results (July 23, 2014), https://www.jdpower.com/Cars/Ratings/Performance-and-Design/2014/2014-apeal-study-results.

[237] J.D. Power, Safety Features Score Big, Boosting New-Vehicle Appeal, July 27, 2016, http://www.jdpower.com/press-releases/jd-power-2016-us-automotive-performance-execution-and-layout-apeal-study.

[238] Joseph Dobrian, 2018 New Car Appeal Shows Biggest Improvement in History (July 25, 2018), https://www.jdpower.com/cars/ratings/performance-and-design/2018/2018-us-apeal-study-results.

[239] J.D. Power, Infographic: 2018 Performance and Design Key Stats, July 25, 2018, https://www.jdpower.com/cars/ratings/quality/2018/infographic-2018-us-apeal-study-key-stats.

Graphing Attributes Against Fuel Economy: Data from these long-running, robust consumer satisfaction surveys can be plotted against relative changes in attributes like average horsepower, size, acceleration, and fuel economy. The resulting graph, Figure 1 below, is not a full economic analysis, but even a coarse look at the data is revealing.

These are the data sources for the graph that appears below:

- Horsepower: graphed in red below, data on the percent change in average light-duty vehicle horsepower since a baseline of 1994 is drawn from EPA's 2018 report on *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends*.[240]
- Weight: graphed in yellow below, data on the percent change in average light-duty vehicle weight since a baseline of 1994 is also drawn from that 2018 EPA report.
- Acceleration: graphed in orange below, numerical data on acceleration is not provided directly by the 2018 EPA report; however, numerical estimates of relative changes in average vehicle acceleration since 1994 were backed out from EPA's own chart on acceleration.[241]
- Fuel economy: graphed in green below, data on the percent change in average adjusted fuel economy since 1994 is also drawn from EPA's 2018 report.[242]
- Consumer Satisfaction: graphed in various shades of blue below, there are three sets of data on consumer satisfaction.
    - The American Customer Satisfaction Index (ACSI) has conducted annual surveys since 1994 about consumers' satisfaction with "recent purchases and driving experiences" in both mass-market and luxury cars and trucks.[243] Their survey captures opinions about gas mileage, driving performance, dependability, safety, comfort, and other "critical elements of the automobile experience."[244] Scores out of a possible 100 are given for each manufacturer and as an industry-wide average going back to the baseline year of 1994.[245] The industry-wide average is used here.
    - J.D. Power has conducted the U.S. Automotive Performance, Execution and Layout (APEAL) Study for twenty-three years. Its most recent survey interviewed nearly 68,000 purchasers and lessees of new Model Year 2018 vehicles within ninety-days of ownership.[246] The survey covers 90 attributes in 10 categories: fuel economy, exterior,

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[240] EPA (2018a), at tbl. 2.1.

[241] *Id.* at Figure 3.11.

[242] Adjusted fuel economy values "reflect real world performance and are not comparable to automaker standards compliance levels." EPA, *Trends* at 4.

[243] For example, in 2018, ACSI conducted 4,649 interviews about "recent purchases and driving experiences. *See* 2018 ACSI Report. As a result, their data may reflect more than just purchases of new vehicles, and may include purchases of used vehicles and driving experiences in vehicles that the interviewee did not directly purchase.

[244] ACSI, Automobiles, https://www.theacsi.org/industries/manufacturing/automobile.

[245] ACSI, Benchmarks by Company: Automobiles and Light Vehicles, https://www.theacsi.org/index.php?option=com_content&view=article&id=149&catid=&Itemid=214&i=Automobiles+and+Light+Vehicles.

[246] Joseph Dobrian, J.D. Power, *2018 New Car Appeal Shows Biggest Improvement in History*, July 25, 2018, https://www.jdpower.com/cars/ratings/performance-and-design/2018/2018-us-apeal-study-results.

seats, interior, driving dynamics, storage and space, engine and transmission, visibility and safety, HVAC, and audio/communication/entertainment/navigation.[247] Historical APEAL scores are not compiled in a single database online, but many can be pieced together from press releases and old media coverage. We have compiled industry-wide APEAL scores going back to 2001 (except for the year 2002, which was not available online).[248]

  - From personal communications with J.D. Power employees, as well as from observations on how more recent press releases discussed historical scores, we learned that the scale for the scoring was changed between 2005 and 2006.[249] Therefore, there are two separate sets of data from the APEAL survey: 2001 to 2005, with year 2001 results as the baseline; and post 2006, with year 2006 results as the baseline.

There may be some slight time lag between the year when a survey was conducted and the model year of the vehicles covered, though note that, for example, the APEAL survey conducted in the summer of 2018 focused on Model Year 2018 vehicles. The ACSI survey results also cover more than just customer experiences with new vehicles, and also includes all recent vehicle purchases. Yet despite such limitations, the raw data is still revealing.

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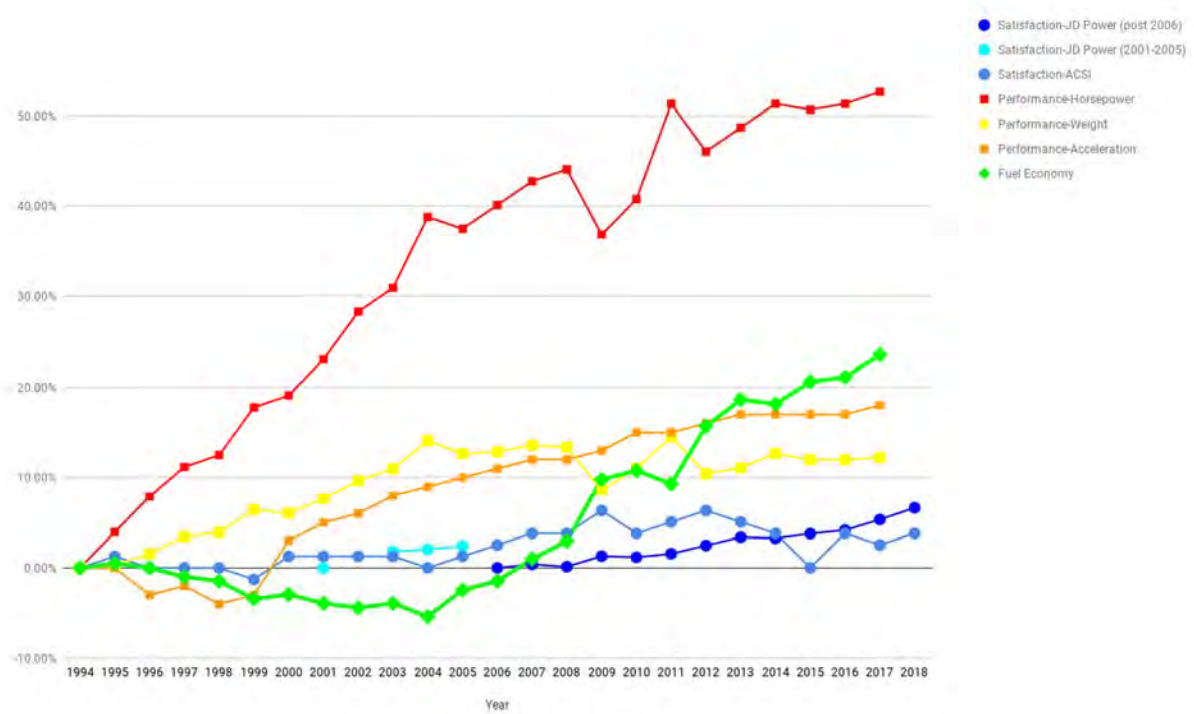
[247] J.D. Power, *U.S. Automotive Performance, Executive and Layout (APEAL) Study*, http://www.jdpower.com/press-releases/jd-power-2017-us-automotive-performance-execution-and-layout-apeal-study.

[248] Data compiled from: 2018 score (https://www.jdpower.com/cars/ratings/performance-and-design/2018/2018-us-apeal-study-results); 2013-2017 scores (http://www.jdpower.com/cars/articles/jd-power-studies/infographic-2017-us-apeal-study-key-stats); 2012 score (http://www.jdpower.com/press-releases/2012-us-automotive-performance-execution-and-layout-apeal-study); 2010-2011 scores (http://www.jdpower.com/cars/articles/jd-power-studies/2011-apeal-study-results); 2009 score (https://www.thetorquereport.com/news/porsche-once-again-leads-in-2009-j-d-power-apeal-study/); 2007-2008 scores (https://web.archive.org/web/20090221020855/http://www.jdpower.com/corporate/news/releases/pressrelease.aspx?ID=2008078); 2006 score (https://acurazine.com/forums/automotive-news-6/j-d-power-apeal-study-news-%2A%2A2014-results-page-1-%2A%2A-394014/; and *American Drivers Rate Midland Motors*, Birmingham Post UK, June 30, 2006, 2006 WLNR 113085817); 2005 score (*Exhaust Notes*, Winnipeg Free Press, Sept. 30, 2005, 2005 WLNR 15414064; and *Lexus Owners Love Their Cars: Power Study*, Globe & Mail, Sept. 29, 2005, 2005 WLNR 15327636); 2004 score (*Nissan Scores Well in Consumer Survey*, Clarion-Ledger (Jackson MS), Oct. 15, 2004., 2004 WLNR 23140691; and *Notebook*, Automotive News (Newsday), Nov. 4, 2004, 2004 WLNR 5166450); 2003 score (http://money.cnn.com/2003/10/07/pf/autos/jdpower_apeal/); 2001 score (*Standard Catalog of Buick 1903-2004* p.329, listing the industry average APEAL score for 2001), *available at* https://books.google.com/books?id=PO65ddhim6kC&pg=PA329&lpg=PA329&dq=%22Automotive+Performance,+Execution,+and+Layout%22+2001+average&source=bl&ots=rPwLoRViPJ&sig=8o2uv-GkvDjIGBlA41hjvP9C0w0&hl=en&sa=X&ved=0ahUKEwjN3MWXr73bAhVpjFQKHcdsC9wQ6AEIVjAH#v=onepage&q=%22Automotive%20Performance%2C%20Execution%2C%20and%20Layout%22%202001%20average&f=false.

[249] E-mail Correspondence between Jason A. Schwartz and J.D. Power staff (June 12, 2018).

Figure 1. Changes in Vehicle Attributes versus Changes in Consumer Satisfaction with Vehicles



Overall, consumer satisfaction with their recent vehicle purchases has been mostly flat since 1994, with some possible slight upticks in recent years. The huge increase in vehicle horsepower from 1994 through 2011—a relative increase of over 50%—does not appear to have had any obvious effect on consumer satisfaction. Vehicle weight and acceleration also rose from the late 1990s through about 2011, but have remained relatively flat since, and there again is no obvious relationship between their early rise and consumer satisfaction.

Meanwhile, horsepower has continued to grow, and to a lesser extent acceleration has continued to increase, even as fuel economy has shot up significantly over the last decade. This period of both significant growth in fuel economy and moderate increases in horsepower and acceleration, does appear to correlate with a slight uptick in consumer satisfaction in recent years.

Though further study would be required, from this graphical presentation of the data there appears no obvious reason to believe that a rise in fuel economy will cause a decrease in vehicle performance or consumer satisfaction—to the contrary, a rise in fuel economy at least appears correlated with similar upticks in horsepower and consumer satisfaction. Furthermore, this graphical presentation of the data shows large increases in vehicle performance attributes in the late 1990s and early 2000s that do not appear to be obviously correlated with any contemporaneous increases in consumer satisfaction. One reason why horsepower could increase by 50% without consumers becoming much happier about their vehicle purchases is because motor vehicles in general, and especially their performance attributes like horsepower, acceleration, and size, are positional goods. The theory and evidence of vehicles as positional goods is explored further in the next section.

E. Vehicles' positional attributes create externalities and impede consumers from achieving efficient levels of fuel economy absent a cooperative regulatory solution

In the regulatory impact analysis, the agencies assert that because requiring manufacturers to focus on fuel economy will necessarily entail lost consumer welfare as the manufacturers sacrifice other improvements to horsepower, weight, and volume, consumers will be "substantially better off under the agencies' proposed action than if the baseline standards remained in force."[250] In fact, the exact opposite may be true: because horsepower, weight, and volume are all positional attributes, the consumption of increasing levels of those attributes may deliver little if any increased consumer welfare.

The value of a "positional good" depends on how it compares with similar goods possessed by others.[251] The owner of a positional good derives more welfare from that good than expected when considering only its functional qualities. The prominent explanation for this phenomenon is that highly visible consumption becomes a signal for status,[252] and people value status because they anticipate it will translate into more favorable treatment in economic and social interactions.[253] For example, jewelry, silk ties, and expensive champagne all have very little functional value, but their consumption is conspicuous and conveys status to others.

Other goods, like cars, have both functional and positional value. Consumers may partially value vehicle size and horsepower for their functional utility like hauling capacity and speed, but a growing body of research indicates that many consumers do not necessarily want the biggest and fastest vehicle, so long as their vehicle is bigger and faster than their friends' and neighbors' vehicles. According to a recent U.S. survey on the visibility of 31 expenditure categories (from food to mobile phones), new or used motor vehicle purchases were the second most visible

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[250] PRIA at 934, 943, 1097; *see also* 83 Fed. Reg. at 43,255 (predicting welfare losses relating to the performance of more efficient vehicles).

[251] Frank (1985), at 101.

[252] *Id.* at 107 ("When an individual's ability level cannot be observed directly, such observable components of his consumption bundle constitute a signal to others about his total income level, and on average, therefore, about his level of ability. . . . [I]mperfect information about ability might create incentives for people to rearrange consumption patterns to favor observable goods."). Consumption patterns might vary depending on the relevant population in the status competition. People might compete among friends, neighbors, and coworkers; within their socio-economic class; with higher classes; or on a society-wide basis. *See* Carlsson et al. (2007), at 590. If a particular population has more reliable, independent information on abilities or income, consumption patterns for observable goods might shift. Frank (1985), at 108.

[253] Weiss & Fershtman (1998), at 802. Status can be instrumental, in that higher status can carry better consumption opportunities, access to better employment, and even better marriage prospects. Hopkins & Kornienko (2004), 1087. Factors like psychology, biological hardwiring, and envy also should not be ignored.

expenditure; related expenditures on gasoline/diesel, vehicle maintenance, and insurance were all substantially less visible.[254] Surveys also consistently confirm that cars are highly positional goods, that people prefer a relative increase in a car's value to an absolute increase,[255] and that the more visible features of cars are more positional.[256] Financial savings, in contrast, are typically considered non-positional.[257]

The more observable prestige features of vehicles include newness, brand, size, design, and power. While many of these traits have functional value (such as capacity, safety, and performance),[258] they also all have relative value: consumers value power not just for speed but for the status signal and for the ability to out-accelerate others at a traffic light; consumers do not necessarily want a *big* car, but they do want a *bigger* car.[259] As Bob Lutz, the former Vice Chairman of General Motors, has stated, "aspirational aspects overwhelm the functional differences" when customers choose cars.[260] Similarly, as J.D. Power has reported, "[w]e strive to own vehicles of which our neighbors will approve."[261] Meanwhile, given the low visibility of

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[254] Heffetz (2011), at 1106 (vehicle purchase had a visibility index of 0.73, second only to tobacco products (0.76); gasoline/diesel had a visibility index of 0.39, car repairs were at 0.42, and car insurance fell near the bottom at 0.23).

[255] Specifically, a majority of people surveyed would trade a decrease in their car's absolute value for an increase in its relative value compared to other people's cars: in other words, they are happy to have their car lose value so long as everyone else loses more value on average. *See, e.g.,* Carlsson et al. (2007), at 588, 593 (reporting results of a Swedish survey); Alpizar et al. (2005), at 412 (reporting results of Costa Rican survey). Though some such surveys were conducted in other countries, if anything positionality for cars could be stronger in the United States, given the American affinity for cars and the income distribution. *See* Heffner et al. (2005), at 2 ("In the words of automobile psychologist G. Clotaire Rapaille, Americans are in 'a permanent search of an identity' and 'cars are very key . . . [they are] maybe the best way for Americans to express themselves.'"); Hopkins & Kornienko (2004) (noting that positional effects increase as society's income increases, because the portion of income spent on conspicuous consumption increases). On the other hand, cars may be more a necessity and less a luxury for some U.S. consumers compared to some consumers in other countries. *See* Grinblatt et al. (2004).

[256] Carlsson et al. (2007), at 588, 593 (finding support for hypothesis that "visible goods and their characteristics, such as the value of cars, are more positional than less visible goods and their characteristics, such as car safety.").

[257] *See, e.g.*, Moav & Neeman (2009).

[258] Carlsson et al. (2007), at 595, could not provide a clear answer to the question of whether cars are completely positional. On average cars are highly positional, but that reflects a good deal of heterogeneity: cars may be completely positional for some people, but are possibly completely non-positional for others. *Id.* at 596.

[259] Verhoef & van Wee (2000), at 4 ("However, most cars in most Western countries have engines with much more power than needed, given the characteristics of infrastructure, speed limits, and travel distances."). *See also* Hoen & Geurs (2011).

[260] George Will, *Americans and Their Cars*, TOWNHALL DAILY, Apr. 18, 2002, *available at* http://townhall.com/columnists/GeorgeWill/2002/04/18/americans_and_their_cars.

[261] Jeff Youngs, J.D. Power, *2007 APEAL Study Results*, Dec. 32, 2006, https://web.archive.org/web/20160514230140/http://www.jdpower.com/cars/articles/jd-power-studies/2007-apeal-study-results

gasoline expenditures and of financial savings, fuel efficiency itself is currently a relatively non-positional good.[262]

A vehicle's size and weight are also positional for safety reasons, in addition to status motivations. To the extent smaller cars may at times fare worse in crashes with bigger cars, consumers may value bigger cars not because of any intrinsic safety value, but because of the average fleet size.

The trouble with positional goods is they impose externalities. This is obvious in the safety context: if Joan upgrades from her compact car to a large pick-up truck, she may feel somewhat safer, but her purchase marginally increases the perceived risk to all other drivers. It also applies in the status context. Again, if Joan buys a big, fast, flashy vehicle to move up the status hierarchy, John's big, fast, flashy car is no longer as rare. John feels relatively worse off and so will have to invest in an even bigger, faster, flashier car just to restore his previous status position. Joan's purchase made John feel worse off (a positional externality), and then John's subsequent purchase made Joan feel worse off (another positional externality), and at the end they wind up with the same relative status that they started with. As a result, both consumers spend resources without actually improving their relative status.

Because vehicle purchase decisions are made non-cooperatively but in fact alter the spending behavior and perceived safety of others, consumers get stuck on a "positional treadmill" that does not increase welfare.[263] Yet if any individual unilaterally tries to opt out of this "expenditure arms race," it would only move that consumer backwards on the status or safety hierarchy, which for most consumers is unacceptable.[264] And given limited resources and limited market options, the over-consumption of positional goods results in under-consumption of non-positional goods (such as fuel efficiency). If consumers could maintain their relative economic position, they might be more willing to pay for non-positional goods.[265]

Fuel economy regulation, therefore, is a cooperative solution that allows consumers to achieve what they could not in the non-cooperative open market: namely, an increase in fuel economy

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[262] *See* Hoen & Geurs (2011).

[263] Frank (2005), at 137.

[264] Frank (2005), at 105-06.

[265] Frank & Sunstein (2001), at 326 ("If people could maintain their relative economic position, they would be willing to pay more, and possibly a great deal more, to purchase many of the goods that regulation attempts to deliver. . . .[W]hen an individual buys additional safety in isolation, he experiences not only an absolute decline in the amounts of other goods and services he can buy, but also a decline in his relative living standards. In contrast, when a regulation requires all workers to purchase additional safety, each worker gives up the same amount of other goods, so no worker experiences a decline in relative living standards. If relative living standards matter, then an individual will value an across-the-board increase in safety more highly than an increase in safety that he alone purchases.").

without losing position in the status hierarchy.[266] Regulations similarly help consumers select fuel economy without falling behind in the safety/size perceived rankings, since with time the average size of vehicles in the fleet will shift. Regulations will also help correct a supply-side problem, since theory predicts that manufacturers will devote their research and development budget to status goods,[267] thus causing an oversupply of positional attributes at the expense of fuel economy.

Positional goods theory explains that: the agencies are incorrect that if manufacturers could redirect their research and development budgets from fuel economy to performance attributes that consumers would inherently become "substantially better off under"; the agencies are incorrect that consumers are able to demand in the market their desired levels of fuel economy; and the agencies are overlooking an important benefit of the regulation, which is correcting the market failures caused by positional externalities.

The Agencies' Proposed Alternative Approaches to Consumer Valuation Ignore Positionality and Other Explanations for the Energy Efficiency Paradox: The agencies suggest two alternative approaches to consumer valuation for the future. They propose either that in the future the agencies should assume that consumers fully (or near fully) value fuel savings in both the baseline scenario and under efficiency standards, or else assume that consumers partly value fuel savings to the same degree in both the baseline scenario and under efficiency standards.[268] The upshot of both alternatives would be similar: the private fuel saving benefits generated by increased efficiency standards would be devalued, and the assumed valuations under the baseline would partly or fully cancel out the private fuel saving benefits under the standards. Either approach would likely send agencies in search of alleged welfare losses attributed to increased fuel efficiency to explain why, if consumers fully value fuel savings, they do not already demand them in the marketplace.

Both of these proposed alternative approaches would be a mistake. There is no evidence that there are substantial private welfare losses associated with increasing fuel economy.[269] To the contrary, the graph presented above depicts neither a loss of consumer satisfaction associated

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[266] Correcting for negative externalities and collective action problems is a classic case for regulation. "Analytically, positional externalities are no different from ordinary environmental pollutants." *Id.* at 364. Such regulation is not about taking public action just because one consumer's increased consumption makes another consumer unhappy or envious; rather, regulation is justified to address a market failure. *Id.* at 365. Even if not everyone wants to solve this particular collective action problem, "we do not require unanimity as a precondition for unquestionably legitimate collective action in other spheres." *Id.* at 366. *See also* Verhoef & van Wee (2000), at 13-14. ("On the free market, consumers would inefficiently strongly stimulate each other to purchase more luxurious variants. Corrective taxes [or a CAFE standard with tradable permits] may protect consumers against such treadmills.").

[267] Cooper et al. (2001).

[268] 83 Fed. Reg. at 43,074.

[269] *See, e.g.*, Huang et al. (2018), at 194 (finding that "automakers have typically been able to implement fuel-saving technologies without harm to vehicle operational characteristics" like "acceleration, handling, ride comfort, noise, braking feel, and vibration").

with increasing fuel economy, nor a gain in consumer satisfaction associated with increasing performance attributes. Moreover, there are several other explanations supported by theory and literature that explain why consumers would fully value private fuel savings achieved under an efficiency standard and yet are unable to demand that the market increase fuel economy under the baseline in the absence of regulatory interventions. Positional goods theory is one important explanation that the agencies have failed to consider, together with explanations about information processing, myopia and internalities, supply-side market failures, and other evidence considered by the agencies in past rulemakings that the agencies now inexplicably ignore. The agencies should continue to value forgone private savings from fuel economy as they have in Tables II-25 to II-28 (once those calculations are corrected for mistakes from the scrappage, rebound, and sales modules).

F. Problems with the agencies' valuation of the refueling surplus

Multiple problems with the agencies' calculation of refueling surplus (the time savings and other benefits from having to refuel less) result in a significant underestimation of the proposed rollback's forgone benefits and show that the agencies have arbitrarily failed to consider important aspects of the issue and have ignored important evidence.

Rebound: First, because the agencies have miscalculated the rebound effect (as described in Section VI), they are overestimating the number of refueling trips that the purchasers of new, more-efficient vehicles would make, and so are underestimating the forgone benefits from the lost refueling surplus.

Outdated Data: Second, the valuation of lost refueling surplus is based on outdated data. Though the agencies' link to the *Value of Travel Time Savings Memo* appearing in footnote 258 of the proposed rollback is a broken link,[270] it seems very likely that the agencies are using an outdated version of NHTSA's own *Value of Travel Time Savings Memo*. The current version was updated last in 2016.[271] The version of the memorandum included in the regulatory docket is the 2011 version.[272] Meanwhile, the values that the proposed rollback uses for the percentages of personal and business travel in urban areas (94.4% versus 5.6%) and in intercity travel (87% versus 13%) match neither the 2016 nor the 2011 versions (both of which list instead, for example, 78.6%

[270] 83 Fed. Reg. at 43,085 n.258.

[271] Dept. of Transp., *The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations* (2016), https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf.

[272] https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0679.

personal travel in intercity); instead, these numbers seem to come from the 2003 version of the memorandum.[273]

Not only are the percentages of personal versus business travel outdated in a way that leads to underestimating the total hourly valuation for intercity travel, but the base wage rate is outdated as well. The agencies inexplicably start with Bureau of Labor Statistics data for "total hourly employer compensation costs *for 2010*," and present the data in uninflated 2010$.[274] Using the same data source and same methodology but updating to current, year 2017 wages would increase the base wage in the agencies' calculations from $29.68 to $35.52.[275] The urban versus rural percentages of the total miles driven figures should also be updated from the 2011 data used in the proposed rollback,[276] to the current FHWA data available for year 2017.[277]

Using these data updates but otherwise keeping the rest of the methodology the same,[278] the total weighted value of travel time per hour used in this regulatory analysis should be at least $21.41, not $17.73. The agencies may have underestimated the value of travel time by 20% just through use of old data.[279]

Excluding Children: The next step in the methodology is to multiply that per individual per hour value of travel time by the average vehicle occupancy during refueling trips. Here, the proposed rollback uses figures of 1.21 people per trip in passenger cars, and 1.23 people per trip in light trucks.[280] The proposed rule cites to the 2011 Tire Pressure Monitoring System study as the

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[273] *See* NHTSA 2012 FRIA at 874 (table viii-6, showing identical numbers as the current proposed rollback's table ii-39); *id.* at 873 n.448 (citing the 1997 and 2003 guidelines).

[274] 83 Fed. Reg. at 43.085 & n.259. At 83 Fed. Reg. 43,088, the proposed rollback does discuss "updating time values to current dollars," but that line follows a reference to having "updated the final rule to reflect peer reviewer suggestions," and includes a citation to a 2012 regulatory docket. It seems likely that this text was cut and pasted from a previous rulemaking (as was much of the analysis and discussions in this section), making it impossible for the reader to tell from the *Federal Register* notice or from the regulatory impact analysis whether the 2010$ figures that appear so prominently in the tables in this section were in fact inflated to current dollars for purposes of tallying forgone benefits.

[275] *See* BLS, *Employer Costs for Employee Compensation Historical Listing*, tbl 1. (data for 2017), https://www.bls.gov/web/ecec/ececqrtn.pdf.

[276] 83 Fed. Reg. at 43,087 n.261.

[277] *Available at* https://www.fhwa.dot.gov/policyinformation/travel_monitoring/17dectvt/17dectvt.pdf. This update would slightly change the weights to about 70% urban, 30% rural, which would slightly decrease the value of time calculation compared to the weights used in the proposed rollback (67.1% urban and 32.9% rural), but would be more up-to-date.

[278] These comments do not necessarily endorse the rest of the methodology. For example, there are questions about discounting personal travel time saved versus business travel time saved.

[279] If the agencies did inflate from 2010$ to more current dollars, the underestimation would still likely exist, though it may not be quite as large.

[280] 83 Fed. Reg. at 43,087.

source of these figures, but the source is unclear because the only document on the Tire Pressure Monitoring System provided in the regulatory docket is the

User's Coding Manual.[281] The agencies' failure to make available the full data and methodology used to calculate these average occupancy figures frustrates any meaningful public review. Nevertheless, the agencies do disclose that their estimated occupancy figures specifically exclude children under 16 years of age,[282] because "it is assumed that the opportunity cost of children's time is zero."[283]

This is the third major problem with the refueling valuation: the exclusion of children's value of time. The choice not to count children violates both NHTSA's own guidelines and best practices for cost-benefit analysis. In the 2016 *Value of Travel Time Savings* memorandum, NHTSA considers whether the value of travel time is different for parents versus children, but ultimately concludes that "it must be assumed that all travelers' VTTS are independent and additive," and later expands that "Although riders may be a family with a joint VTTS or passengers in a car pool or transit vehicle with independent values, these circumstances can seldom be distinguished. Therefore, all individuals are assumed to have independent values. Except for specific distinctions [such as personal versus business travel], we consider it inappropriate to use different income levels or sources for different categories of traveler."[284]

Turning to other cost-benefit guidelines, OMB's *Circular A-4* instructs agencies to estimate "gains or losses of time in work, leisure and/or commuting/travel settings," but nowhere distinguishes between children's and adult's valuations, except to note that, for health effects, "the monetary values for children should be at least as large as the values for adults . . . unless there is specific and compelling evidence to suggest otherwise."[285] Writing on the concept of "standing in cost-benefit analysis," Dale Whittington and Duncan MacRae conclude that "there is a clear consensus that children should be counted" in cost-benefit analysis.[286] The agencies fail to provide any compelling argument why they should break from this clear consensus and treat all children's time as worthless.

In 1965, when Congress first directed the control of motor vehicle air pollution to protect "the health or welfare of *any person*" after taking into "appropriate consideration . . . economic

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[281] https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0681.

[282] 83 Fed. Reg. at 43,087 n.262.

[283] *Id.* at 43,086.

[284] 2016 VTTS Memo, at 5, 12.

[285] OMB Circular A-4 at 31, 37.

[286] Whittington & MacRae. (1986), at 666.

costs,"[287] Congress clearly had in mind not just the welfare and costs of adults, but of "any person." And when Congress mandated the "maximum feasible average fuel economy" after considering "economic practicability . . . and the need of the United States to conserve energy,"[288] it spoke not just of the needs of adults, but of the entire U.S. population. By excluding all children under the age of sixteen, the agencies arbitrarily undercount the proposed rollback's forgone refueling benefits.

Erasing 40%: A fourth major problem with the agencies' refueling valuation is the decision to erase 40% of the total value due to the assumption (drawn from the Tire Pressure Monitoring System study) that "40% of refueling trips are for reasons other than a low reading on the gas gauge" and that "owners who refuel on a fixed schedule will continue to do so."[289] But if vehicles become more efficient such that the gasoline tank is less empty after driving a given number of miles, either drivers will make fewer refueling trips or, minimally, those who continue to refuel on a fixed schedule will spend less time at the pump on each refueling trip, because their gasoline tanks will not have been as depleted over a given period of time. The agencies' own calculations indicate that time spent filling and paying at the pump makes up nearly two-thirds of the total time spent on average refueling trips for both cars and trucks.[290] Even for drivers who continue to refuel on a fixed schedule, they will save time at the pump, because their tanks will be less empty at the start of refueling. The agencies cannot completely discount those time savings.

Additionally, not every refueling trip that is "for reasons other than a low reading on the gas gauge" is automatically an example of someone who "refuel[s] on a fixed schedule." The *User's Coding Manual* for the Tire Pressure Monitoring System study included multiple possible responses for the primary reason for the stop besides either low gas tank or a routine schedule, including refueling trips motivated because it was "convenient at this time," "to get/do something else (e.g., food, rest stop)," to take advantage of "price," to "top off for specific reason (e.g., before long trip)," or for some "other" reason.[291] The refueling portions of stops based on all these reasons may become shorter or may not occur at all if vehicles become more efficient and need less frequent refueling. The agencies cannot throw out the refueling time savings associated with all these other reasons for typical refueling stops.

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[287] Pub. L. 89-272, 79 Stat. 992 (Oct. 20, 1965) (emphasis added); *compare* 42 U.S.C. § 7521(a) (controlling pollution that "endanger[s] public health or welfare," after giving "appropriate consideration to the cost of compliance").

[288] 49 U.S.C. § 32902(f).

[289] 83 Fed. Reg. at 43,088.

[290] *Id.* at 43,087, tbl. II-41.

[291] NHTSA (2017) at 236.

Moreover, the relevance of the agencies' data is questionable. The *User's Coding Manual* for the Tire Pressure Monitoring System study on which the agencies so heavily rely suggest that data was collecting on "vehicles entering the gas station to refuel during five 15-minute data collection time periods (08:00 – 08:15 a.m., 1000 – 10:15 a.m., 12:00 – 12:15 p.m., 2:00 – 2:15 p.m., and 4:00 – 4:15 p.m.). These time periods were to last the full 15 minutes, unless a weather-related reason or cooperation issues resulted in the need to prematurely suspend data collection at that site."[292] The study seems not to have captured those who refuel outside the hours of 8am-4pm, nor to have captured refueling behavior during inclement weather. There is no reason to believe based on the study that drivers who refuel outside of those specific conditions would continue to operate on a rigidly fixed refueling schedule regardless of how full the tank of their more fuel-efficient vehicles may be.

Altogether, the agencies have thrown out 40% of the refueling time savings benefits without a reasonable justification for ignoring those potential benefits—on top of the underestimations of time savings due to the rebound miscalculation, the use of outdated data, and the complete exclusion of all children under the age of 16.

Fuel Cost and Emission Savings*:* Finally, the agencies also may be excluding the cost savings and emissions savings from not having to combust fuel to drive to refueling stations as often. The agencies acknowledge that while these savings "may seem like a small amount" per individual and per year, they are "much more significant at the macro level."[293] Yet even though the agencies explained how "direct estimation . . . of this benefit" would be possible, instead the agencies insisted that "this benefit is implicitly captured in the separate measure of overall valuation of fuel savings."[294] The agencies do not clearly explain how these additional cost savings and emissions reductions are actually accounted for in their methodology, and given all the myriad problems with the agencies' calculations of vehicle miles travel (as detailed throughout these comments), it is quite possible that these additional refueling benefits are, in fact, not "implicitly accounted for elsewhere" in either the fuel savings or emissions reductions calculations. If not, then that is an additional undercounting of the forgone refueling benefits of the proposed rollback.

The agencies also ignore the health and welfare consequences of the emissions associated with refueling and refueling stations.[295] Residential proximity to gasoline stations, for example, may have "a significant association" with childhood leukemia, due to benzene emissions from

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[292] NHTSA (2017) at 31. *See also id.* at 210 (suggesting that no interviews with refueling drivers were conducted after 6pm).

[293] 83 Fed. Reg. at 43,088.

[294] *Id.* at 43,088 (also insisting that emissions benefits are also "implicitly accounted for elsewhere").

[295] *Compare* 83 Fed. Reg. at 43,344 (where the agencies consider the "exposure and health effects associated with traffic," but not those associated with refueling).

gasoline.[296] Regular exposure to refueling stations, from employment or otherwise, may also have genotoxic and other serious health effects.[297] It is not clear that the agencies' consideration of upstream emissions from the fuel distribution system fully capture the health effects from exposure during refueling and from proximity to or working at refueling stations. If not, then the agencies have ignored yet another important aspect of the regulatory issue before them.

G. Distributional impacts

The agencies assert that the alleged reduction in vehicle purchase price will particularly "make the difference" for "some low-income purchasers."[298] First, the agencies' assumptions about the likely change in purchase price are problematic. Not only have the agencies overestimated the average change in purchase price because of multiple mistakes in their analysis—for example, as discussed in these comments, the agencies' failure to accurately model how manufacturers will efficiently use all available compliance flexibilities, including penalties—but the agencies ignore evidence specifically on the price of lower-cost vehicles.[299] For example, a study by Synapse Energy Economics shows that over the last ten years, the price of lower-cost vehicles has remained constant even as fuel economy has risen with the standards.[300] The study shows that while the range of prices of new vehicles has increased, those increases occurred because the price of high-end vehicles went up as more features were added; the price of more affordable vehicles, on the other hand, has not changed.[301] Similar findings were also reported in EPA's own analysis leading up to the 2017 Final Determination. In that analysis, EPA found that car sales recovered to pre-recession sales levels by 2015 under increasing fuel-efficiency standards and have continued to rise since then.[302] Ultimately, EPA found in the 2017 Final Determination that "prices in recent years, adjusted for quality and inflation, have been flat, not increasing."[303]

Second, the agencies have failed to consider the other side of the coin for impacts to low-income consumers: the loss of fuel savings. Low-income consumers spend a relatively larger fraction of

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[296] Infante (2017); Steinmaus & Smith (2017).

[297] *E.g.*, Rekhadevi (2010).

[298] 83 Fed. Reg. at 43,223.

[299] *See* Section II.

[300] Tyler Comings & Avi Allison, Synapse Energy Economics Inc., *More Mileage for Your Money: Fuel Economy Increases While Vehicle Prices Remain Stable* 5 (2017), https://consumersunion.org/wp-content/uploads/2017/03/Synapse-CU-Affordability-Report-3-15-corrected-1.pdf.

[301] *Id.*

[302] Draft TAR at 6-2 (2016).

[303] EPA, Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation—Response to Comments 136 (2017) [hereafter "Final Determination RTC"].

their income on fuel than on the up-front price of their vehicles compared to high-income households. As a result, fuel-efficiency increases are more beneficial to low-income consumers than they are to high-income consumers.[304] In other words, the proposed rollback will not *help* low-income consumers as the agencies claim. Instead, reducing the standards will likely harm these consumers the most. As Greene & Welch note, "[The 2022-2025] fuel economy improvements will benefit all income groups and . . . the impacts will be progressive. The highest income quintile is projected to average a savings of 0.5% of their income annually, increasing uniformly to 2.2% of income saved annually for the lowest income quintile."[305] The evidence on the impact of the existing standards on low-income consumers does not support the proposed rollback.

IV. GENERAL PROBLEMS WITH THE AGENCIES' DATA ANALYSIS

The agencies' proposed conclusions regarding sales, fleet size, and VMT are fatally flawed because the agencies made grave mistakes in their econometric analysis, leading to results that should not be used to inform policymaking. These mistakes include:

- **Failing to account for endogeneity** – endogeneity occurs when findings about an explanatory variable—for example, about the impact of new vehicle price on sales—cannot be given a causal interpretation for one of the following reasons:[306]
    - **Omitted variable bias** – omitted variable bias occurs when the agencies fail to control for important variables that have an influence on a feature (like scrappage) but are correlated with one of the variables used to calculate that feature (like new vehicle prices); when this error is present a regression can show incorrect predictions about the relationship between the variables;[307]
    - **Simultaneity** – simultaneity arises when one or more of the explanatory variables is jointly determined with the dependent variable;[308] of particular concern is reverse causation where the variable of interest (like car sales) affects the explanatory variable (like new car price);
- **Unreliable data** – unreliable data limit the extent to which the agencies can learn about the historical relationships and thus predict future circumstances;
- **Overfitting –** overfitting occurs when an analyst includes individual variables and interactions of variables merely to improve the extent to which the model predicts past behavior, instead of basing the specific formulation of the model on a strong theoretical foundation.

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304 Draft TAR at 6-2.

305 Greene & Welch (2017), at 13.

306 Cameron (2005), at 92.

307 Wooldridge (2009), at 89-90 (for background on the bias introduced by omitted variables).

308 *Id.* at 546.

All of these problems permeate the agencies' analysis. To evaluate the effects of a policy change, the agencies must understand the true relationships underlying the various elements they investigate. Once those relationships are uncovered and quantified, inferences can be drawn to inform new policies. Those inferences need to be based on causal relationships and not just correlations. Correlations can only show that two elements tend to move together, but when two elements move together that does not necessarily mean that the change in one variable is the cause of the change in the values of the other variable.

For instance, a researcher could look at income data and asthma data and conclude that there is a relationship between low income and high asthma incidence. However, this is not a causal relationship but rather a correlation. It is not the low income in itself that causes asthma but rather environmental factors that tend to be associated with income. For instance, lower income households tend to live closer to highways and freeways as the car noise and pollution make the housing there more affordable. At the same time, major road proximity has been found to elevate risk of asthma.[309] Consider a policy that subsidizes sports facilities in wooded areas for people with low income. Based on historical data, a researcher could infer that there is a relatively low value in building such facilities, given that the low-income population tends to suffer heavily from asthma and thus will spend little time using the facility. But such a conclusion would overlook the fact that with the low-income population spending considerably more time in areas with clean air, the prevalence of asthma in that group could drop. A new sports facility could break the correlational link between the income and asthma, thus demonstrating that any conclusions that had been based on the historical correlations were wrong.

The need to uncover the causal, structural relationships between elements of interest for policymaking was pointed out for the first time by Robert E. Lucas in his seminal article, describing what has been knowns as the "Lucas critique."[310] In the article, Lucas argued that it is a mistaken approach to try to predict the effects of a change in economic policy solely on the basis of relationships observed in historical data, especially highly aggregated historical data. Lucas argued that "[g]iven that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models." In other words, a policy change might affect or even completely break the correlated relationships. Lucas also adds that reliance on correlations for setting policy is invalid because any attempt to compare different alternatives would be meaningless without any knowledge of the actual causal relationships.[311]

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[309] For discussions about road proximity and asthma incidence, *see* Li, et al. (2011), at 34.

[310] Lucas (1976), at 19–46. The article has been quoted in over 1,000 economic papers (according to the scientific database scienwebofknowledge.com) and multiple textbooks. It has also spurred the shift macroeconomics towards using micro-foundations. *See* Sargent (1987), at 397–98.

[311] Lucas (1976), at 41.

Given that the agencies have set out to predict how the baseline standards and alternatives affect elements such as new car sales, scrappage rates, miles driven, and fatalities in the Proposed Rule, the agencies should examine and uncover the causal relationships between those elements based on good data and economic modeling. But rather than follow the economic literature and principles of good econometric analysis, the agencies have focused only on a series of correlations not causal relationships. Endogeneity problems that manifested themselves as omitted variable bias and simultaneity bias are rampant in the agencies' analysis.

Throughout the agencies' analysis, they ignore signs of these problems. For example, the agencies exclude several critical variables from the scrappage analysis based on incorrect coefficient signs and/or statistical significance, despite the importance of those variables to theory and past analyses[312]; the value of a vehicle as scrap metal or as parts due to statistical insignificance; and the interest rate due to unexpected sign and worsening overall fit of the regressions.[313] Other times, the agencies merely try to explain away the problem without addressing the counterintuitive results, like in the case of the incorrect sign on fuel efficiency for new SUVs and vans in the scrappage model.[314] Instead of ignoring these problems, the agencies should consider the inconsistent results as evidence of serious econometric problems and attempt to address the underlying issues.

V. THE AGENCIES' ANALYSIS OF HOW FUEL ECONOMY AND EMISSION STANDARDS CHANGE FLEET COMPOSITION, VEHICLE TRAVEL, AND SAFETY IS FUNDAMENTALLY FLAWED

The agencies assert that higher new vehicle prices[315] under the baseline standards will cause consumers to reduce their purchases of new vehicles, and retain or buy used vehicles.[316] The agencies analyze these changes using newly developed models of the new vehicle and used vehicle fleets and find huge increases in the total fleet size and vehicle miles traveled (VMT). The agencies then find that the baseline standards will cause a number of negative effects including, most importantly, increased fatalities.[317] Specifically, the agencies claim that the change in composition of the vehicle fleet will result in 6,180 to 7,880 additional fatalities for

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[312] PRIA at 1012, 1030, 1032.

[313] *Id.* at 1030.

[314] *Id.* at 1024.

[315] Whenever we refer to an "increase in new vehicle price" or "higher new vehicle price," this refers to a shift from the Proposed Rule to the baseline standards.

[316] The agencies refer to this effect as slower "turnover." 83 Fed. Reg. at 42,993. The two models, when combined, can be used to analyze the change in the distribution of vehicles by model year caused by a change in fuel economy and emission standards. However, because the models are disconnected, it is impossible to determine which new vehicles replace which used vehicles. It is therefore impossible to estimate the actual change in turnover of vehicles due to the baseline standards using the models the agencies have developed.

[317] 83 Fed. Reg. at 42,993.

model years 1977 to 2029, "as operated throughout those vehicles useful lives," or approximately 50 percent of the total fatalities attributed to the baseline standards.[318]

The agencies' assertion that the baseline standards will cause vehicle prices to go up in such a way that consumers alter their purchasing decisions is flawed. We address that issue in Section II. But even if the agencies are correct that the baseline standards will cause new vehicle prices to increase, their analysis of the implications of those price increases—and, in particular, their estimates of additional fatalities associated with those increases—is fundamentally flawed for two critical reasons.

First, the agencies' estimates and modeling of the impact of price increases on total fleet size and vehicle miles traveled (VMT) violate economic theory. Correcting the agencies' errors in this area will significantly reduce (or even reverse) the purported effect of the baseline standards on safety.

Second, even if the agencies are right that increased new vehicle prices lead to an increase in the number and proportion of older vehicles in the market, the safety impact of those vehicles is overstated. The data supporting the agencies' conclusions are improperly inflated in ways that contradict the agencies' prior analyses and the available evidence.

A. The agencies' assumption that fleet size and VMT will increase under the baseline standards is arbitrary and capricious

The result of the agencies' analysis of the baseline greenhouse gas standards and fuel economy standards—and the effect of rolling back those standards—is strongly dependent on new modeling that attempts to estimate how changes in new vehicle prices and fuel economy affect the number of vehicles by model year and body style (car, SUV, pickup) (the "composition" of the fleet). The agencies use separate models to estimate the composition of the vehicle fleet: (1) a "dynamic sales model," which estimates the change in new vehicle sales for different levels of fuel efficiency and greenhouse gas emission standards;[319] and (2) a "dynamic scrappage model," which estimates the change in the composition of the used vehicle fleet for different levels of fuel efficiency and greenhouse gas emission standards.

The dynamic *sales* model is based on the theory that increasing fuel efficiency will increase new vehicle prices and reduce consumer demand for new vehicles.[320] The dynamic *scrappage* model

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[318] *Id.* at 43,152-53 (estimating total fatalities attributed to the baseline CAFE standards, which includes a combination of the effects from the sales model, scrappage model, and dynamic fleet share model); *id.* at 43,157 (estimating the same for a rollback of the GHG emission standards); id. at 43,254 (explaining that the fatality impacts are calculated for "model years through 2029 as operated throughout those vehicles' useful lives").

[319] This is supplemented by a "dynamic fleet share model," which estimates the change in the distribution of new vehicle sales between cars, SUVs, and trucks.

[320] *Id.* at 43,075.

is based on a theory that increases in the cost of buying new vehicles will reduce demand for new vehicles and increase demand for relatively new used vehicles. The increase in demand for used vehicles causes an increase in the price of relatively new used vehicles and, therefore, longer retention of older used vehicles.[321] This effect cascades throughout the used vehicle fleet, eventually resulting in an increase in the price of very old vehicles that might otherwise have been sold for parts and raw materials ("scrapped").[322] The increase in the value of these cars can reduce the rate at which they are scrapped rather than held or resold.[323]

But while those theories may be relatively uncontroversial, the agencies then make a totally unsupported leap to assert that "[b]ecause higher used vehicle prices will lower the number of vehicles whose cost of maintenance is higher than their value, *it is expected that* . . . some vehicles that would have been scrapped without replacement under lower new vehicle prices will now remain on the road because their value will have increased," referred to as "non-replacement scrappage" by the agencies.[324] According to the agencies, that non-replacement scrappage leads to a significant increase in the number of total vehicles on the road, which is attributable to the baseline standards.[325]

The agencies' analysis then assumes that vehicles at each age, including those that, but-for the baseline standards would have been scrapped, are driven the number of miles established in a set of VMT schedules. That is, the agencies assume that existing VMT schedules should be applied to those additional vehicles and thus uses those schedules to calculate the number of fatalities that are attributable to scrappage.[326] Because those schedules assume each vehicle of a certain age and type in the fleet drives a set amount of miles without any adjustment for the increase in total fleet size or vehicle quality (i.e., wear and tear and durability), the finding that the standards cause the fleet size to increase results in a significant increase in total VMT. This increase in VMT in turn drives fatalities.[327]

There are two severe flaws in this analysis, which render the rule arbitrary and capricious and which we discuss in turn below:

- First, the agencies have provided no explanation to support the assumption that higher prices (even if they were real), would lead to non-replacement scrappage and an increase

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[321] The agencies' analysis uses a combination of the increased price of new vehicles and the decrease in cost per mile (CPM) of operating new vehicles as proxies for how the standards will increase the prices of used vehicles. PRIA at 1004.

[322] 83 Fed. Reg. at 43,092.

[323] *See* PRIA at 998.

[324] *Id.* at 1004; 83 Fed. Reg. at 43,095.

[325] PRIA at 1004, 1058.

[326] 83 Fed. Reg. at 43,099.

[327] *Id.* at 43,188; PRIA at 998.

in the total fleet size. Indeed, the academic literature and standard economic theory demonstrate that the assumption is unreasonable.

- Second, even if there were additional vehicles on the road, the agencies have not provided a reasonable explanation to support the assumption that total vehicle miles traveled should increase. Again, the academic literature and standard economic theory demonstrate that the assumption is unreasonable.

Any sales and scrappage modeling should take this established economic research into account. In addition, as we also explain in detail below, the agencies' analysis is riddled with serious econometric errors. Should the agencies still seek to estimate scrappage effects, we summarize our advice on a "path forward" below. Ignoring the fundamental principles that we outline here would be arbitrary and capricious.

1. The agencies' assumption that an increase in vehicle price will substantially increase the size of the used vehicle fleet is fundamentally flawed

The agencies use a reduced form scrappage model to estimate scrappage rates.

The model ignores the simultaneous interactions and the impact that the variables in the model have on each other and fails to take basic economic theory into account.

The model produces a substantial increase in the size of the used vehicle fleet. The increase is so large that it substantially exceeds the decrease in aggregate new vehicle sales that is predicted by the dynamic sales model. The results of these two models lead to a large increase in total aggregate fleet size attributable to the baseline standards. These conclusions are flawed for a number of reasons discussed at length below:

- They are inconsistent with basic economic theory;
- They are inconsistent with the academic literature, including the work of Howard Gruenspecht, the economist whom the agencies rely on for their theory; and,
- They produce results that are inconsistent with even the agencies' explanation of the relationship between fuel economy and scrappage.

a.) Standard economic theory supports an assumption that fleet size will either stay the same or decrease with an increase in vehicle prices

i.) Fleet size will either stay the same or decrease with an increase in vehicle prices

Economic theory supports the possibility that new vehicle price increases may change the distribution of new and used vehicles and, ultimately, could slow scrappage of used vehicles that would have been replaced by other vehicles. If the price of new vehicles increases with more stringent standards, some portion of households that would have purchased a new vehicle may instead keep their current vehicle or purchase a used vehicle. This shift out of the aggregate demand curve for used vehicles may ultimately increase the number of *used* vehicles on the road.

But economic theory provides no support for the idea that a shift to used vehicles will cause an increase in the total number of vehicles on the road.[328]

First, price changes cause only relatively modest changes in scrappage rates in the first place because prices are not the most important factor in scrappage decisions. Most scrappage is due to age-related factors that are unrelated to increases in price.[329] As a result, the elasticity of scrappage with respect to used vehicle price is low (between -0.4 to -0.7),[330] meaning that the shift to used vehicles for a given price increase is low.[331] As such, even if there is a shift to used vehicles, the effect of price on scrappage should be small, and certainly not so large that it overwhelms the reduction in new vehicle sales.

Second, when price increases on both used and new vehicles, the value of the services provided by those vehicles does not change. As a result, in equilibrium, when price increases and the value of the services is unchanged, the amount of the good purchased decreases. In other words, a potentially scrapped vehicle is diverted from the scrap heap only if there is used vehicle demand that the owner can meet by choosing to sell rather than scrap. But the additional used vehicle demand is directly related to a reduction in new vehicle demand. There is no reason to believe that it will increase the number of *total* vehicles on the road. Any shift towards used vehicles is connected to the decrease in new vehicles. New and used cars are substitutes,[332] and as such we should expect that the quantity and prices in the new vehicles sales market will affect quantity and prices in the used vehicles sales market and vice versa.[333]

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328 As explained further below, just as new vehicle *price* affects scrappage rates only by changing used vehicle demand (and therefore price), changes in new vehicle fuel efficiency (holding price constant) also only affect scrappage rates by changing used vehicle demand (and therefore price). Therefore, fuel efficiency increases should affect only fleet composition and not fleet size. New vehicle fuel efficiency (holding price constant) would have the opposite effect on fleet composition that increased new vehicle price has. As a positive attribute, higher new vehicle fuel efficiency will increase demand for new vehicles, thereby reducing demand for (and price of) used vehicles.

329 Bento et al. (2018), at 178 (stating that "the inelasticity of this parameter suggests that accurately modeling vehicle lifetime is of first order importance, as most scrappage will occur due to age-related, exogenous scrappage rather than policy induced, endogenous scrappage").

330 Bento et al. (2018), at 159; Jacobsen & van Benthem (2015), at 1325.

331 Jacobsen & van Benthem (2015), at 1333 (Table 6).

332 PRIA at 930, 1053.

333 For example, in his dissertation, Howard Gruenspecht, includes the scrappage rate, new car price, and new car sales in his regression for used car price. Gruenspecht (1982a), at 81, 99-101. In his structural scrappage regression, Gruenspecht includes new cars sales. *Id.* at 106-107. In his corresponding reduced form regression, he includes vehicle miles traveled per capita to address overall demand for driving, in addition to the vehicle stock in the previous period. *Id.* at 86, 109-113. Finally, Gruenspecht demonstrates that the quantity of new vehicle demand is a function of vehicle miles traveled per capita and vehicle stock in the previous period, in addition to new vehicle price. Gruenspecht (1982a), at 87; *see also* Goulder et al. (2012), at 192 (using a model that solves for supply-demand equilibrium in the new and used car markets").

Ignoring these facts, the agencies assert that higher new vehicle prices will reduce scrappage rates more than they reduce new vehicle purchase rates, so that over time, more used vehicles are retained than needed to replace forgone new vehicle purchases.[334] The enormous discrepancy between the change in new vehicle purchases and the increased fleet size is due in part to the agencies' irrational decision not to connect the results of the new vehicle sales model and the scrappage model so that they influence each other.[335] Moreover, many of the variables—including used car prices, used car scrapping rates, and new car sales—are functions of each other and therefore using one to predict the other can be circular (that is, they suffer from the simultaneity bias). For example, changes in the price of new vehicles changes the scrappage rate of used vehicles. But changing the supply of used vehicles (via scrappage) also affects the price of new vehicles.[336] Lowering the number of used vehicles on the market may increase used vehicle prices, which may reduce the price disparity between relatively new used vehicles and brand new vehicles, thereby increasing demand for new vehicles and, therefore, the price of new vehicles.

The agencies argue that it is not necessary to connect the new vehicle purchase decision and used vehicle scrappage because different households are making the decision to buy a new car and scrapping a used car.[337] But while different households might be making those decisions, the decisions are connected through the market, as new vehicle sales, new vehicle price, used vehicle price, and scrappage rates are jointly determined in the marketplace. The agencies should connect the results from the new sales model and the scrappage model.

Third, instead of an increase, it is actually more likely that price increases would cause a small decrease in the total fleet size. Most households that would have purchased a new vehicle but that instead purchase a used vehicle will likely purchase a close substitute (i.e., a low age/mileage used vehicle). This effect moves down through the fleet before it affects scrappage. As explained above, as the new vehicle price increase raises the prices for used vehicles, a portion of buyers that would have bought young used vehicles will buy vehicles that are slightly older; and vehicles owners who would have bought the older used vehicles will buy even older vehicles; and so on down the chain. Some of the last buyers at the bottom of that chain will be supplied by vehicles that, without the standards, would have been scrapped. But a portion of used vehicle purchasers that would have purchased a used vehicle before used vehicle prices went up

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[334] 83 Fed. Reg. at 43,099 ("Our models indicate that the ratio of the magnitude of the scrappage effect to the sales effect is greater than one so that the fleet grows under more stringent scenarios").

[335] *Id.* (explaining that "while both models are informed by new vehicle prices, the model of vehicle sales does not respond to the size and age profile of the on-road fleet, and the model of vehicle scrappage rates does not respond to the quantity of new vehicles sold").

[336] *See* Gruenspecht (1982a), at 82.

[337] 83 Fed. Reg. at 43,099.

will instead choose to forgo a vehicle purchase. This happens as some who may have been planning to replace their old used car may now decide that, facing higher prices, they are better off opting out of the market into alternative forms of transportation. These consumers may instead make the same number of car trips using fewer vehicles. For example, some families may be unable to afford a used car for their teen, or will sell their sedan to buy a used minivan instead of being able to keep both. Others may reduce their need for a vehicle (or second vehicle) and travel by alternative means such as walking, biking, ride sharing service, or public transit.[338] The magnitude of this decline in fleet size is dependent on the price elasticity of used vehicle supply and the elasticity of substitution between used vehicles and alternative forms of transportation. If demand is very elastic, for example because teenage drivers can get rides with friends or mass transportation is readily available in that location, there will be more of a shift than if demand is inelastic. Either way, this force will likely *reduce* the total number of used vehicles on the road.

ii.) The agencies' explanations for their fleet size results are unavailing

The agencies offer a few explanations to address the fact that their description and results are inconsistent with basic economic theory, but those arguments are unavailing.

First, the agencies assert that the number of vehicles not scrapped will be higher than the decrease in new vehicles sales[339] because the used vehicle fleet is so much larger than the new vehicle fleet.[340] But the total number of vehicles (new and used) and total VMT is determined in general equilibrium where supply meets demand. These market clearing conditions are influenced by underlying supply and demand curves, which are related to the elasticity of demand and the elasticity of scrapping, not magnitudes of the relative markets.

Second, the agencies argue that households require more than one used vehicle to replace the full lifetime of a new vehicle and that this increases the fleet size.[341] But as fleet size is measured on a per annual basis, more cars with a shorter-life span does not lead to a larger annual fleet size. Moreover, this reasoning is predicated on VMT schedules remaining constant (which they should not, as discussed below). In addition, households purchase "close substitute[s] for new models"[342] and those substitutes are unlikely to be multiple used vehicles. Instead, previous purchasers of new

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[338] *See, e.g.*, Gruenspecht (1982a), at 120; Letter from Dr. Mark Jacobsen and Dr. Arthur van Benthem at 2, Docket No. EPA-HQ-OAR-2018-0283 and Docket No. NHTSA-2018-0067 (Oct. 8, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-2650 [hereafter "Jacobsen & van Benthem Docket Letter"].

[339] PRIA at 1057.

[340] *Id.* at 1057.

[341] Responses to Interagency Comments on NPRM Round 8 Received 7-11-2018, at 2-3, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (12th Attachment, pdf page 3).

[342] PRIA at 930.

vehicles will purchase a relatively new used vehicle, an effect that moves down the chain, as explained above.

Third, the agencies concede that their results may not be "intuitive for reviewers" because normally increased prices would not lead to a bigger fleet, rather "reduced prices of new vehicles and increased sales," as promised under the Proposed Rule, "should lead to a larger on-road fleet."[343] The agencies nonetheless argue that "the increased sales" that one might expect from reducing prices under the Proposed Rule are "more than offset" by the accelerated scrappage shown in the agencies' modeling. But this reasoning does not help the agencies because it is the *results of the model* that violate economic theory. The agencies cannot support the theoretical validity of their model by pointing to the results of their model. The fact that a model shows a counterintuitive result is a reason to fix the model, not a reason to dismiss intuition and theory.

For all these reasons, EPA was correct to note in comments on the Proposed Rule prior to its publication that "[t]he total number of registered vehicles would not change significantly as a result of consumer decisions to retain used vehicles longer instead of purchasing new vehicles."[344] As EPA recognized, it is inconsistent with basic economic principles to expect that fleet size would decrease with the Proposed Rule, relative to the baseline.[345]

b.) *The agencies' scrappage assumptions are inconsistent with the academic literature*

In an effort to support the assumption that increased prices lead to a larger fleet, the agencies cite heavily to several academic papers. But those papers do not support the conclusions the agencies reach. Namely, while the academic literature supports a connection between new vehicle prices and slower replacement scrappage, the literature does not support the assumption that fleet size would increase due to non-replacement scrappage. Instead, they show that vehicle price increases and fuel efficiency increases are likely to, if anything, decrease fleet size as explained above.

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[343] 83 Fed. Reg. at 43,098 ("While it might be natural to assume that reduced prices of new vehicles and increased sales should lead to a larger on-road fleet, in our modelling, the increased sales are more than offset by the somewhat accelerated scrappage that accompanies the estimated decrease in new vehicle prices.").

[344] EPA review of CAFE model with "GHG" settings, Slide 8 (08-Mar ver.), attached to Email from William Charmley to Chandana Achanta regarding Material for today's Light-duty GHG NPRM discussion, June 18, 2018, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th attachment).

[345] *See id.*; Responses to Interagency Comments on NPRM Round 8 Received 7-11-2018, at 2-3, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (12th Attachment, pdf page 3).

i.) The cited literature does not support the assumption that price increases will lead to a slower non-replacement rate of scrapped vehicles and fleet size increases

The agencies' scrappage assumptions are based primarily on a paper and dissertation by Howard Gruenspecht, which studied the impact of fuel efficiency regulations on pollution reductions.[346] In those papers, Gruenspecht found that pollution reductions may be partially offset if a policy-induced fuel efficiency increase causes some potential new-vehicle purchasers to switch from lower-emitting new vehicles to higher-emitting used vehicles, and from lower-emitting used vehicles to higher-emitting older used vehicles.[347] Under Gruenspecht's theory, this effect culminates in a slower rate of vehicle scrappage.

The agencies repeatedly cite to Gruenspecht to support the assumption that higher vehicle prices will lead to both replacement and non-replacement scrappage, which the agencies largely do not distinguish and call collectively the "Gruenspecht effect."[348] But the agencies misunderstand the papers. Gruenspecht's research was concerned with the effect of increases in new vehicle price on the scrappage of used vehicles *that would have been replaced by new vehicles or newer used vehicles*—what the agencies refer to as slower "replacement scrappage," not with non-replacement scrappage.[349] In fact, as Gruenspecht explained in his dissertation, which formed the basis for the 1982 paper, "*the desired number of vehicles in the stock is insensitive to variation in the price of new cars"* and "the primary effect of a change in new car prices is to alter the composition of the vehicle stock via its effect on scrapping decisions" not to change fleet size.[350] Indeed, because of this, Gruenspecht held the "aggregate vehicles miles travelled (VMT) and the total number of vehicles" constant in his analysis, a fact that the agencies ignore in the Proposed Rule.[351]

The other cited authors that have actually studied the phenomenon addressed in the Gruenspecht paper also all address only replacement scrappage, and do not address at all the idea of non-replacement scrappage. For example, the agencies point to an analysis conducted by the California Air Resources Board as support for "including some estimate of the Gruenspecht effect," but the agencies themselves acknowledge that CARB did not analyze non-replacement

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[346] 83 Fed. Reg. at 43,093.

[347] Gruenspecht (1982a), at 129-135; Gruenspecht (1982b), at 330.

[348] 83 Fed. Reg. at 43,093, 43,094, 43,095, 43,096; PRIA at 932, 999, 1002, 1013, 1014.

[349] 83 Fed. Reg. at 43,095 ("Aggregate measure of the Gruenspecht effect will include changes to scrappage rates both from slower replacement rates, and slower non-replacement scrappage rate"); PRIA at 1004. Other academic papers refer to this effect as "used car leakage." *See* Jacobsen & van Benthem (2015), at 1331.

[350] Gruenspecht (1982a), at 120 (emphasis added).

[351] Gruenspecht (1982b), at 328-29.

scrappage.[352] As such the CARB analysis has no bearing at all on the question of whether the agencies should assume that slower non-replacement scrappage is "expected."[353]

Another paper that the agencies cite in support of their scrappage model is an empirical analysis of the relationship between fuel price increases and scrappage rates among used vehicles conducted by Mark Jacobson and Arthur van Benthem.[354] Unlike the Gruenspecht and CARB analyses, Jacobsen & van Benthem did not hold fleet size constant.[355] But after finding that an increase in the price of used vehicles gives owners an incentive to postpone the decision to scrap,[356] Jacobson & van Benthem found a decline in the fleet size when estimating the Gruenspecht effect, not an increase, as the agencies find.[357] The paper did not set out to estimate the *magnitude* of any effect on the total fleet size and cannot be read as support for any magnitude estimate. But because the paper shows a decline in fleet size, it cannot be used to support any conclusion that fleet size should go up with reduced scrappage. As the authors have explained in a letter to the agencies regarding the Proposed Rule, under standard economic theory, if the baseline standards increase vehicle prices, the total fleet size would likely decrease over time.[358] Similarly, an earlier paper by Goulder, Jacobson & van Benthem suggested that tighter emission standards would lead to an overall decrease in fleet size, even after accounting for an increase in used car sales.[359]

In addition to these papers, the agencies assert that Greenspan & Cohen's paper offered "additional foundations from which to think about vehicle stock and scrappage."[360] But that paper does not address non-replacement scrappage. And by the agencies' own admission, Greenspan & Cohen hypothesized a pathway through which "engineering scrappage seems to *increase,*" rather than decrease, with increasing emissions standards because emissions controls

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352 83 Fed. Reg. at 43,094.

353 PRIA at 1004 ("Because higher used vehicle prices will lower the number of vehicles whose cost of maintenance is higher than their value, it is *expected* that not only will replacements of used vehicles slow, but also, that some vehicles that would have been scrapped without replacement under lower new vehicle prices will now remain on the road because their value will have increased. Aggregate measures of the Gruenspecht effect in this analysis will include changes to scrappage rates both from slower replacement rates, and slower nonreplacement scrappage rates") (emphasis added).

354 83 Fed. Reg. at 43, 093, 43,094, 43,097 (citing Jacobsen & van Benthem (2015)).

355 Jacobsen & van Benthem (2015), at 1329-1330.

356 *Id.*, at 1313.

357 Jacobsen & van Benthem (2015) found a decline in the fleet size when estimating the Gruenspecht Effect. If NHTSA has not already done so, NHTSA will see this result after running the Jacobsen & van Benthem (2015) code. *See* Jacobsen and Benthem Data, https://www.aeaweb.org/aer/data/10503/20130935_data.zip.

358 Jacobsen & van Benthem Docket Letter at 1.

359 Goulder et al. (2012), at 200 (Table 6.3).

360 PRIA at 1000-1001.

may make vehicles more complicated to maintain.[361] As such, that paper does not support the agencies' argument in the Proposed Rule that higher emissions standards cause reduced scrappage.

The agencies cite to a number of other academic papers as support for their scrappage model.[362] But the cited literature does not support the agencies' analysis.

For example, the papers by Walker, Parks, & Bento et al. estimated the effect of the elasticity of scrappage with respect to new or used vehicle price.[363] The agencies do not use these elasticity estimates in their modeling and do not analyze whether the implied elasticities of scrappage derived from their scrappage model are consistent with this literature. Were the agencies to use those estimates, it is likely that the scrappage effect would decrease substantially because, as Bento et al. found, these elasticities show that most scrappage is due to age-related factors that are unrelated to increases in price.[364]

Greene & Chen (1981) and Feeney & Cardebring (1988) analyzed the life expectancy of different types of vehicles and did not look at the impact of a fuel efficiency program or vehicle price changes on those rates.

Hamilton & Macauley (1999) also looked at vehicle longevity and found that it was likely related to factors such as the driving environment. The paper did not address the impact of vehicle price or fuel efficiency on scrappage.

Busse et al. (2013), Sallee et al. (2016), and Alcott & Wonzy (2014) all focused on whether and how much consumers value fuel efficiency, using data on used vehicles. The former two papers did not calculate a scrappage rate as a function of vehicle price of fuel efficiency. Of these papers, only Alcott & Wonzy (2014, p. 784) estimated a simple scrappage model (i.e., vehicle survival probability as a function of vehicle age, model year, and fuel economy), though this estimate did not analyze the price effect on scrappage.

Li et al. (2009) focused on the effect of gasoline price on fleet fuel economy, not the effect of vehicle prices on scrappage. While Li et al. (2009) controlled for the effect of fuel efficiency on used vehicle scrappage, the paper did not address the key issue underlying the agencies' theory that an increase in existing vehicle prices will reduce the scrappage rate of those vehicles.

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[361] See 83 Fed. Reg. at 43,093; PRIA at 1000. Greenspan and Cohen's results show that any impact on the durability of vehicles doesn't meet the standard 95% significance level with a t-statistic of -1.3. Greenspan & Cohen (1999), at 374-375.

[362] *See* 83 Fed. Reg. at 43,094 (citing to Walker (1968), Parks (1977), Greene and Chen (1981), Feeney and Cardebring (1988); Greenspan and Cohen (1999); Hamilton and Macauley (1999); and Bento et al. (2018)).

[363] Walker (1968); Parks (1977); Greenspan and Cohen (1999); and Bento et al. (2018).

[364] Bento, et al. (2018), at 178 (stating that "the inelasticity of this parameter suggests that accurately modeling vehicle lifetime is of first order importance, as most scrappage will occur due to age-related, exogenous scrappage rather than policy induced, endogenous scrappage"); Goldberg (1998), at 31 (explaining that "the substitution effects towards used cars were estimated to be small" and that "policies oriented towards shifting the composition of the new car fleet towards more fuel efficient vehicles seem promising").

Thus, none of these papers is relevant to the Gruenspecht effect. In sum, contrary to the agencies' assertions, the economic literature provides no support for the agencies' underlying assumption that higher vehicle prices lead to slower non-replacement scrappage.

ii.) The empirical findings of the rebound literature show that increased fuel efficiency should not increase fleet size either directly or through higher new vehicle prices

The empirical literature on the rebound effect also supports the assumption that an increase in new vehicle price or fuel efficiency will not change the overall fleet size and that, if anything, it should *reduce* total vehicles on the road:

- In a study of the relationship between gasoline prices and travel demand, Paul Schimek hypothesized that an increase in vehicle price decreases vehicle stock.[365] Using U.S. time series data primarily from the Federal Highway Administration, Schimek separately estimated the effect of gas prices on vehicle stock, vehicle fuel efficiency, and vehicle miles traveled.[366] His results confirm the hypothesis that real vehicle price has a *negative*, statistically significant impact on vehicle stock.[367]
- In their 2007 study estimating the rebound effect caused by changes in fuel efficiency, Kenneth Small and Kurt Van Dender derived estimates of the relationship between vehicle price and fleet size. By simultaneously estimating a system of equations for VMT per capita, fleet size, and fuel efficiency for the United States from 1966 to 2001, Small and Van Dender also found that an increase in new vehicle price has a *negative*, statistically significant effect on total vehicle stock.[368] They also found that changes in fuel cost per mile had a statistically insignificant effect on fleet size, with the sign of the effect varying by the method of regression.[369]
- Phillippe Barla and coauthors applied the methodology developed by Small and Van Dender to panel data at the provincial level in Canada from 1990 to 2004.[370] They found that new vehicle price, vehicle km traveled per adult, and fuel cost per km all have a negative but statistically insignificant effect on the per-adult stock of vehicles.[371]
- In a 2010 paper, Kent Hymel, Kenneth Small, and Kurt Van Dender extended the methodology developed by Small and van Dender (2007) by including an additional

[365] Schimek (1996), at 84.

[366] Schimek (1996), at 85 (applying OLS after rejecting simultaneity).

[367] *Id.*, at 86 (Table 2).

[368] Small and Van Dender (2007), at 39 (Table 3).

[369] *Id.* (showing coefficient of vehicle price, pv, with a negative statistically significant value).

[370] Barla et al. (2009), at 390.

[371] *Id.* at 398.

simultaneous equation for congestion.[372] They found that the price of new vehicles has a statistically insignificant effect on vehicle stock.[373] A 2015 paper by Hymel and Small also found a statistically insignificant impact.[374]

Overall, these results are consistent with the assumptions utilized by Gruenspecht and the findings of Jacobsen and van Benthem: if an increase in vehicle price has any effect on vehicle stock, it is likely negative. The agencies' contrary analysis is fatally flawed.

c.) *Charts showing simplified impact of a change in new vehicle price*

Figure 2 below demonstrates in simplified form, the changes in supply and demand that might lead from a change in the price of new vehicles. For purposes of simplicity, in these charts we abstract from simultaneity in the vehicle market. For example, we do not show the demand and supply for vehicle miles traveled and safety, which are simultaneously determined with the number of new and used vehicles. For comparability, we also assume that consumer valuation of the fuel efficiency increase is less than ΔK, as the agencies assume in the sales module, though the opposite could be true shifting households from used to new vehicles.

<u>In the first chart</u>, when prices go up, sales decrease from N_1 to N_2 and prices of new vehicles increase from P_1 to P_2. In other words, new vehicle demand shifts out and new vehicle supply shifts in.

<u>The second chart</u> shows changes in the used vehicle market. As increases in new vehicle price shift out used vehicle demand, demand for used vehicles (on net) shifts out and causes increasing sales from U_1 to U_2 and price from C_1 to C_2. The change in prices on the used car market feeds back into the demand curve for new cars. The total effect of the interactions between the two markets is the increased share of used vehicles. The change in vehicle stock is $\Delta U - \Delta N$. This would does not lead to an overall increase in fleet size (i.e., $\Delta U - \Delta N \leq 0$).

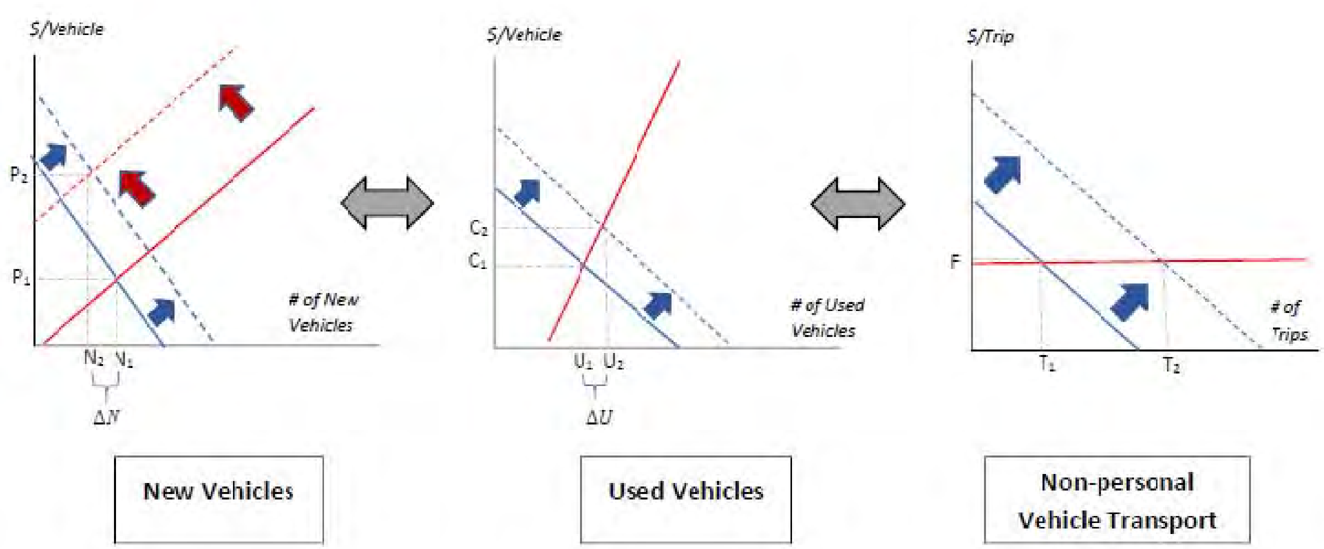
<u>In the third chart</u>, as the price of used vehicles increases, because of the shift in demand for public transportation, the number of mass transit trips increase from T_1 to T_2. Similarly, some households who forgo buying a new vehicle will instead carpool or find other sharing vehicle sharing arrangements within and between households; this will increase the number of passengers per vehicle.

[372] Hymel (2010), at 1221.

[373] *Id.* at 1231 (Table 3 showing a lack of significant of coefficient corresponding to *pv*).

[374] Hymel and Small (2015), at Table B2.

Figure 2. Theory Underlying Gruenspecht Effect (from Proposed Rule to Baseline Standards)



Red and blue curves in the above charts represent the supply and demand curves, respectively, for their corresponding market. In the case of non-personal vehicle transport, we assume that the marginal cost is constant (i.e., the supply curve is horizontal).

d.) *Further econometric and analytical errors*

i.) Omitted variables

In the scrappage model, the agencies have, without explanation, omitted a number of other variables that are critical to understanding the scrappage effect including:[375]

- Turnover rate and/or other connections between new and used vehicle markets and VMT (e.g., new vehicle sales, VMT per capita, and vehicle stock);[376]
- The price of scrapped metal and other variables critical to the scrappage theory laid out in the literature by Walk, Parks, Gruenspecht, and Bento[377]

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[375] PRIA at 1012

[376] In his structural scrappage regression, Gruenspecht (1982a) at 106-107, includes new cars sales. In his corresponding reduced form regression, Gruenspecht, 1982a), at 86, 109-113, includes vehicle miles traveled per capita to address overall demand for driving, in addition to the vehicle stock in the previous period. Bento et al. (2018), at page 171, (Table 3)include turnover rate in their structural scrappage regression.

[377] As noted by Gruenspecht (1982b) at 328, a vehicle is scrapped when the price of a vehicle less its scrappage cost is less than its scrappage value. According to the literature cited by NHTSA, maintenance and repair costs (Walker (1968); Parks (1977) at 1104; Gruenspecht (1982a), at 105-114; Greenspan and Cohen (1999); Bento et al., (2018)) and scrappage value (Parks (1977) at 1104; Gruenspecht (2011), at 105-114; Bento et al., (2018)), are almost always included in scrappage regressions. In the exception to the rule, Jacobsen & van Benthem (2015) include various

- Environmental causes of scrappage, including improvements in crash avoidance technology and national migration to fair weather areas; and[378]
- Percent of imported vehicles.[379]

In addition, using new vehicle price to determine scrappage rates fails to control for several variables that affect used vehicles and are independent of new vehicles. For example, odometer readings affect used vehicle price because more driving implies more wear and tear, and lower remaining vehicle value, holding age constant.[380] Vehicle brand can affect used vehicle price because it is a proxy for vehicle durability, which is correlated with used vehicle price and scrappage.[381] Some vehicle brands are associated with durability and a robust used vehicle price. Brand (along with model year) can control for the "repair incidence distribution."[382]

For the sales model, in addition to fuel efficiency, the agencies fail to control for several other important confounding variables.[383] Some key variables that the agencies should control for are: vehicle attributes; vehicle quality or durability; vehicle search costs; socio-economic and demographic variables; and geographic variables.[384] Vehicle miles traveled per capita, vehicle stock and other connections to the used vehicle market, and aggregate VMT are also omitted.[385]

Failure to address the omission of variables critical to the theory underlying the agencies' modeling conclusions raises serious questions about the agencies' ability to appropriately estimate the effect of new vehicle prices on fleet turnover. Indeed, if variables used in the academic literature unexpectedly have an incorrect sign or are insignificant, the agencies should consider the possibility that the model is missspecified or that factors in the model are endogenous.[386]

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fixed effects to address potential omitted variable bias. Consistent with the theory, new vehicle price and all other variables that affect scrappage via used vehicle price should be divided (i.e., indexed) by the maintenance and repair costs. Gruenspecht (1982b), at 328; Parks (1977), at 1105; Greenspan and Cohen (1999), at 375. This is also true for scrappage value or scrappage price (i.e., the value of scrap metal). Gruenspecht (1982b); Parks (1977) at 1104.

[378] Hamilton and Macauley, (1999).

[379] Bento et al., (2018), at 174.

[380] Greenspan and Cohen, (1999) at 375 to 376.

[381] Chen and Lin (2006) at 749 (Table 2); Parks (1977); Jacobsen and Benthem (2015); Li et al. (2009).

[382] Gruenspecht (1982a), at 97, 109-113.

[383] PRIA at 949

[384] Li et al. (2009); McCarthy (1996) at 454.

[385] Gruenspecht (1982a), at 87 (explaining that the quantity of new vehicle demand is a function of vehicle miles traveled per capita and vehicle stock in the previous period, in additional to new vehicle price).

[386] For example, fleet turnover and its common proxy variable – new vehicle sales - are potentially endogenous. Bento et al. (2018) at 163. Due to the aggregate nature of the data (Li et al., (2009) at 125), many other variables

ii.) The impact of fuel efficiency on scrappage in the agencies' results is evidence of a grave error

According to standard economic theory, when price is held constant, fuel efficiency should increase the value of a vehicle and cause demand for the vehicle to go up, leading to higher scrappage rates. In other words, when fuel efficiency improves, that increases demand for new vehicles, which reduces demand for used vehicles, reduces the price of used vehicles, and ultimately, increases (replacement) scrappage.[387] Fuel efficiency would not cause the fleet size to increase. Like new vehicle price, changes in fuel efficiency should not lead to a change in total fleet size, but only a relative change in the proportion of new and used vehicles, as explained above.

The agencies agree that increasing fuel efficiency without changing vehicle prices should increase scrappage.[388] But when the agencies control for price in the scrappage model, the model provides the opposite result: an increase in fuel efficiency leads to both decreased scrappage and an increased fleet size. This is evidence of a grave error.

The error is evident in a sensitivity that the agencies provide. The agencies include cost per mile (CPM) of new vehicles in the scrappage model in order to take into account the effect that fuel efficiency will have on used vehicle demand and scrappage.[389] In the PRIA, the agencies then present results of a sensitivity analysis where they disable the new vehicle sales model and dynamic fleet share model, and rebound,[390] and assume that the baseline standards will cause a $0 price increase in new vehicles.[391] Notably, this sensitivity case does not disable the entire

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may suffer from endogeneity problems; the most critical of which is maintenance and repair costs. PRIA, 1011-1012.[386] Indeed, NHTSA recognizes the potential endogeneity of maintenance and repair costs. PRIA, 1011-1012.

[387] *See* Jacobsen & van Benthem, (2015), at 1318; Gruenspecht (1982a); Gruenspecht (1982b).

[388] 83 Fed. Reg. at 43,093 ("Where [consumers'] additional value of fuel savings associated with a technology is greater than any loss of value from trade-offs with other attributes, the demand for new vehicles will also shift *upwards*."); PRIA at 1027 ("As expected, the cost of travel for new vehicles is inversely related to the scrappage of cars and pickups—as new vehicles are more efficient there is an increase in the demand for new vehicles, and a decrease in the demand for used vehicles, holding new vehicle price constant").

[389] PRIA at 1027. Note, however, that this is only relevant if consumers value fuel efficiency. If consumers do not value fuel efficiency, the CPM on new vehicles would not affect vehicle purchasing decisions and so would not need to be included in the scrappage model. Put another way, only non-quality improvements are arbitraged into used vehicle price. Hamilton and Macauley (1999), at 257 (another way to address this problem would be to subtract the portion of fuel efficiency increases that consumers value from the new vehicle price increase to create a quality adjusted price variable).

[390] This is because the only elements of the agencies' analysis that change VMT are the number of vehicles by Model Year (as determined by the sales and scrappage models) and the rebound analysis, and the only elements of the agencies' analysis that change fatalities are the VMT by model year.

[391] PRIA at 1531 (describing the "Scrappage and Fleet Share Disabled" as an analysis of the baseline and proposed standards when the new vehicle sales remain at levels specified for MY 2016 and new vehicle prices are kept at MY 2016 levels for the purpose of estimating scrappage).

scrappage module. Rather under this case, the fuel efficiency improvements of the baseline standards (expressed as changes in CPM) continue to affect scrappage decisions, and therefore the distribution of vehicle model years within the used vehicle fleet and the total vehicle fleet size.[392]

As such, any difference in fleet size between the baseline standards and the Proposed Rule in this sensitivity case is fully attributable to the fuel efficiency effect on scrappage.[393] In addition, because the agencies present each sensitivity case with the rebound effect disabled, any change in VMT or fatalities between the baseline standards and the Proposed Rule in this sensitivity case is fully attributable to the fuel efficiency effect.

But while holding new vehicle price constant should mean that scrappage goes up, the agencies' sensitivity analysis shows the opposite. As shown in Table 1, the agencies' analysis shows that holding new vehicle price and rebound constant leads to a theoretically nonsensical decrease in scrappage and, as a result, an *increase* in fleet size (by 59 million vehicles), VMT (by 280 billion miles), and fatalities (by 2640 deaths). In fact, these nonsensical results are the cause of 40% of the fleet size increase and fatalities—as well as the related portion of the CO_2 increases, congestion, and fuel consumption—that the agencies attribute to the baseline standards. This points to deep flaws in the agencies' scrappage model.

Table 1. Cumulative Changes in Fleet Size, Travel (VMT) and Fatalities Through MY 2029 Under Baseline CAFE and CO_2 Standards (Without Rebound)

(adapted from Tables 13-5 and 13-6 of the PRIA[394])

Sensitivity Case	**Fleet Size (millions)**	**VMT (billion miles)**	**Fatalities**
Reference Case	190	690	6340
Scrappage and Fleet Share Disabled	59	280	2640

The error appears to be driven by the fuel efficiency estimates for new SUVs and vans. The agencies' scrappage model is separated into different regressions for three styles of vehicle: cars, Vans/SUVs, and Pickups.[395] In the regression for each style, the agencies include variables for new vehicle price and new vehicle CPM as the explanatory variables for determining scrappage

[392] *Id.* at 1050-1051 (describing the scrappage model as using the same variables but with new vehicle price effectively set to its MY 2016 value, and showing that variables related to CPM have not been set to zero).

[393] This is because the only elements of the agencies' analysis that change fleet size are the new vehicle sales, scrappage, and dynamic fleet share model.

[394] PRIA at 1540, 1542.

[395] *Id.*at 1006.

rates. In addition, the agencies include a number of control variables related to vehicle age, model year, used vehicle CPM, and GDP.[396]

The coefficients of the new vehicle CPM variables for each body style represent the extent to which the model expects new vehicle fuel efficiency (represented as new vehicle CPM) to change scrappage rates for that body style. Negative values for the new vehicle CPM variables represent a prediction that as new vehicle fuel efficiency increases (i.e., the costs of driving a new car decrease), scrappage rates will increase. Positive values for new vehicle CPM represent the prediction that as new vehicle fuel efficiency increases (i.e., the costs of driving a new car decrease), scrappage rates will decrease. Economic theory would, therefore, predict only negative values for the new vehicle CPM variable: to the extent new vehicles of different body styles cause different changes to used vehicle demand for a given fuel efficiency change, the only difference in the model should be the magnitude of the change.

But in running the model, the results show that the relationship between scrappage rates and the fuel efficiency of one of those categories of vehicles (SUVs and vans) is positive and of such a high magnitude that it is throwing off the rest of the agencies' results, as shown in Table 2. Specifically, the magnitude of new SUVs and vans is 6.6 times larger than the magnitude of the new car CPM value, and over 13.9 times larger than the new pickups CPM value. The high relative magnitude of the value for SUVs is causing the scrappage model to generate lower scrappage, a larger fleet, additional VMT, and more fatalities due to improvements in fuel efficiency, holding new vehicle price constant.[397] And this effect increases over time because the agencies' dynamic fleet share model increases the proportion of new vehicles that are SUVs (and pickup trucks) as compared to cars.[398]

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[396] *See Id.* at 1044. The agency also includes lagged versions of these variables (e.g., the new vehicle price in the prior year), interactions between the variable and itself (e.g. age^2 and age^3), and interactions between variables (e.g., the interaction between age and model year). The inclusion of interaction variables make it very difficult to evaluate the results of the regression for an individual variable of interest. However, because new and used vehicle CPM are included without any interactions, the results for these variables can be interpreted as the effect of CPM changes on scrappage rates. This is done simply by adding up (new or used) CPM with the lagged variable for (new or used) CPM. *Id.* at 1027 ("By summing the current and lagged period new vehicle cost per mile coefficients, the overall level effect of the cost of travel can be computed by body style").

[397] Because the agencies do not present the effect of changes in CPM on scrappage for the three body styles combined, it is not possible to determine the exact combined effect.

[398] *Id.* at 953, 1046 ("Rather than apply the shares based on the regulatory class distinction [taken from the EIA's NEMS model], the CAFE model applies the shares to body-style. This is done to account for the large-scale shift in recent years to crossover utility vehicles that have model variants in both the passenger car and light truck regulatory fleets.").

Table 2. Aggregated New Vehicle CPM Coefficient Values[399] from Scrappage Model

(adapted from Tables 8-20 and 8-21 of the PRIA[400])

Sensitivity Case	**Cars**	**Vans/SUVs**	**Pickups**
Reference	-0.02087	0.137725	-0.00994
Scrappage Price Disabled	-0.02087	0.137725	-0.00994

There is no possible reason for CPM to have an impact on Vans/SUVs that is up to 14 times larger than for new cars and trucks. Despite the importance of the issue, the agencies try to explain away the inconsistency in one short sentence in the PRIA: "It may be either that cost per mile is negatively correlated with van/SUV attributes consumers value more than fuel economy and/or that increases in the cost of travel result in a shift away from pickups and towards vans/SUVs which may be slightly more fuel efficient."[401]

But that explanation is insufficient. The agencies provide no specific support for the idea that consumers would value other attributes over fuel efficiency so much more than for new pickups. And if consumers are shifting "from pickups and towards vans/SUVs which may be slightly more fuel efficient," that should have the opposite effect because it would show higher valuation of fuel efficiency.[402] Moreover, the agencies do not explain why this effect would be so much more significant for SUVs than for cars or pickups. If the agencies' theory was true, then the CPM coefficients would have opposite *and offsetting* effects between Vans/SUVs and pickups. Yet the SUV coefficients are *substantially* larger than those for pickups.

The sheer magnitude of interrelated econometric errors in the scrappage model (as explained throughout these comments) makes it difficult to pinpoint the specific problem that led to results such as a CPM variable for Vans/SUVs that is the wrong sign and of such high a magnitude that it overpowers the results of other variables, but it is possible that econometric errors led to this problem.

New vehicle CPM is endogenous with many other variables. Scrappage, new vehicle sales, and fuel efficiency are all determined simultaneously and the agencies' did not take this into account.[403] In addition, the agencies have explicitly excluded several theoretically important

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399 Aggregated CPM is the sum of New CPM and Lag New CPM, as described by the agency. *Id.* at 1027.

400 *Id.* at 1044, 1051

401 *Id.* at 1027.

402 *Id.*

403 Small and Van Dender (2007), at 31 (explaining the potential endogeneity of the fuel cost per mile); Li et al. (2009), at 125 (explaining that due to the aggregate nature of the data many other variables may suffer from

explanatory variables (e.g., the cost of maintenance and repair), which are potentially correlated with fuel efficiency.[404]

Notably, the agencies' methodology is inconsistent with almost all of the scrappage studies that the agencies cite as support for their approach.[405] A paper by Shanjun Li et al., provides a useful example of how the agencies could include fuel efficiency in their regression without raising the econometric concerns that may be leading to their nonsensical results. Li et al. include fuel price and vehicle fuel efficiency (gallons per mile) of used vehicles as well as a variable that captures the interaction of fuel efficiency of used vehicles and fuel price in their regression as explanatory variables.[406] Unlike the agencies' model, the regression analysis used in the Li et al. paper found results that are consistent with economic theory: a decrease in overall demand for vehicles and an increase in demand for more fuel-efficient cars.[407]

Another possible error is that the agencies' scrappage regression is overfit. For example, the agencies' regression for Vans/SUVs is different than the regression for cars and trucks. For Vans/SUVs, the agencies include age and age squared, whereas for cars they also included age cubed.[408] The agencies are overfitting their model to predict past behavior by including variables that have no clear relationship with scrappage rates or new car price (such as age cubed), rather than taking the more economically appropriate process of theorizing a model and the variables that should be included in it. Out-of-sample testing would help NHTSA highlight this potential overfit problem. If the agencies cannot address this error, they have two options. They can select an atomistic dataset that has sufficient detail to capture the key features of the scrappage market. Alternatively, they can choose to zero out the incorrect coefficient. As the model currently stands, this incorrect sign leads to fundamentally flawed results.

Moreover, the CPM results in the scrappage model are inconsistent with the agencies' sale model. In the sales module, the agencies have chosen to ignore consumer demand for fuel

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endogeneity problems, such as maintenance and repair costs); *See also* Gruenspecht (1982a), at 82; PRIA at 1015-1016.

[404] *Id.*at 1000 (indirectly making this point with respect to fuel efficiency and maintenance and repair costs when emphasizing that "Greenspan & Cohen also note that engineering scrappage seems to increase where EPA emission standards also increase; as more costs goes towards compliance technologies, it becomes more expensive to maintain and repair more complicated parts, and scrappage increases"). In other words, maintenance and repair costs are correlated with respect to fuel efficiency and scrappage rates.

[405] Walker (1968); Parks (1977); Gruenspecht (1982a); Greenspan and Cohen (1999); Bento et al. (2018). Note that Jacobsen & van Benthem (2015) include a variable related to *used* vehicle fuel efficiency for the same reason the agencies include used vehicle CPM. Jacobson and van Betham (2015), at 1318. However this is different than the inclusion of new vehicle CPM at issue here.

[406] Li et al. (2009), at 127.

[407] Gruenspecht (1982a), at 81.

[408] PRIA at 1025.

economy and significantly boosted the price impact of the baseline standards as a result.[409] But in the scrappage model, the agencies have incongruously allowed consumer valuation of fuel economy to drive a significant portion of the estimated fatalities. This inconsistency is arbitrary and capricious.

2. The agencies' assumption that VMT will go up is flawed

Even if the agencies are correct that the total fleet size would go up with an increase in prices (and they are not), the agencies' conclusion that the increase in the total fleet size would automatically lead to an increase in total VMT is illogical.

The agencies' analysis shows an overall increase of over 2 trillion additional vehicle miles traveled attributable to the baseline standards through 2050.[410] This increase comes from two sources: (1) the rebound effect and (2) an increase in fleet size due to non-replacement scrappage combined with an assumption that each vehicle of the same age and body type drives a fixed average number of miles per year. We address the first effect, rebound, in Section VI. The second effect is the result of a critical error.

Specifically, because the agencies assume that each additional car is driven a number of miles equivalent to the average VMT rate of a car of its age without adjusting per-vehicle VMT based on fleet size increases, the total VMT predicted by the model becomes inflated. And because the agencies' estimates of fatalities attributable to the baseline standards are primarily a function of fleet VMT, the inflated VMT results in substantially inflated fatality estimates and quantified economic costs.[411]

The agencies provide no theoretical explanation for the increase beyond conclusory claims that "if more used vehicles are supplied, there likely is some small resulting increase in VMT" and a "small increase in VMT is consistent with a larger fleet size."[412] But in fact, economic theory, the academic literature, and the agencies prior analyses[413] all show that an increase in the price of new vehicles would not lead to an increase in overall VMT. Instead, aggregate VMT, like vehicle stock, would remain constant or decline. The fact that changes in VMT go in the *opposite direction* (positive rather than negative) from what theory and the literature would support demonstrates that the agencies' modeling approach is critically flawed.

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409 *See* III.

410 PRIA at 1412.

411 *Id.* at 1412.

412 83 Fed. Reg. at 43,099; *see also id.* at 43,098 ("The overall size of the on-road fleet determines the total amount of VMT."); PRIA at 1055, 1058 ("[I]t is reasonable to assume that changing the distribution of vehicle age and the fleet size across regulatory alternatives will result in non-constant VMT across those alternatives.").

413 77 Fed. Reg. at 62,716 (explaining the agencies' prior approach, which uses static vehicle turnover model and non-rebound VMT schedules that do not vary based on the stringency of the standards); *see also* Draft TAR at 10-6.

a.) *The increase in VMT that the scrappage model produces is inconsistent with economic theory and the academic literature*

Economic theory does not support the agencies' conclusion that an increase in new vehicle price would lead to an increase in aggregate VMT. Vehicles are durable goods that are purchased not for immediate consumption, but for the consumption of a stream of services over time (in this case VMT). Economic theory makes clear that households select their vehicle and VMT to maximize utility subject to their budget constraints.[414] The number of miles a consumer decides to drive is determined by the relative cost of driving (i.e., its price), subject to a budget constraint.[415] For example, because a consumer's budget constraint is affected by the fixed cost of the vehicle, a policy that increases the price of used vehicles reduces the amount consumers choose to use their vehicle.

In other words, vehicle ownership decisions are influenced by the relationship between fixed costs of owning a vehicle and the value (consumer surplus) that consumers derive from that vehicle ownership.[416] In sum, VMT is influenced by vehicle choice and vehicle choice is influenced by VMT.[417] And a "unified model of vehicle choice and usage" is necessary.[418] In a paper on the distributional effects of fuel efficiency standards, Sarah West summarizes this point:

> The joint nature of the demand for vehicles and miles complicates estimation of these demands. The choice of vehicle and VMT are related because characteristics that influence a household to purchase a certain vehicle may also influence that household's choice of miles . . . . Since the demand for VMT depends on the price per mile, and thus fuel efficiency, the household's choice of vehicle affects their demand for miles, and vice versa. To reliability estimate the demand for miles, one must construct a model of the joint choice of vehicles and miles.[419]

The papers that have analyzed the impact of price changes on VMT in this way have found that increased price decreases total VMT, rather than increases VMT as the agencies found. For example, a 2008 paper by Lucas Davis used household (i.e., microeconomic) data to show that demand for durable goods (such as vehicles) is a function of the marginal cost of using the good

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[414] Gillingham (2011), at 3; Davis (2008), at 531-32; Durbin and McFadden (1984) (discussing simultaneous decisionmaking of purchase and usage for durable goods); West (2004), at 737; Goldberg (1998), at 4-5; Small and Van Dender (2007), at 26.

[415] West (2004), at 739-740; Davis (2008), at 532-33.

[416] Gruenspecht (1982a), at 120.

[417] Goldberg (1998), at 4-5, 8; West (2004), at 737; Davis (2008), at 532-33.

[418] Goldberg (1998), at 4-5.

[419] West (2004), at 737.

and of net income (conditional on household characteristics).[420] Davis' results are consistent with a reduction in VMT as new vehicle price increases. The marginal cost of driving component that determines VMT is not a function of purchase price, but is instead a function of the price of driving and the opportunity cost of driving (i.e., the value of time spent driving as measured by wages) (conditional on the good's characteristics). However, the net income component that determines VMT is a function of the good's price. Because an increase in prices reduces relative income, it would also reduce VMT. [421]

Small and van Dander also estimated rebound using a methodology that relies on macroeconomic data. Their analyses also showed that VMT goes *down* when new vehicle price goes up.[422]

Thus, even if, as the agencies hypothesize, some households end up purchasing multiple used vehicles (or retaining a used vehicle and purchasing an additional used vehicle) to achieve the same level of transportation services as they would have had with a new vehicle,[423] there is no reason to think that they will end up consuming substantially more transportation services (through additional VMT).[424]

To be sure, changes in new and used vehicle prices could have some effect on VMT. Households that were planning to purchase a vehicle without the standards will face one of three choices if standards increase the price of new and used vehicles:

- For consumers that purchase older vehicles, they may choose to drive fewer miles per year than they would have without the standards for reasons beyond effects on the direct cost-per-mile of driving (which should be captured in estimates of rebound). Older vehicles may be less enjoyable to drive than newer vehicles and older vehicles may be less reliable, leading consumers to forgo some trips that they would have taken with a newer vehicle.[425]
- For those households that choose to spend more money on a vehicle when vehicle prices rise, remaining household income will decline and so consumption of other goods (including driving) may decline.

[420] David (2008), at 533.

[421] *See also* West (2004), at 737; Goldberg (1998), at 4-5. To the extent that any shift to used cars increases any consumer's income, that effect would be small because the shift is not big, as explained above.

[422] Small and Van Dender (2007), at 38-39.

[423] PRIA at 1058 ("used vehicles only have a portion of their original life left, so that it will take more than one used vehicle to replace the full lifetime of a new vehicle, at least in the long-run").

[424] Fleet size increases could have some small increase in VMT because vehicles that are more available will be driven more.

[425] 83 Fed. Reg. at 43,104 (discussing the findings of West et al. (2015), who found that "[b]ecause these replacements offered lower-quality transportation service, their buyers did not drive them more than the vehicles they replaced").

- As discussed above, some households may choose to forgo purchasing a vehicle at all, which could lead the overall fleet size to decrease. These households would obtain transportation services through alternative means (public transportation, bicycle, ride sharing). This would cause an overall, though likely small, decrease in fleet VMT.

Because of these possibilities, to the extent the standards cause a shift from new vehicles to used vehicles, and towards older rather than newer used vehicles, the amount of total driving done by used vehicles, and in particular older used vehicles, relative to new vehicles, may increase. But without significant changes to the demand for VMT, any non-rebound related increases will be a transfer of VMT from new vehicles (that are not sold) to newer used vehicles. None of the scenarios described suggest that economic theory would expect an increase in aggregate VMT.

Gruenspecht recognized the theory behind this principle in his 1982 dissertation[426] and acknowledged that total VMT should not change as a result of the shift from new cars to used cars.[427] As a result, when running the EPA Mobile Source Emissions Model to assess the impact of fuel efficiency regulations on pollution reduction, he imposed an equality constraint on total U.S. VMT. In explaining his decision to control against a decrease he explained:

> "If the relationship between annual per vehicle VMT and vehicle age is held constant despite the shift in the composition of the vehicle stock, aggregate VMT would decrease due to the greater use of low annual VMT (i.e., older) vehicles when standards applied to new cars are made more efficient. To offset this effect, which would be unlikely to accompany real world shifts in composition, annual per VMT is adjusted upwards proportionately by an amount sufficient to restore the baseline level of aggregate VMT."[428]

Gruenspecht's underlying theoretical insight that VMT should not change demonstrates that the agencies' approach is incorrect.

In comments to NHTSA prior to the publication of the Proposed Rule, EPA also took the position that economic theory provides no support for the agencies' conclusion that increases in fuel efficiency and greenhouse-gas emission standards will result in an increase in aggregate VMT, other than through the rebound effect. EPA staff highlighted for NHTSA that with or without the standards, demand for VMT is unchanged, other than through potential changes in the marginal cost of driving, which should already be addressed by the rebound effect.[429] EPA

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[426] The dissertation is dated 1982. The agencies mistakenly cite it as his 1981 dissertation.

[427] Gruenspecht (1982a), at 126.

[428] *Id.*

[429] EPA Further Review of CAFE Model & Inputs, June 18, 2018 at 5, attached to Email from William Charmley (June 18, 2018) ("A change in the overall fleet size due to the Augural standards might not in and of itself be problematic, as long as the VMT schedules are adjusted to account for overall travel activity that is distributed over

staff correctly explained: "With no rebound, we would not expect to see any change in total VMT, since by definition rebound is measured as the change in VMT for a given change in fuel cost per mile."[430] NHTSA never provided an adequate explanation for dismissing EPA's comments and publishing the Proposed Rule.

In sum, the agencies' decision to employ a methodological approach that results in a significant increase in VMT, even though such an increase is inconsistent with economic theory, the academic literature, and agency staff analysis, is arbitrary and capricious. The agencies' reliance on the fatalities and costs that arise from the increase in VMT to justify the rollback is also arbitrary and capricious.

b.) *Any VMT changes caused by the baseline standards should already be captured by the rebound estimates*

Moreover, to the extent that VMT changes at all when price or fuel efficiency changes, that VMT change should already be accounted for in the agencies' rebound estimates. (We separately critique the agencies' rebound estimates in Section IV.)

As we explained above, VMT does not go up with changes in scrappage. But VMT can go up with rebound. As explained more at length in Section IV, rebound is comprised of three separate effects. Two of those effects cause increased driving because of consumers' increased income: (1) a reduction in the relative cost of driving compared to other forms of transportation—the "substitution effect;" (2) an increase in consumers' overall income (since they have to spend less on gasoline) that results in consuming more of many things (including driving)—the "income effect." The third effect depresses driving: (3) a reduction in consumers overall income (since consumers have to spend more for a more expensive but fuel efficient car) that results in consuming less of many things (including driving)— "the capital cost income effect."

Several of the rebound papers that the agencies assess in their rebound estimate calculate the rebound effect of increased fuel efficiency by looking both at the effect that fuel efficiency has on lowering the cost of driving, as well as on total driving and fleet size (partially through changes in vehicle prices).[431] For example, Small and van Dender (2007) define the rebound effect as $\frac{\varepsilon_{M,PM}+\varepsilon_{M,V}\varepsilon_{V,PM}}{1-\varepsilon_{M,V}\varepsilon_{V,M}}$ where $\varepsilon_{M,PM}$ is the elasticity of VMT to the fuel cost per mile, $\varepsilon_{M,V}$ is the elasticity of VMT to fleet size, $\varepsilon_{V,PM}$ is the elasticity of fleet size to the fuel cost per mile, and $\varepsilon_{V,M}$ is the elasticity of fleet size to VMT. In this way, these papers effectively already

a larger number of vehicles."), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th attachment).

[430] *Id.* at 9.

[431] Scimek (1996), at 84; Small and Van Dender (2007), at 31; Barla et al. (2009), at 389-391; Hymel et al. (2010), at 1223-1224; Hymel and Small (2015), at 31.

account for any possible fleet size changes.[432] These papers demonstrate that, to the extent fleet size is changing at all, that change is best captured through the rebound effect, and not through the scrappage estimates in the Proposed Rule.

c.) *Vehicles scrapped under the proposed policy and not the baseline policy are marginal by definition, and the average VMT does not apply*

Even if the agencies are correct about the impact of non-replacement scrappage (and they are not, as discussed above), the agencies' use of average VMT schedules in the calculations also led to a significant inflation in the agencies' estimates of aggregate VMT increases. Some of the most critical variables for analyzing VMT schedules are: fleet size and composition, accident and repair rates of vehicles of a particular age and class (i.e., controls for quality), vehicle brand (i.e., a control for durability), number of households owning vehicles, and average number of vehicles per household. In the VMT calculations, the agencies applied VMT schedules that were calculated using the number of miles traveled by the average vehicle for a given age and style (car, SUV, pickup truck, van, medium-duty pickup/van) to vehicles that would have been scrapped if not for the baseline standards.[433]

But the agencies ignored confounding variables that could make those vehicles only "marginal" vehicles, with characteristics that would have made them candidates for earlier scrappage relative to the average vehicles of that particular body style and vintage without the baseline standards. These characteristics might include more wear and tear (i.e., higher odometer readings and more accidents) and lower durability (i.e., of a brand with higher scrappage rates). Conditional on age, vehicles with higher odometer readings are both more likely to be scrapped and more likely to be driven fewer miles annually.[434] There is reason to believe that these marginal vehicles are also driven less than average vehicles of the same style and vintage. Data from Sweden indicate that some portion of scrapped vehicles are not driven prior to scrappage even though they are registered and could be driven.[435] As such, it is inappropriate to assume that the vehicles that would be scrapped under the Proposed Rule but would not have been scrapped

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[432] *See also* Joshua Linn, Resources for the Future, *Missing Fuel Cost Savings: Some Clues Emerge* (Oct. 9, 2018), http://www.rff.org/blog/2018/missing-fuel-cost-savings-some-clues-emerge (analyzing the agencies' VMT conclusions with respect to both scrappage and rebound and concluding that they are double counted).

[433] 83 Fed. Reg. at 43,090 ("the CAFE model tabulates 'mileage accumulation' schedules, which relate average annual miles driven to vehicle age, based on vehicles' body style").

[434] The current VMT schedules indicate that households drive vehicles less as the vehicles depreciate. While the agencies' VMT schedules vary VMT by vehicle age, odometer readings are a better indicator of depreciation than age. Busse, et al. (2013), at 233; Salee, et al. (2016), at 63-65. Because "conditional on age, vehicles with higher odometer readings have less remaining life," and have lower economic value (higher depreciation). Salle et al. (2016), at 66 (Figure 1); *see also* Jacobsen & van Benthem (2015), at 1330. At the same time, high mileage vehicles are likely driven less because less reliable vehicles (i.e., vehicles that are more likely to break down) impose a higher marginal costs of driving.

[435] Feeney and Cardebring (1988), at 455.

under the baseline standards would be driven the same as an average vehicle of their age and style.

Given the divergent characteristics of the non-scrapped vehicles and average vehicles, it is also likely that buyers of these almost scrapped vehicles are different than the vehicle owner of the average vehicle of that particular age and style. For example, the drivers may be younger, have lower incomes, live in places where driving every day is not necessary, etc. The owners of marginal vehicles likely make different driving decisions than would the average owners of the average vehicles of the corresponding age and style. Those owners may drive their vehicles less for any number of reasons.

By assuming all vehicles in the fleet are driven the amount that an average vehicle of that age and style are driven even after a vast increase in the fleet size, the agencies have failed to control for omitted variables and inflated the estimates of aggregate VMT increases.

An additional concern with the aggregate VMT analysis is the datasets the agencies use to construct the VMT schedules. For vehicles older than fifteen years, that dataset includes data from the 2008 recession.[436] But as the agencies themselves acknowledge, that year is unrepresentative and so should not be used. Given that a significant number of affected vehicles in the model are fifteen years or older,[437] a significant portion of VMT may come from vehicles whose schedules were calculated using this skewed data. This likely has serious consequences for the aggregate VMT estimates.

d.) *The agencies' analysis is inconsistent with their rebound welfare analysis*

The agencies' VMT analysis is also inconsistent with the agencies' rebound analysis, which finds that all fatalities stemming from those additional vehicle miles are offset by the private welfare benefits of increased driving.[438] It is arbitrary and capricious to include these offsetting benefits for rebound but ignore them for scrappage. Specifically, according to the agencies, drivers would gain expected utility from driving that must exceed their private cost from increased fatality risk (i.e., in this case from having a vehicle in the baseline policy that they do not have under the preferred policy). If an owner does not want to drive his or her used car more (i.e., does not want to take the relative risk to enjoy driving a used car more), that owner can sell the used car to someone else who would want to drive it (otherwise, it would be scrapped). In that case, the *marginal private benefits of driving* are equal to *the marginal costs of driving*. Therefore, the *private benefit of driving* must be greater than the *private fatality cost*, since we know that the private costs of driving include more than just fatality risk (i.e., time and gas

436 PRIA at 973.

437 83 Fed. Reg. at 43,097.

438 *Id.* at 43,105 (showing that the costs of rebound are offset by the welfare benefits).

prices). Given that the agencies have included this welfare benefit in the rebound analysis, they should include it in the scrappage context.

3. Path forward

a.) *The agencies must conduct more study and have their models peer reviewed*

As explained above, the agencies' brand new scrappage model goes against basic economic theory.[439] In light of this, as well as the model's novel application, the agencies must have the model peer-reviewed.[440] The agencies should also conduct more inter-model comparisons. As discussed earlier, Bento et al. (2018) estimated that scrappage elasticity is -0.4 and Jacobsen and van Benthem (2015) estimated that it is -0.7.[441] The agencies' results are not consistent with these elasticity estimates. The agencies must provide an explanation for the divergence.

Out-of-sample testing is also necessary for the agencies' scrappage and sales models—as is true of any model. The nonsense results found by NHTSA indicate that NHTSA's scrappage model performs poorly out-of-sample.[442] The need for these kinds of checks is also consistent with the agencies' past consideration of the challenges of modeling scrappage. In its 2016 Proposed Determination, EPA rejected the use of a scrappage model based on the fact that the analysis requires additional scrutiny.[443] Specifically, EPA called for out-of-sample testing and inter-model comparison.[444] Such analyses would be consistent with similar out-of-sample analyses conducted in the scrappage literature.[445] The agencies have not identified anything in the literature or their approach that explains the change in EPA's conclusion on this point now.

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[439] PRIA at 1049 ("In summary, this analysis includes the effect of differentiated fuel economy regulations that only affect new and not used vehicles—and to our knowledge is the first dynamic vehicle scrappage model implemented in a larger framework.").

[440] See 77 Fed. Reg. 62,624 (summarizing the many studies that supported the Clean Car Standards and describing the peer-review that the agencies used to analyze that information).

[441] Jacobsen & van Benthem (2015), at 1333 (Table 6); *see also* Walker (1968), at 505; Gruenspecht (1982b), at 330; Bento et al. (2018), at 159. Though less relevant due to age, older papers estimate that the elasticity of scrappage with respect to new vehicle price is between -0.7 to -1.0. Walker (1968), at 505; Gruenspecht (1982b), at 330.

[442] Jacobsen & van Benthem Docket Letter. Their concern is unsurprising, as the agencies likely overfitted the data as the agencies selected models to maximize their explanation of in sample variation; this is true even as the agencies apply Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) in addition to root mean squared error (RMSE). See PRIA at 1015.

[443] EPA, Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation at A-43 (2016), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3DO.pdf [hereinafter "Proposed Determination].

[444] *Id*.

[445] Parks (1977), at 1111-1114; Greenstone and Cohen (1999), at 367-380.

b.) *In order to study the impact of new vehicle sales on scrappage and VMT, the agencies should link new vehicle sales and changes in used vehicle retention*

A fundamental flaw of the agencies' analysis is that the agencies have developed separate and unconnected models to estimate the size and composition of the fleet, and the number of miles traveled by various vehicles within that fleet. Consumer decisions regarding when to buy or not buy a new vehicle; decisions about buying, holding, selling, or scrapping a used vehicle; and decisions about how many miles to drive each vehicle that is owned; are all related to each other. The agencies' failure to connect these models is a large part of what is leading to unjustified results. The agencies should abandon their clearly incorrect approach and retain the approach the agencies have used for past fuel efficiency and GHG emission standards.

However, if the agencies insist on evaluating the dynamic changes in fleet composition that would be caused by the baseline standards, they must modify their approach in order to take into account these interconnections. There are a number of options for doing this, including:

- Developing an interconnected vehicle choice model;
- Using more sophisticated econometric techniques to connect the existing separate models;
- Controlling for all omitted variables;
- Applying fleet size and VMT constraints on the existing scrappage model while correcting for some of the econometric errors in the agencies' current approach.

In any of these cases, the agencies should control for omitted variables[446] and abide by the fundamental principles that we have laid out in these comments.

i.) Retaining the peer-reviewed approach from the Clean Car Standards

Without a robust methodology to account for the interconnections between the different fleet composition models, the only economically valid path forward would be to adopt the approach that the agencies used in their regulation promulgating the Clean Car Standards: assume a

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[446] If it is not possible to control for the omitted variables, the agencies should consider included fixed effects for the following variables: brand fixed effects, vehicle type (segment or class) fixed effects; time scale fixed effects; geographic fixed effects; age and model year fixed effects, including dummies for the interactions between them. *See* Li et al. (2009) (dummies can control for omitted vehicle attributes and explaining that geographic fixed effects can capture unobserved demographics and other unobserved geographic variables that affect vehicle demand); Hamilton and Macauley, (1999), at 254; Li et al., (2009); PRIA, 948, 1012 (finding strong evidence of time trend in their new vehicles sales analysis and noting that scrap metal quantity decreases over time indicating the potential need for time-period fixed effect); Parks (1977), at 1104, at 1110; Gruenspecht, (1982a), at 97; Hamilton and Macauley, (1999); Jacobsen and Benthem (2015), at 1321. The agencies currently use polynomial variables for age and model year, however fixed effects are flexible and commonly applied in the literature. To "avoid imposing restrictions on the pattern of scrapping responses to new car price development across age groups," Gruenspecht (1982a) at 115) interacts new vehicle price with age dummies. Given the high statistical significance of these parameters, the agencies should consider this alternative instead of time trends.

constant, not dynamic, fleet.[447] Use of the new scrappage model in its current form without fleet size constraints is not a valid option.

In order to address any effects caused by the aging of the vehicle fleet,[448] the agencies could develop a simpler logistic scrappage model like those that solely capture the effect of vehicle age on scrappage, but those would not generally show an increase in overall VMT or fleet size.[449]

ii.) Vehicle choice model

An approach that models consumer decisionmaking using a vehicle choice model could, in theory, be a coherent and integrated approach to estimating the effect of the baseline standards on fleet composition. This is the approach taken by Jacobsen and van Benthem in a paper that the agencies repeatedly cite.[450] However, before making this change, the agencies would have to address the significant shortcomings of vehicle choice models that they identify in the Proposed Rule and ensure that those problems are addressed.[451]

iii.) Simultaneous equations

The agencies could investigate the use of simultaneous equations to estimate new vehicle sales, scrappage, and vehicle-miles traveled simultaneously.

Specifying structural models of the various components, rather than the reduced form, disconnected models, used in the Proposed Rule would aid in both ensuring consistency with the literature, as well as in identifying sources of endogeneity and candidate instrumental variables.

The agencies could build on the estimation strategies begun in Small and Van Dender (2007).[452] However, the agencies would need to separate total fleet size into new and used components.[453]

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[447] 77 Fed. Reg. at 62,716 (explaining the agencies' prior approach, which uses static vehicle turnover model and non-rebound VMT schedules that do not vary based on the stringency of the standards); *see also* Draft TAR at 10-6.

[448] Bento et al. (2018), at 178.

[449] Walker (1968), at 503; Green and Chen (1981), at 383; Feeney and Cardebring (1988), at 460; Hamilton and Macauley (1999), at 253; Bento et al. (2018), at 161.

[450] Jacobson and van Benthem (2015), at 1328-1329 (the authors refer to their model as a simulation model that captures leakage from scrappage and vehicle choice); Proposed Determination at A-43 ("We note that it relies on an estimated model of consumer vehicle choices that, as with most other models, has not been tested for out-of-sample validity or comparability with other models.").

[451] 83 Fed. Reg. at 43,076-43,078. EPA has previously argued that vehicle choice models are insufficient for policy making. Proposed Determination at A-44, A-47, A-48. EPA concluded that vehicle choice models are poor predictors of future shares, *id.* at A-45, often are out-performed by constant share models and have not been tested for their forecast ability. *Id.* at A-44).

[452] *See generally* Small and Van Dender (2007), at 30-33 (discussing methods).

[453] Id.

In addition, in order to properly control for variables at the vehicle and household level, the agencies should estimate VMT schedules of marginally scrapped vehicles.

iv.) Fleetsize and VMT constraints

If the agency does not adopt one of the above approaches, the only economically valid approach would be to apply "constraints" on aggregate fleet size and VMT in the VOLPE simulation so that aggregate fleet size and VMT does not change across the proposed and baseline rules. This approach would not be a panacea and would not address all of the flaws outlined above. But it would at least constrain the errors driving the increases in fleet size and VMT.

In interagency comments to NHTSA, EPA staff proposed a similar solution. EPA recommended that the agencies impose constraints on fleet size and VMT so that the agencies can isolate the Gruenspecht effect (or shift to used vehicles).[454] The methodology proposed by EPA staff would also allow fleet size to grow over time (in line with historical observation) and to just capture the scrappage factor: the aging of the fleet.[455]

In response to EPA's suggestions, NHTSA asserted that it could not use the adjustment factors proposed by EPA because they would be internally inconsistent.[456] But the agencies' scrappage results are inconsistent with basic economic logic and the academic literature and that is why these constraints are necessary. In fact, Gruenspecht himself recognized the need to impose fleet size and VMT constraints after modeling the connections between new car market, the used car market, and households' VMT decisions (as acknowledged by the agencies).[457] Gruenspecht explained that the disadvantage of the reduced form model he used (i.e., where scrappage is modeled as a function of new vehicle price and not the theoretically correct used vehicle price) is

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[454] Summary points from EPA review of CAFE model (NPRM version)–Effect of EPA code revisions. Meeting with Office of Management and Budget/OIRA 6/18/2018, slides 2-3, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th Attachment, pdf pages 4-5); EPA Further Review of CAFE Model & Inputs at 6-7 (June 18, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th Attachment, pdf pages 15-16).

[455] *See* Bento et al., (2018) at 178. Specifically, EPA found that the scrappage rate curves so that overall fleet size is unaffected by the policy (though it grows over time) and that VMT increases only with the rebound effect (and not scrappage). Summary points from EPA review of CAFE model (NPRM version)–Effect of EPA code revisions, Meeting with Office of Management and Budget/OIRA 6/18/2018, slides 2-3, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th Attachment, pdf pages 4-5); EPA Further Review of CAFE Model & Inputs at 6-7 (June 18, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th Attachment, pdf pages 15-16).

[456] NHTSA, Responses to Interagency Comments on NPRM Round 8 Received 7-11-2018, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (12th Attachment, pdf page 4).

[457] Gruenspecht (1982a), at 120, 126; Gruenspecht (1982b), at 329.

that it may produce inaccurate results and that constraints were thus necessary.[458] Specifically, he states:

> The primary argument in favor of the structural approach is based on the observation that new car markets are cleared primarily through quantity variation, while used car markets are cleared mostly though price adjustments. Therefore, used car prices and new car prices need not move in tandem. According to the framework developed in Section 4 and 5, there is no direct link between rational scrapping decisions and new car prices. Therefore a direct regression of scrapping rates on new car prices may fail to yield coefficients that approximate those obtained by solving a structural scrapping model that explicitly models the link between new car prices and used car prices.[459]

In other words, there is no direct link between new vehicle prices and used car scrappage. Instead, any link between scrapping decisions and new car prices is only indirect through the price of used cars. Because of this indirect connection, it is possible that a model will produce strange and theoretically inconsistent results without constraints, as the agencies' model indeed produced in the Proposed Rule.

An additional argument that NHTSA cited is that fleet size and VMT constraints may reverse the aging trend of the fleet observed over the last few decades.[460] But as the methodology could allow average historical fleet size growth as a modeling input, this concern is invalid. In fact, EPA provided an alternative approach to NHSTA during the period before the agencies published the Proposed Rule and modified the code to allow "the user to select a fleet growth rate."[461] The agencies provide no evidence that the problem could not be overcome in that way now.

Even if fleet size and VMT constraints are imposed on the model, other changes are still necessary to ensure that the agencies' approach will yield valid results. In particular, the agencies will need to carefully consider the connections between the simultaneously determined variables among the various disparate new vehicle sales, scrappage, and VMT models. In doing so, the agencies should carefully consider how the variables are connected based on theory. For

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[458] Gruenspecht (1982a), at 93.

[459] Gruenspecht (1982a), at 93.

[460] NHTSA, Response to Interagency Comments on NPRM Round 8 Received 7-11-2018, at 3-4, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (12th Attachment, pdf pages 3-4).

[461] Summary points from EPA review of CAFE model (NPRM version)–Effect of EPA code revisions, Meeting with Office of Management and Budget/OIRA 6/18/2018, slides 2-3, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th Attachment, pdf pages 4-5); EPA Further Review of CAFE Model & Inputs at 6-7 (June 18, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th Attachment, pdf pages 15-16).

example, Gruenspecht (1981): included the scrappage rate, new vehicle price, and new vehicle sales in his regression for used vehicle price;[462] in his structural scrappage regression, Gruenspecht (1982) included new vehicle sales;[463] in his corresponding reduced form regression, Gruenspecht (1982) included vehicle miles traveled per capita in order to address overall demand for driving, in addition to the vehicle stock in the previous period.[464] Gruenspecht (1982) also demonstrated that the quantity of new vehicle demand is a function of vehicle miles traveled per capita and vehicle stock in the previous period, in addition to new vehicle price.[465] The agencies should include the variables that Gruenspecht and others have traditionally included in their scrappage analysis, including price of vehicles indexed by maintenance and repair costs, the price of scrap metal, and interest rates.[466]

One shortcoming of this methodology is that it cannot capture the possibility of fleet size and VMT declining as new and used vehicle prices increase. Specifically, holding VMT and fleet size constant ignores the possibility that people will switch from used vehicles to shared forms of transit (e.g., mass transportation, existing household vehicles) as these prices increase. These features could cause a decline in fleet size and VMT should the new vehicle price change be large and should be assessed.[467] The agencies should model that as well

B. Safety consequences of changes in fleet composition

Even if the agencies are right that higher new vehicle prices will lead to an increase in the fleet size and total VMT (and they are not), their safety estimates are inflated.

1. Demand for vehicle safety should lower the impact of scrappage estimates

To make their fleet composition calculations, the agencies calculated the change in "distribution of both ages and model years present in the on-road fleet."[468] Then the agencies combined that information with data showing the fatality rates of vehicles by model year.[469]

But in calculating the impact that the price increases have on fatalities through slower turnover, the agencies have failed to consider the impact that a consumer preference for safety would have

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[462] Gruenspecht (1982a), at 81, 99-101.

[463] *Id.* at 106-107.

[464] *Id.* at 86, 109-113.

[465] *Id.* at 87.

[466] *Id. at 70.* Gruenspecht (1982a), at 103, 109-113, 117 (including interest rates).

[467] Jacobsen & van Benthem Docket Letter at 2. (referring to a switch from the baseline policy to the Proposed Rule and stating that the extent to which the fleet will decrease "depends on the magnitude of the price changes and the aggregate elasticity to the outside good").

[468] 83 Fed. Reg. at 43,135.

[469] *Id.* at 43,135-37.

on that slower turnover.[470] For some time, the literature has demonstrated that consumers prefer safer vehicles. Since the 1980s, a top vehicle safety rating for a particular vehicle model has significantly increased demand for that vehicle model.[471] The agencies themselves acknowledge that safety is a vehicle attribute that consumers value.[472] Given this preference, consumers may continue to choose relatively safer new and used cars and manufacturers may continue to supply relatively safer vehicles, and so the impact that any decreased turnover would have on safety would be muted.

It would be unreasonable for the agencies to ignore the fact that safety affects consumer decisionmaking. Academic economists have developed tools that can facilitate analysis of these types of interconnected relationships. For example, fuel efficiency programs may lead to more congestion through rebound, but the additional congestion itself deters travel and depresses the impact of the additional congestion. For that reason, Hymel et al. used simultaneous equations that capture the inter-connected relationship between fuel efficiency and congestion to estimate the impact of fuel-efficiency programs on congestion.[473] Likewise, Small and Van Dender recognized the endogenous characteristic of fuel efficiency: fuel efficiency causes more driving and more driving causes a demand for fuel efficiency to increase. Because of this interaction, Small and Van Dender calculated the impact of fuel efficiency programs on VMT through simultaneous equations.[474] As these papers show, all the vehicle aspects (VMT, fuel efficiency, vehicle age) are interrelated and ignoring the feedback effects (those interconnectedness), as the agencies are currently doing, produces flawed or even meaningless results. The agencies should estimate the simultaneous interaction between fuel-efficiency standards and safety. Without fixing these flaws, the agencies' results are arbitrary and capricious.

2. The failure to control for confounding factors has led to inflated estimates

The agencies also fail to control for confounding factors. There are three major causes of crashes: "the driver, the vehicle, and the environment in which crashes occur."[475] Within these categories, many different features besides design can lead to changes in the real-world

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[470] *See* PRIA at 952-953 (listing the inputs in the sales model, which does not include any variable or proxy variable for vehicle safety).

[471] McCarthy (1990), at 534-41 (explaining that studies in the 1980s showed that vehicle safety was one of the most important attributes for consumers); *see also* Kaul et al. (2010) (describing US consumer preferences for safety features).

[472] PRIA at 933 ("this analysis recognizes that manufacturers' changes in the fuel economy and emissions levels of new vehicles in response to raising or lowering federal standards may also entail changes in other attributes that . . . potential buyers also value . . . include[ing] . . . occupant safety").

[473] Hymel et al. (2010), at 1220-21.

[474] Small & Van Dender (2007), at 30-31; *see also* Hymel & Small (2015), at 95 (using simultaneous equations to calculate impact of fuel efficiency on VMT).

[475] Farmer and Lund (2006), at 342.

performance of the on-road vehicle fleet. For example, improved safety laws and programs (including speed limits and licensing laws), urbanization (i.e., congestion), driver behavior like seat belt use, improved road design, improved traffic law enforcement, less alcohol-impaired driving, economic downturns, and improvements in ambulance response times can all lead to fewer fatalities.[476]

As such, these factors are typically studied in the literature through the age of the vehicle (as a proxy for driver), the model year (to account for vehicle design), and the calendar year (to account for environmental factors).[477]

In the Proposed Rule, the agencies attempt to quantify the influence of vehicle age and vintage (i.e., model year) on fatalities by analyzing aggregate fatality data from years 1996 to 2015.[478] Specifically, the agencies look at "real world performance in the on-road vehicle fleet."[479] The agencies explain that they used age as a proxy variable for driver behavior[480] and vehicle model year as a proxy for safety technology trends. The agencies use the results of those quantifications to predict how changes in turnover will affect road fatalities.

But those quantifications are inflated for two reasons.

First, the agencies fail to control for the third factor that is relevant to crashes: environmental changes.[481] Specifically, as the driving environment has generally improved over time,[482] the coefficients corresponding to model year overestimate improvements in the safety features between the model years. Not controlling for all the non-vehicle variables that increase safety

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[476] See Famer & Lund (2006), at 339-341; Farmer & Lund (2015), at 685-686 (citing the 2008 recession, improvements in road design, and improved driver behavior as potential factors that improved on-road performance); *see also* Anderson & Searson (2015) at 202 (explaining that a vehicle's age and crash risk are likely correlated with the characteristics of the average driver associated with vehicles of a particular age as well as with the distance and type of driving associated with vehicle age and explaining that "[r]isks created by conditions separate from the vehicle (road-safety related changes to infrastructure, speed limits, other legislation, enforcement and behavior)" likely also have an impact on the crash statistics).

[477] Farmer and Lund (2006), at 341-342; Anderson and Searson (2015), at 202.

[478] 83 Fed. Reg. at 43,136. Specifically, the agency regresses U.S. fatalities per billion miles on a polynomial of vehicle age (a proxy for driver behavior) and model year fixed effects: $F_{it} = \beta_0 + \sum_{j=1}^{4} B_j * {Age_{it}}^{j} + \sum_{i=1976}^{2014} \gamma_i * MY_i + \varepsilon_{it}$ where F_{ijt} are fatalities of model year *i* in calendar year *t*, Age_{it} is vehicle age of model year *i* in calendar year *t*, MY_i is model year *i*, and ε_{it} is the error term. In this regression, γ_i are the values of interest (i.e., improvements in safety).

[479] 83 Fed. Reg. at 43,140.

[480] Farmer and Lund (2006), at 341-342; PRIA at 1406-1407.

[481] *See Id.* at 1382; 83 Fed. Reg. at 43,136 (explaining that the model lacked the "internal structure" to account for vehicle speed, seat belt use, drug use, or age of drivers); PRIA at 1392 (stating that "fatality rates associated with different model year vehicles are influenced by the vehicle itself and by driver behavior" ignoring environmental factors altogether).

[482] Farmer and Lund, (2015) at 686 (Figure 2).

over time is unacceptable and biases the results towards very high fatalities under baseline standards.

Second, the vehicle age variables are only a rough proxy for driver behavior because they can only capture driver behavior that does not change over time. For example, if the social acceptance of drunk driving decreases and consequently drunk driving decreases, the age variable would not capture that change. As such, the agencies could not adequately control for driver behavior trends. And a decrease in fatalities could look like it was caused by vehicle improvements over time rather than societal changes.

In statistical terms, because of these problems, the safety estimates suffer from omitted variable bias. The agencies recognize the issues with respect to seat belt use trends but ignore (or fail to recognize) the overall extent of this problem in their analysis.[483]

Omitted variable bias is a serious statistical problem in the vehicle safety context. Omitted variable bias occurs when an omitted variable (e.g., environmental and behavior trends) is correlated with the included regressor (e.g., the age of the vehicle and model year), and when these omitted variables are determinants of the dependent variables (e.g., fatalities).[484] Environmental and behavioral trends clearly affect fatalities and are correlated perfectly with age and model year. Since the bias gets worse as the regressors become more correlated (e.g., age of the vehicle and model year) with the omitted variables (e.g., environmental and behavior trends),[485] the perfect correlation of the calendar year variable with model year plus age creates a severe bias.

As a result of the omission of these variables in the safety analysis, the agencies do not capture causal relationships between vehicle vintage (i.e., model year) and vehicle age and fatalities, but only correlations, leading to misleading and sometimes even meaningless estimates.

Figure 3 shows that results of the agencies' age estimates contradict the literature and intuition. That Figure confirms that the agencies' analysis captures meaningless correlations and not causation. Figure 3 plots the agencies' estimate of the relationship between car age and fatalities and shows a huge drop in fatalities as vehicles age.[486] But as the literature demonstrates, fatalities clearly increase with vehicle age.[487] Indeed, NHTSA recognized this in 2013, in a report cited

483 PRIA at 1395-1399.

484 Stock and Watson (2007), at 187.

485 *Id.* at 190.

486 The estimated relationship is given by polynomial: $28.59 - 3.63\text{x} + 0.76x^2 - .04x^3 + 0.0005x^4$. *See* 83 Fed. Reg. at 43,138.

487 Farmer and Lund (2006), at 339 (Figure 3); Farmer and Lund (2015), at 686 (Figure 1).

and described in the Proposed Rule.[488] And the agencies also recognized this in the Proposed Rule.[489]

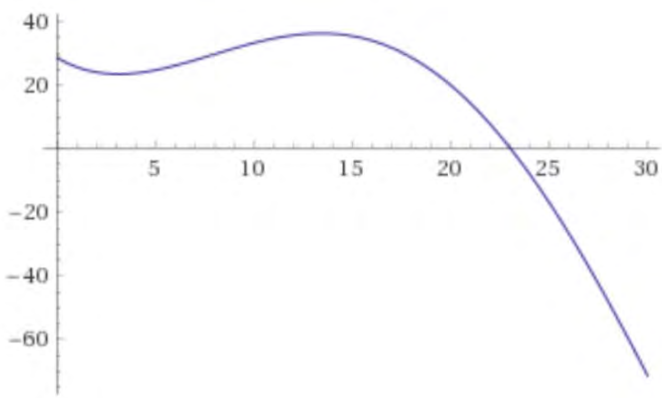

Figure 3. Agencies estimate of relationship between car age (x-axis) and fatalities per billion miles (y-axis)

As Figure 3 helps show, estimating correlations instead of causal relationships poses huge problems for the type of predictive analysis that the agencies have set out to do. As economic textbooks have long acknowledged: "Knowing that two factors are correlated provides no predictive power; prediction requires understanding the causal links between the factors."[490]

The agencies do not adequately address these biases, despite several strategies that are available in the literature. For example, analyses, including by NHTSA itself, have been able to calculate the impact of vehicle design changes on safety, while controlling for many of the related and confounding behavioral or environmental factors.[491] In its prior rules, NHTSA itself has controlled for vehicle age, body type, air bag deployment, roadway function class, day/night, occupant age, gender, number of vehicles in crash, restraint use, principal impact point, speeding involved, speed limit, ejection status, rollover, interstate road, occurring at an intersection, motorcycle involved in the crash, roadway departure, number of occupants; even more

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[488] 83 Fed. Reg. at 43,135 (describing National Center for Statistics and Analysis, *How Vehicle Age and Model Year Relate to Driver Injury Severity in Fatal Crashes* 6 (Aug. 2013), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811825).

[489] *Id*.

[490] Grueber (2010), at 66.

[491] *See* Farmer & Lund (2015), at 685-686 (describing studies); Blows et al. (2003), at 354 (controlling for driver demographics (e.g., age, sex, race, education level), behavioral characteristics (e.g., alcohol and marijuana consumption, driving speed, seatbelt usage), and vehicle characteristics (engine size, inspection certificate); Ryb et al. (2013), at 257 (controlling for driver age, sex, weight, seatbelt use); Farmer and Lund (2006), at 339-341.

behavioral variables are controlled for in the literature.[492] Indeed, in the PRIA, the agencies showed how fatalities by vehicle age are correlated with seat belt usage, alcohol consumption, and speeding.[493] The agencies concluded: "[t]herefore, it is important to control for behavioral aspects associated with vehicle age so only vehicle design differences are reflected in the estimate of safety impacts."[494] Inexplicably, the agencies then claimed to have addressed this issue by controlling solely for vehicle age.[495] However, given the omission of important confounding factors in the analysis, controlling solely for age is insufficient.

Rather than control for these factors when analyzing the actual safety impact of changes in fleet turnover, the agencies argue that they are unable to include additional control variables because "[v]ehicle interactions are simply not modeled at this level."[496] But NHTSA has managed to control for these factors before.[497] And as the model's results are counterintuitive and in conflict with economic research, the agencies should fix the model rather than ignoring the problem. The agencies further argue that they cannot control for these variables, because they cannot project (i.e., forecast) the variables into the future.[498] But as long as the agency controls for the confounding variables, it does not matter how those variables change in the future.

Given the flaws of the current methodology and the importance of the safety findings to the agencies' ultimate results, the agencies should control for all of the variables that they have controlled for in the past and which are controlled for in the literature. This should also include all relevant variables from the mass-footprint regressions discussed below to avoid double counting the impacts of vehicle mass on fatalities.

Additionally, as the usage of aggregated data does not allow for full identification of the effects,[499] the agencies should disaggregate their data (i.e., use more atomistic or regional data) allowing them to break the strict equality between calendar year, model year, and age of vehicle (discussed above); this would allow the agencies to control more generally for trends in environment and behavioral safety over time.[500] For example, the agencies can create model year

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[492] Glassbrenner (2012), at 26-39, 4349; NHTSA (2013b), at 2-3; NHTSA (2018), at 528.

[493] PRIA at 1393-94.

[494] *Id.* at 1394.

[495] *Id.* at 1394-95.

[496] *Id.* at 1381.

[497] NHTSA (2013b), at 2-3.

[498] PRIA at 1381-82.

[499] *See* NHTSA (2013b), at 6

[500] Ideally, we would like to control for other safety trends over time independent of vehicle design. Ideally, the agency could instead estimate $F_{it} = \beta_0 + \sum_{j=1}^{4} B_j * Age_{it}{}^{j} + \sum_{i=1976}^{2014} MY_i + \sum_{k=1}^{K} \mu_k * Time_t{}^{k} + \alpha X_{it} + \varepsilon_{it}$ where X_{it} would control for more detailed behavioral and environmental variables (discussed in the previous suggestion)

groups for which safety features do *not* change (i.e., between model redesigns) to break the link between calendar year, model year, and vehicle age[501]; this requires data at the vehicle model and body style level in addition to calendar year and model year.[502] The agencies should also consider running an age-period-cohort (APC) model as a sensitivity analysis, where model year is the cohort.[503] The agencies should also conduct a sensitivity analysis that replaces the age variable with a calendar year variable and use that specification if it improves model fit.

The agencies performed some plausibility checks on their results, but they are unconvincing. For example, the agencies compared their results with those of Glassbrenner, one of the authors who has conducted studies on the impact of vehicle design improvements and who has controlled for some of the confounding factors discussed above.[504] The agencies also compared their results with data from Kahane, who controlled for seatbelt usage.[505] The agencies claimed that it is "encouraging" that their approach and the Kahane and Glassbrenner approaches showed a "similar directional trend" in their results.[506] But the fact that the directional trend is similar does not address whether or not the agencies' approach ignores too many confounding variables to be at all reliable. Indeed, the agencies could be *vastly* inflating the change in fatalities and the directional trends could still go in the same direction. In fact, the agencies acknowledge that their analysis shows some significant divergence with the data provided by Kahane and attribute this difference to the fact that Kahane directly controls for seatbelt usage whereas their analysis does not.[507] Comparing the results with the Kahane and Glassbrenner results is thus not sufficient. The agencies should control for the confounding variables themselves, as described here, and provide the estimates to the public for comment. Any other strategy would lead to unreliable and inflated results.

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and the polynomial of time (i.e., calendar year or the year that the accident occurred in) would control for more generally for trends in environment and behavioral trends. However, panel data only allows an analyst to control for two of these three variables, as the calendar year equals vehicle age plus model year. Anderson and Searson (2015), at 203. A consequence of this technical problem in safety regressions is that analysts can only control for two out of the three variables using a standard regression analysis, such that the coefficients of the remaining variables (i.e., the age variable and the model year fixed effects) suffer from omitted variable bias. This situation is known as the classical age-period-cohort (APC) problem that arises in human health studies. *Id.*

[501] Farmer and Lund (2006), at 336.

[502] *Id.* at 335.

[503] *See* Anderson & Searson (2015), at 203-205 (discussing age-cohort models).

[504] PRIA at 1395-1396.

[505] *Id*. at 1396-1397.

[506] *Id*.

[507] PRIA at 1397.

Given the counterintuitive results shown above for vehicle age, the agencies should also expand the set of model fit tests. Specifically, they should compare the model results to Farmer and Lund (2015) and NHTSA (2013); the latter of which is an update of Glassbrenner by NHTSA.

3. The agencies have not provided an adequate explanation for why past safety trends are likely to continue until the mid-2020s

The agencies' estimates of safety trends lacks an adequate explanation. To evaluate the impact of turnover on safety, it is critical to understand the improvements in safety that would be obtained through more turnover as distinct from those that would be obtained regardless of fleet turnover. Specifically, the agencies must come up with an estimate or prediction about the safety improvements that would be missed with lower turnover. In the Proposed Rule, the agencies analyze the past safety trends and assume that the past trend in safety improvements will continue until the mid-2020s.[508]

But data on existing and past safety trends reflects improvements that are different in kind from the safety improvements that are expected between now and the mid-2020s, and so data on past trends is not a good basis for concluding that safety will continue to increase along the same trajectory through the mid-2020s.

The safety trend data reflects a number of improvements that were made to vehicles, which generally improve passenger safety if and when there is a crash. For example, the improvements that have been adopted over the past decade or so include, electronic stability controls,[509] side airbags,[510] and bumper alignment.[511] But to improve safety in the future, manufacturers will have to adopt more engineering changes that help vehicles *avoid* crashes, rather than focusing on mitigating them. Some potential technologies include forward collision warning; crash imminent braking; dynamic brake support; pedestrian automatic emergency breaking (PAEB); rear automatic breaking; semi-automatic headlamp beam switching; rear turn signal lamp color; lane departure warning; and blind spot detection.[512] Crash avoidance technology may not be adopted as easily or readily as crash mitigation technologies have been. In fact, the agencies acknowledge that the effectiveness of crash avoidance technologies and the pace of their adoption "are highly uncertain."[513] These future safety technologies differ from past safety technologies in a fundamental way. Should those new safety technologies be adopted, the predicted fatalities for

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[508] 83 Fed. Reg. at 43,139.

[509] Wenzel (2013), at 71-81.

[510] *Id.* at Figure 3.

[511] *Id.* at Figure 4.

[512] *See* 83 Fed. Reg. at 43,139-40.

[513] *Id.* at 43,139.

all the older vehicle vintages will have to be lowered as well because effective crash avoidance technologies will lower all vehicles' fatality costs.

NHTSA should explain how its assumption that the trends will continue through the mid-2020s is valid.

VI. THE AGENCIES' CHOICE OF REBOUND EFFECT IS ARBITRARY AND CAPRICIOUS

Improved vehicle efficiency makes driving cheaper, and so encourages more driving. This is termed the "rebound effect."[514] Rebound is expressed in terms of the percentage of any fuel economy savings that will be lost once consumers act on those preferences for increased driving. That additional driving results in a number of costs (increased air pollution, fuel consumption, traffic congestion, and vehicle crashes), and benefits (additional consumer utility of driving, reduced time to refuel vehicles) and the agencies have previously considered these costs and benefits when setting their standards.[515] The agencies relied on a 10% rebound estimate in the Clean Car Standards. But now the agencies have arbitrarily doubled that estimate.[516]

To arrive that the new estimate, the agencies make significant changes to their assumptions about the magnitude of the rebound effect. These changes result in a significant increase in the costs and fatalities that the agencies attribute to the baseline standards.[517] These fatalities and costs serve as a justification for rolling back those standards.[518] These methodological changes account for 3,170, or 25 percent of the additional fatalities that the agencies ascribe to the baseline standards,[519] and 6.5-6.8 percent of the quantified net benefits that the agencies claim would be gained from rolling back the baseline standards.[520] But the agencies' methodological changes are inconsistent with the best available evidence regarding rebound. And the agencies have failed to provide a reasoned basis for their new rebound conclusions.

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[514] 77 Fed. Reg. at 62,924. More specifically, this is considered the "direct" rebound effect. While the academic literature also discusses an indirect rebound effect, *see* Gillingham et al. (2016), at 72, that effect has not been incorporated into the agencies' analysis and is not the subject of our comments on rebound.

[515] Draft TAR at 10-9 to 10-10-21; 77 Fed. Reg. at 62,716.

[516] *Compare* 77 Fed. Reg. at 62,716, 62,924 (10%) *with* 83 Fed. Reg. at 43,104 (20%).

[517] PRIA at 1546, 1548 (showing higher net benefits of roll back under agencies new rebound assumptions than under previous rebound assumptions).

[518] 83 Fed. Reg. at 43,211 (explaining that NHTSA considers increased emissions that result from additional driving due to the rebound effect); *id.* at 43,212 (explaining that NHTSA considers increased fatalities that result from additional driving due to the rebound effect); *id.* at 43,230 (explaining that EPA considers the level of GHG emission reductions, which is determined, in part, by increased driving due to rebound); *id.* at 43,231 (explaining that EPA considers additional fatalities that result from increased driving due to rebound).

[519] *Id*. at 43,153; see also PRIA at 1540.

[520] *Id*. at 1546, 1548.

A. Defining rebound

There are three different components of rebound with fuel efficiency regulations. First, fuel efficiency lowers the per mile cost of driving. As the activity costs less, consumers will do more of it compared to other things. This is called the "substitution effect." Second, as driving costs less, consumers can afford more of everything, including driving. This is called the "income effect." Third, the decrease in the cost of driving is enabled by fuel efficiency technology that could increase the cost of the vehicle.[521] So consumers who spend more money upfront on a fuel efficient vehicle will have less income to spend on other products, including driving. This "capital cost income effect" has a negative rebound effect by offsetting the income effect from fuel savings. These components of rebound should be analyzed using the following formula: ΔVMT equals $\frac{\partial q^H}{\partial p}\Delta p + \frac{\partial q}{\partial I}(q\Delta p - C)$

Where:

- $\frac{\partial q^H}{\partial p}$ is the change in (Hicksian) demand for VMT from a price change,
- $\frac{\partial q_0}{\partial I}$ is the change in (Marshallian) demand for VMT from an income change,
- q is the demand for VMT,
- p is the cost per mile of driving, and
- C is the additional cost associated with acquiring the improved energy efficient vehicle.[522]

This definition includes the three independent effects on VMT from the purchasing of a vehicle:

- $\frac{\partial q^H}{\partial p}\Delta p$ measures the substitution (effect) towards more driving with a decrease in the cost of driving (from a more efficient vehicle);
- $\frac{\partial q}{\partial I}q\Delta p$ measures the increased demand for driving due to more money being in a household's pocket from a lower cost of driving;
- and $\frac{\partial q}{\partial I}C$ measures the decreased demand for driving due to less money being in a household's pocket from the capital cost of acquiring the vehicle.

B. The agencies arbitrarily changed their rebound estimates to 20% from the previous estimates of 10%

The agencies have proposed to use a rebound estimate of 20% after previously setting it at 10%.[523] But the agencies have failed to show that there are good reasons for their decision to

[521] For more detail on this aspect of the formula, see Section II.

[522] Gillingham (2014b), at 11375-11378.

[523] 83 Fed. Reg. at 43,104.

reverse course in this way.[524] The agencies cite NHTSA's 2005-2011 CAFE standards to assert that they are merely returning to past practice in using a 20% rebound estimate.[525] But in doing so, they ignore 10 years of their own analyses, the advances in the academic literature, and expert conclusions regarding the appropriate rebound estimate. Since that 2005 rulemaking, the agencies have updated their analysis and they have not relied on that 20% rate. In 2010, the agencies used a 10% rebound estimate as part of the agencies' joint CAFE and GHG emission standards for MY2012-2016.[526] In 2012, in adopting the Clean Car Standards, the agencies again arrived at the conclusion that an estimate of 10% would best reflect the rebound expected for the baseline standards.[527] In 2016, in the Draft TAR, the agencies collectively updated their evaluation of the literature and proposed to reaffirm their conclusion that 10% was the appropriate rebound estimate.[528] In 2017, EPA finalized its portion of that proposal and found that the 10% rebound estimate was appropriate.[529] In fact, as far back as 2009, NHTSA determined that the literature did not support a 20% rebound estimate.[530]

All of the arguments that the agencies provide for reserving course on these prior analyses are unavailing. As such, the agencies have failed to satisfy their duty to provide a "reasoned explanation . . . for disregarding facts and circumstances that underlay or were engendered by the prior policy."[531]

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[524] Fox Television Stations, 556 U.S. at 515.

[525] 83 Fed. Reg. at 43,104 (explaining that the use of 20% "represents a return to the value employed in the analyses for MYs 2005-2011 CAFE standards").

[526] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 Fed. Reg. 25,324, 25,516-516 (May 7, 2010) (explaining use of 10% estimate).

[527] 77 Fed. Reg. at 62,924.

[528] Draft TAR at 10-9 to 10-21.

[529] *See* Final Determination (concluding that the baseline standards were appropriate in light of the Draft TAR, Proposed Determination, Proposed Determination TSD, and public comments); EPA, Proposed Determination on the Appropriateness of the Model year 2025-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation: Technical Support Document at 3-8 to 3-21 (2016), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100Q3L4.PDF?Dockey=P100Q3L4.PDF [hereafter "Proposed Determination TSD"] (reconsidering rebound literature on rebound considered as part of Draft TAR and literature since Draft TAR to conclude 10% rebound estimate is appropriate).

[530] At that time, NHTSA used a 15% rebound rate when establishing the MY 2011-2015 CAFE standards, without EPA's involvement. NHTSA, Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks: Final Regulatory Impact Analysis at VIII-5 to VIII-8 (2009), https://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf (explaining why NHTSA selected a 15% rebound estimate); *id.* at I-47 to I-49 (explaining why the agency rejected a 20% rebound estimate advocated by some commenters).

[531] *Fox Television Stations*, 556 U.S. at 516.

1. The agencies point to no new evidence supporting a 20% rebound and, in fact, ignore new evidence on rebound that does not support the new 20% assumption

In order to support a 20% rebound estimate, the agencies primarily point to an average that they calculate from various rebound estimates in the academic literature and criticize their prior conclusions as inconsistent with those averages.[532]

As a preliminary matter, the data that the agencies discuss in the proposed rule has generally already been discussed and considered by the agencies in previous rulemakings in which they arrived at the 10% rebound estimate. And the agencies have not identified a meaningful change in the facts, which would justify the new estimate. Specifically, the table on pre-2008 studies that the agencies cite contains the same data that the agencies used to arrive at a different conclusion in 2012.[533] As is made clear in Table 3 below, derived from the various cited rules, virtually all of the post-2008 studies that the agencies now list and discuss were already considered when the agencies promulgated the Clean Car Standards and when they reaffirmed those standards as part of the Draft TAR and EPA's Final Determination. The agencies have not explained how they arrived at different factual conclusions using the same evidence.

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[532] 83 Fed. Reg. at 43,100-101, 43,104, 43,105.

[533] NHTSA 2012 FRIA at 849 (TABLE VIII–1, presenting summary statistics on rebound estimates for pre-2008 studies).

Table 3. Post-2008 Rebound Studies Discussed or Considered as Part of Rulemaking and Analyses

	SAFE Proposed Rule[534]	Clean Car Standards[535]	TAR[536]	EPA Final Determination[537]
Small and Van Dender (2007)	X	X	X	X
Barla et al. (2009)	X		*	*
Bento (2009)	X		X	X
Waddud (2009)	X		X	X
Hymel et al. (2010)	X[538]	X	X	X
Gillingham (2011)		X	X	
West and Pickrell (2011)	X		X	
Anjovic and Haas	X			
Green (2012)	X (not discussed)	X	X	X
Su (2012)	X		X	X
Linn (2013)	X		X	X
Frondel and Vance (2013)	X		X	X
Liu (2014)	X		X	X
Gillingham (2014)	X		X	X
Wang and Chen (2014)				X
Weber and Farsi (2014)	X			
Hymel & Small (2015)	X		X	X
West et al. (2015)	X		X	X
DeBorger (2016)	X		X	X
Gillingham et al. (2016)			X	X
Stapleton et al. (2016, 2017)	X (only in PRIA[539])			

Italicized studies are studies that have been considered in previous agency analyses but that are not discussed in the Proposed Rule.
Bold studies are studies considered in the Proposed Rule that have not been considered previously.
* included in discussion of Gillingham (2016)

534 PRIA at 983-992.

535 EPA & NHTSA, Joint Technical Support Document: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards at 4-23 to 4-24 (2012) [hereafter "Clean Car Standards TSD"].

536 Draft TAR at 10-9 to 10-19

537 Proposed Determination TSD at 3-8 to 3-21.

538 The agencies discuss Hymel et al. (2010) but do not include it in the list of studies they considered. *See* 83 Fed. Reg. at 43,103; PRIA at 983.

539 *Id.* at 992.

As Table 3 shows, the Proposed Rule identifies three studies that the agencies did not previously consider: Anjovic and Haas (2012), Weber and Farsi (2014); and Stapleton et al. (2016; 2017).[540] But the agencies do not even purport to rely on these new studies as particularly relevant when selecting their rebound estimate.[541] And in any event, the new studies do not provide strong new support for the agencies' 20% rebound estimate. All three of the papers studied rebound outside the United States, which, as we explain in detail below, should receive relatively less weight. Moreover, Weber and Farsi (2014) used cross-sectional data (an analysis of rebound in only one year), which, as we also explain below, should also receive relatively less weight. Therefore, the only new evidence that the agencies considered does not support the change in position.

While the studies the agencies discuss in the proposed rule have previously been considered, the Proposed Rule inexplicably fails to discuss a number of studies that were previously considered. As demonstrated by the bolded studies in Table 3, the agencies fail to discuss, mention, or even list a number of studies that they previously considering in arriving at their 10% rebound estimate, including Gillingham (2011), Wang and Chen (2014), and Gillingham (2016). These latter two studies provided substantial support for the agencies' 2012 and 2016 decisions to use a 10% rebound estimate.[542] The agencies also fail to analyze Greene (2012), even though it is listed in a table in the PRIA.[543] That paper also provided strong support for the agencies' previous 10% rebound findings.[544] Ignoring these studies now is arbitrary and capricious.

As Table 3 helps illustrate, contrary to the agencies' claim,[545] they have not conducted a complete survey of the economic literature on the rebound effect with respect to vehicles. Many of the missing studies are high-quality studies that should inform the agencies' decisionmaking. Besides the studies that the agencies previously considered, the agencies also omit many of the recent papers on this topic, including a 2015 study by Ken Gillingham, A Jenn, and I.M

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540 *See* 83 Fed. Reg. at 43,101.

541 *See* PRIA at 992-994 (discussing the key studies the agencies use to select a rebound estimate without discussing any of these studies).

542 Draft TAR at 10-19 to 10-20 (listing Gillingham (2016) in the "Basis for Rebound Effect Used in the Draft TAR" section); Proposed Determination TSD at 3-16, 3-19 (discussing Wang and Chen (2014) as the only new study since the Draft TAR, and relying on the fact that the study found *no* rebound effect for households other than low-income households as part of the "Basis for Rebound Effect Used in this Proposed Determination" discussion).

543 PRIA at 983 (listing Green (2012) in Table 8-8 without any further discussion).

544 Proposed Determination TSD at 3-12 to 3-13, 3-20 (stating that Greene (2012) "appears to support the theory that the magnitude of the rebound effect "is by now on the order of 10 percent" and discussing the study in the "Basis for Rebound Effect Used in this Proposed Determination" section); Draft TAR at 10-14, 10-20 (same).

545 PRIA at 982 ("Table 8-8 summarizes estimates of the rebound effect reported in research that has become available since the agencies' original survey, which extended through 2008").

Azevedo,[546] and a 2018 paper by T.P. Wenzel and K.S. Fujita.[547] These estimates generally contain rebound estimates that are lower than 20% and the agencies should not ignore them.

In addition, a large number—32—of the studies identified in a recent meta-analysis of the rebound literature are missing from the agencies' analysis, including 14 US-based estimates.[548] Of these omitted estimates, Wang and Chen (2014) and Dillon et al. (2015) are particularly useful rebound studies because they provided estimates of U.S. rebound, estimated fuel efficiency rebound (which, as is described below is distinct from other less useful estimates of rebound that appear in the literature), and used methods that account for endogeneity.[549] These additional studies do not support the agencies' decision to reject the 10% estimate and adopt the 20% instead and the agencies should not ignore them either.

2. The Proposed Rule's criticisms of the 10% rebound estimate are not compelling

In defending their reinterpretation of the evidence, the agencies primarily argue that the basis for the 10% rebound estimate was limited to a 2007 study by Small and Van Dender, whose assumptions have not borne out.[550] Specifically, the agencies argue that the 10% estimate was justified only if income increases are as assumed in that paper, and according to the agencies, follow-up analyses by Hymel et al. (2010) and Hymel and Small (2015), found a weaker relationship between rebound and income and produced higher rebound estimates as a result.[551] But this argument is wrong for several reasons.

First, the agencies are incorrect that the single Small and Van Dender (2007) study formed the only basis for their prior conclusion that rebound falls as incomes rise and that a 10% estimate was appropriate. In their 2012 Clean Car Standards, the agencies also cited to a wider range of academic literature, including Greene (2007), and Hymel et al. (2010), to support the specific claim that rebound will decline over time due to increases in income.[552] The agencies reaffirmed this claim in 2016 and cited several high quality and more recent academic studies, including Wadud et al. (2009), Green (2012), Gillingham (2014), and Hymel and Small (2015).[553] In the

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546 Gillingham et al. (2015).

547 Wenzel & Fujita (2018).

548 *Compare* Dimitropoulos et al. (2018), at 173 (identifying 45 studies, including 21 studies of the U.S.) *with* PRIA at 983 (identifying 16 studies, including 10 studies of the U.S. included in Dimitropoulos et al. (2018) and 3 studies of the U.S. that are not included in Dimitropoulos et al. (2018)).

549 Dillon et al. (2015); Wang & Chen (2014). Note, however, that both studies omit capital costs and are cross-sectional estimates; the latter study provides only short-run estimates. *See* Dimitropoulos et al. (2018), Appendix D.

550 83 Fed. Reg. at 43,104-105; PRIA at 989.

551 77 Fed. Reg. at 62,924 (discussing academic literature supporting a rebound rate that declines over time)

552 77 Fed. Reg. at 62,924 (citing Greene (2007), and Hymel et al. (2010)).

553 Proposed Determination TSD at 3-20 ("Wadud et al. (2009) and Gillingham (2014) find that household and individual-vehicle rebound increases, respectively, with increases in household income"); Draft TAR at 10-20

2016 analyses, the agencies also cited a 2016 peer-reviewed assessment of the rebound literature by Ken Gillingham and coauthors.[554] The Gillingham paper developed selection criteria for identifying the most reliable studies, and selected only two studies of US rebound effect as meeting the criteria.[555] Both of these studies arrived at rebound estimates below 10%.[556] All of these papers supported the previous conclusion that rebound falls with income. Ignoring all of this support for the 2012 and 2016 determinations is arbitrary and capricious.

Second, the agencies now point to a handful of studies that they had already considered, including Hymel et al. (2010), Hymel and Small (2015), and claim those studies undermine the agencies' previous conclusions about the relationship between income and rebound and the 10% estimate.[557] The agencies fail to acknowledge that they previously used these very studies to *support* the income effect, as described above. Moreover, while some of the rebound estimates presented in those studies are higher than those found in Small and Van Dender (2007), those higher estimates do not undermine the 10% estimate for several reasons.[558] For example, the 18% estimate in Hymel and Small (2015) that the agencies now rely on was produced using a deliberately simplified model, which the agencies previously concluded is more relevant for estimating rebound from changes in fuel prices than rebound from changes in fuel efficiency.[559] In any event, using more sophisticated modeling, the Hymel and Small (2015) paper found a 4.0%-4.2% rebound estimate, which the authors found to be more representative than the 18% rebound estimate cited by the agencies.[560] As such, that paper recognizes that the 18% estimate may not be accurate. In addition, Hymel and Small (2015) studied a time period that included the

("Greene [2012] reports evidence that the magnitude of the rebound effect is likely to be declining over time as household incomes rise which would be consistent with Gillingham's (2014) results showing that individual-vehicle rebound increases with household income").

[554] Draft TAR at 10-20; Proposed Determination TSD at 3-20.

[555] Gillingham (2016), at 75 (Table 1). Of the 8 studies cited, the only two estimates for the U.S. are below 10% (focusing on the data for the more recent time period from Hughes et al. (2008). The four state estimates average to 13%. *Id.*

[556] Gillingham (2016) at 75. Gillingham also lists estimates from U.S. states, which average to 13%. *Id.*

[557] *See* 83 Fed. Reg. at 43,105.

[558] Draft TAR at 10-17 ("these influences are small enough in magnitude that they do not fully offset the downward trend in VMT response elasticities due to higher incomes and other factors. Hence, even assuming that the variables retain their 2003–2009 values into the indefinite future, they would not prevent a further diminishing of the magnitude of the rebound effect if incomes continue to grow at anything like historic rates").

[559] Draft TAR at 10-17 (explaining that the Hymel and Small conclusions are "important to understand the rebound effect based upon fuel prices, they may not be as relevant to the rebound effect due to fuel efficiency").

[560] Hymel and Small (2015), at 98 ("The results for our preferred specification, labeled Model 3, are summarized in Table 3"); *id.* at 103 (Table 8, presenting US 2000-2009 average fuel efficiency elasticity under more sophisticated Models 3 and 5 of -0.042 and -0.040). The confusion over their preferred estimate likely arises because they refer to model 1 as their "base specification" and "base model" as it similar to the model estimated in Small and Van Dender (2007).

2008 recession, which the authors characterizes as a period of "turmoil in energy markets;" the authors noted that the financial crisis biased their estimates upwards.[561] The agencies have elsewhere criticized data based on this time period as non-representative.[562] And the papers still found a significant income effect and found that the rebound effect declines with income increases, which confirms rather than undermines the findings of Small and Van Dender (2007).[563] As Professor Kenneth Small, one of the authors of Small and Van Dender (2007), Hymel et al. (2010), and Hymel and Small (2015), has explained in a letter to the agencies,[564] the agencies mischaracterize the conclusions of these papers; due to expected future changes in income and other factors, Small states that the best estimate of the type of rebound at issue in the Proposed Rule is *substantially* lower than even the agencies' previous 10% estimate: 0.2% in 2025.[565]

The agencies also point to the recent study from DeBorger et al. (2016), as evidence that the income effect in Small and Van Dender was overstated.[566] But that study, according to its authors, lacked sufficient data to robustly test for the existence of the income effect, and called for additional testing of their results with respect to the income effect.[567] Even then, like Small and Van Dender (2007), the study found a negative income effect (though it is statistically insignificant). [568] Moreover, the study was based in Holland which differs considerably from the

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[561] PRIA at 993-994 (citing Hymel and Small (2015), at 94 (discussing weakness of studies of driving during the "most significant recession since the 1930s, accompanied by turmoil in housing markets including foreclosures requiring many people to move"); Hymel and Small (2015), at 93 ("We also estimated Model 2 omitting years 2008 and 2009, in order to evaluate the effect of the financial crisis on the rebound effect. This change decreases the rebound effect through changes in pm, pm2, and pm ∗ inc. The short run rebound effect falls by about 1 percentage point and the long run rebound effect falls by about 8 percentage points, relative to the version of Model 2 that includes years 2008 and 2009. One would expect that drivers would be more sensitive to driving costs following the financial crisis, and our estimation bears that out… The estimates from a version of Model 1 without years 2008 and 2009 also yielded smaller rebound effect estimates compared to the 1966–2009 version.").

[562] 83 Fed. Reg. at 43,089; PRIA at 966.

[563] Hymel and Small (2015), at 102-103 ("Furthermore, we confirm earlier findings that the rebound effect became substantially smaller in magnitude over the course of that time period, probably due to a combination of higher real incomes, lower real fuel costs, and higher urbanization").

[564] Letter from Dr. Kenneth Small, Docket No. EPA-HQ-OAR-2018-0283 and Docket No. NHTSA-2018-0067 (Sept. 14, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-2698; *see also* Hymel et al. (2010) (estimating rebound of 13% in 2004); Hymel and Small (2015) (estimating rebound of 18% during 200-2009 period).

[565] Letter from Dr. Kenneth Small at 2, Docket No. EPA-HQ-OAR-2018-0283 and Docket No. NHTSA-2018-0067 (Sept. 14, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-2698.

[566] PRIA at 983.

[567] DeBorger et al. (2016), at 13 (emphasizing that their result "has to be corroborated by other studies").

[568] The study found a statistically insignificant relationship between income and rebound, the direction of that impact was still negative. *Id* ("Although we use panel data, the number of MOT-tests observed in a 10-year period is too small to carry out a panel data analysis of the impact of changes in income on the coefficients for fuel price and

U.S., and should be given considerably less weight on this issue than Small and Van Dender (2007), Hymel et al. (2010), and Hymel and Small (2015). As such, that study does not support the agencies' proposed conclusions.[569]

Third, the agencies' argument that the slowdown in income from the levels expected in 2012 undermines the prior 10% estimate is incorrect. The relevant time-period for estimating income growth and rebound is the period during which consumers will be using vehicles subject to the baseline standards: 2020 to 2050, not the earlier time periods discussed in Small and Van Dender (2007) and Hymel and Small (2015). At this time, the agencies expect GPD per capita to be substantially higher during the 2020 to 2050 period than the 2000s.[570] Pointing to the fact that income grew at a slower rate than expected in the 2007 paper does not undermine the agencies' conclusions in issuing the Clean Car Standards that over the 2020-2050 period, income will be sufficiently high to support a 10% rebound estimate.[571]

Fourth, the agencies provide an unsupported assertion that rebound may *increase* as income increases because increases in income will allow consumers to own multiple cars, which will then be driven more. The agencies argue that higher income families have multiple vehicles and cite to "some studies," which they do not identify, that find that households with multiple vehicles have higher rebound.[572] In fact, a systematic analysis of studies suggests that the rebound effect is *smaller* for households with multiple vehicles.[573] The Proposed Rule's analysis on this point conveniently ignores the Wang and Chen (2014) study, which found that the rebound effect is only significant for households making $25,000 or less—an important insight that should be taken into account in rebound assessments.[574]

As these papers all show, the relationship between rising incomes and lower rebound is strongly supported. The literature indicates that the rebound effect should decline with rising income for

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fuel efficiency in our demand equation. However, what we can do is carry out a cross-sectional analysis and analyze whether the sensitivity of kilometre demand for changes in the fuel price and in fuel efficiency depend on a household's place in the income distribution…The point estimates also seem to suggest that the sensitivity of demand to changes in fuel efficiency declines with income. However, the interaction term of the fuel efficiency variable with income is not significant at the usual significance levels, and we are unable to reject the hypothesis that the size of the rebound effect is independent of a household's position in the income distribution").

569 PRIA at 989 n. 528.

570 *Id.* at 993.

571 *Id.* at 982 ("income growth that had been anticipated to erode the value of the rebound effect had not materialized").

572 *Id.* at 989.

573 Dimitropoulos (2018), at 170-171.

574 Proposed Determination TSD at 3-16 (Wang and Chen (2014) "find that the rebound effect is only significant for the lowest income households (up to $25,000)").

two reasons.[575] First, as incomes rise, the rebound income effect diminishes because household demand for vehicle travel is closer to saturation levels. In particular, high-income families will feel less of a budget constraint (i.e., they are consuming all goods, including driving, nearer to or at their optimal level).[576] Second, as incomes rise, the opportunity cost of spending time in a vehicle increases. As time costs increase relative to energy costs, the relative importance of energy costs should decline, and drivers should limit the extent to which fuel efficiency will increase driving.[577] This effect is magnified by the fact that as income and driving increase over time, congestion will also increase. This will require drivers to spend more time in their vehicles and limit the extent to which drivers respond to lower prices with more driving.[578]

A few additional details support a lower rebound estimate as income increases. For example, there is evidence in the literature regarding rebound and energy efficiency outside of the passenger vehicle sector, which shows that rebound declines with income.[579] This includes studies of rebound related to residential energy use from greater adoption of efficient appliances such as refrigerators, air conditioners, and solar lanterns. Studies that compare rebound across countries also provide empirical support for the agencies' prior conclusions that the rebound effect declines as income rises.[580] In addition, because congestion can have a moderating effect on rebound, the agencies should model the impact that expected increases in congestion will have on rebound during 2020-2050.[581] Finally, high-quality academic literature that the agencies have failed to consider provides independent support for the prior 10% rebound estimate. In particular, in a 2009 literature review of the direct rebound effect in multiple sectors, Steve Sorrell and coauthors conclude that long-run rebound is between 10% to 30%, with the best estimate closer to 10%.[582]

For all of these reasons, EPA was correct to note during the interagency review process that NHTSA's own analysis and the literature indicate that the rebound effect is expected to decline

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[575] Sorrell et al. (2009), at 1357, 1360 n. 8; Dimitropoulos et al. (2018), at 171.

[576] *Id.* at 1357.

[577] *Id.* at 1366 n. 8.

[578] *See* Hymel et al. (2010) at 1221.

[579] Azevedo (2014), at 411-12 (identifying studies that show that the rebound effect of home energy use varies by income).

[580] *See* Dimitropoulos et al. (2018), at 172.

[581] The agencies should also take into account the relationship between income, congestion, and VMT when developing VMT schedules. *See* Section V.A.2.

[582] Sorrell et al. (2009) at 1360; *id.* at 1361 ("Moreover, most studies assume that the response to a change in fuel prices is equal in size to the response to a change in fuel efficiency, but opposite in sign . . . Few studies test this assumption explicitly and those that do are either unable to reject the hypothesis that the two elasticities are equal in magnitude, or find that the fuel-efficiency is less than the fuel cost per kilometer elasticity . . . The implication is that the direct rebound effect may lie towards the lower end of the above range (i.e., around 10%).")

over time as income rises.[583] As this section demonstrates, the literature does not support the agencies' proposal to abandon the 10% rebound estimate that they previously adopted.

C. The agencies' approach led them to estimate an inflated rebound effect

The agencies have adopted a methodology that uses the average of the estimates of rebound that they have collected.[584] However, using averages is a disfavored approach for a number of reasons. The averaging approach does not address the disparity in precision and quality of the estimates that are part of the average. It does not account for the pertinence of specific estimates to the particular policy context. And it does not address the fact that multiple studies have overlapping samples, overlapping authors, or overlapping methods. Using an averaging method here was inappropriate because the estimates of rebound presented in the academic literature are not equally valid estimates of rebound and are not equally relevant to the question the agencies investigate here. As such, as described further below, a simple average does not lead to a reliable estimate.

The agencies should more proactively evaluate rebound estimates based on selection criteria. In the alternative, the agencies should conduct a sophisticated meta-analysis of the existing rebound literature to arrive at the best estimate, consistent with EPA's guidelines for reaching conclusions using multiple studies. In either case, a rebound estimate of 20% would not be supported.

1. The simple average that the agencies use to calculate the rebound effect in the Proposed Rule is unreliable and produces improperly inflated estimates

Instead of considering all available studies equally, the agencies should consider only those estimates of rebound that are predictive of the kind of rebound at issue here or should give non-preferred studies only partial weight. Many of the studies that the agencies include in their average do not meet the below requirements for full weight or inclusion. That error renders the agencies' conclusions arbitrary and capricious.

In summary, the best estimates include:

- Measures of the driving changes due to changes in fuel efficiency, rather than measures of how driving changes as fuel price changes or that measure how fuel consumption changes as fuel price changes.
- U.S.-based national studies rather than studies of rebound in other countries or within single U.S. states.
- Measures that best reflect the time period of the analysis (i.e., 2020-2050), including studies that use more recent data (i.e., measures conducted after the 2008 recession).

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[583] EPA, *Comments on NPRM and Preliminary RIA sent to OMB,* at 1659 (July 26, 2018) (explaining that literature and NHTSA's previous findings reported "persuasive evidence that the magnitude of the rebound effect is likely to be declining over time").

[584] 83 Fed. Reg. at 43,100 (finding that the average values of pre-2008 studies to be 22-23%); *id.* at 43,105 (discussing 10%-40% average rebound of post-2008 studies); PRIA at 993.

- Studies with high quality identification strategies, including those that account for the endogeneity of fuel efficiency.
- Measures that include data from multiple years (i.e., panel methods) or that apply an experimental/quasi-experimental approach and that are internally valid.
- Short-run and medium run estimates of rebound because long-run estimates suffer from identification problems.[585]

The most important categories of rebound estimates are discussed in turn. The agencies should follow these guidelines.

a.) ***The agencies should consider estimates of fuel efficiency rebound rather than other proxy estimates of rebound***

There are four types of econometric estimates of the rebound effect in the academic literature, some of which are better than others for estimating the rebound rate of fuel efficiency or emissions standards.[586]

The agencies should give the most weight to estimates of the elasticity of distance traveled with respect to fuel efficiency, as this is the directly relevant estimate. For this reason, in a recent meta-analysis of rebound estimates in the literature, Dimitropoulos and coauthors explained that "the elasticity of travel demand with respect to fuel efficiency should be preferred to other measures whenever this is possible."[587]

- **Fuel efficiency rebound**. The most relevant rebound estimate for the purposes of the Proposed Rule is the extent to which driving changes due to changes in fuel efficiency—called the "elasticity of distance travelled with respect to fuel efficiency" or "fuel efficiency rebound." The agencies have previously acknowledged that estimates of fuel efficiency rebound are the most directly relevant measures for the purpose of estimating the effect of the baseline standards.[588]
- **CPM rebound**. When fuel efficiency rebound cannot be measured, the next closest proxy estimate would be to measure the extent to which driving changes as the cost per mile (CPM) of driving decreases—called the "elasticity of distance traveled with respect to the cost of driving" or "CPM rebound." The cost of driving includes fuel costs per mile (fuel price divided by fuel efficiency), but could also include other costs such as depreciation. However, its estimation raises several concerns, in particular because measures of CPM rebound diverge from measures of fuel efficiency rebound for a number of behavioral economic

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[585] Gillingham et al. (2016), at 74-75.

[586] Sorrel et al., (2009), at 1358-1360; Dimitropoulos et al., (2018) at 164.

[587] Dimitropoulos et al. (2018), at 196.

[588] NHTSA 2012 FRIA at 847 ("ideally, the rebound effects measured directly by estimating the change in vehicle use, during some time period that results from a change in vehicle fuel efficient").

reasons. Changes in CPM, and particularly changes in gasoline prices, are highly salient and so have more influence on consumer behavior than fuel efficiency changes.[589] In addition, many of the recent studies that measure the change in cost of driving have been measures of consumer response to fuel price *increases*, but consumers tend to be more responsive to price increases than decreases[590] and because fuel efficiency acts like a price *decrease*, studies that measure rebound based on price increases may overestimate fuel efficiency rebound. The Dimitropoulos meta-analysis found that the elasticity of driving with respect to fuel efficiency is significantly lower than the elasticity of driving with respect to fuel costs and fuel price.[591] In addition, changes in fuel price can change the cost of driving for both new and used vehicles. Studies of CPM rebound often use data on the change in driving behavior of both new and used vehicles. Yet, the change in driving by newer vehicles is less responsive than the change in driving by older vehicles for a given fuel efficiency increase.[592] Therefore, by including used vehicles, studies of CPM rebound will be an overestimate of fuel efficiency rebound. Finally, in a large portion of the studies of CPM rebound, the methods used to measure rebound have been flawed and have biased estimates upward.[593] When costs of driving increase (such as due to a gasoline price hike), consumers are more likely to buy a more fuel efficient vehicle. However, the type of consumer that is likely to buy a fuel efficient vehicle when prices increase is also likely to be the type to benefit most from a fuel efficient vehicle (i.e., they have a long commute).[594] A large portion of studies of CPM rebound do not account for this relationship (such as by controlling for the endogeneity of fuel-efficiency), and so effectively assume that these interactions do not occur. This causes an overestimate of CPM rebound and therefore, when used as a proxy for fuel efficiency rebound, causes the rebound rate to be inflated.

- **Fuel price rebound.** A subset of the cost of driving, fuel price, introduces a third estimate of rebound: the extent to which driving changes due to changes in fuel price— the "elasticity of distance travelled with respect to fuel price" or "fuel price rebound."[595] Fuel price is a component of the cost of driving and so fuel price rebound is a poor proxy for fuel efficiency rebound for the same reasons that CPM rebound is a poor proxy. But fuel price rebound is

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589 Gillingham et al. (2016), at 74; Azevedo (2014), at 409. Some economists argue that the elasticity of distance traveled with respect to fuel efficiency should be higher than elasticity of distance traveled with respect to cost of driving due to its permanence relative to the fleeting nature of price changes. Tierney & Hibbard (2018), at 14. However, empirical evidence does not support this finding, as discussed later.

590 Tierney & Hibbard (2018), at 15.

591 Dimitropoulos et al. (2018), at 169-170.

592 Gillingham et al. (2015), at S49.

593 Small and Van Dender (2007), at 27.

594 *Id.*

595 Dimitropoulos et al. (2018), at 164.

also an overestimate for an additional reason: fuel price rebound considers only reductions in the fuel-related costs of driving, whereas fuel efficiency involves reduction in the cost of driving but also includes the increased cost of purchasing a more fuel efficient vehicle.[596] Studies of fuel price rebound do not take into account the capital cost income effect, which has a moderating effect on rebound. So, when used as a proxy for fuel efficiency rebound, fuel price driving will cause estimates to be inflated.[597]

- **Fuel consumption rebound.** The least useful measure of the rebound effect caused by fuel efficiency changes comes from estimates of the extent to which fuel *consumption* changes as fuel price changes—the "elasticity of fuel consumption with respect to fuel price" or "fuel consumption rebound." This type of estimate does not directly measure changes in driving. And academic studies have shown that changes in fuel consumption will always produce higher rebound estimates than changes in fuel efficiency will in a real world setting (i.e., when fuel efficiency is endogenous), and so this rebound estimate serves as an upper bound when used as a proxy for the rebound effect.[598] This has led some academics to ignore this latter group of estimates when trying to estimate the relationship between fuel efficiency and driving.[599]

Given that fuel efficiency rebound is the effect that the agencies are trying to measure, and given the lack of evidence that the other measures are equivalent, the agencies should focus primarily, if not exclusively, on studies that measure fuel efficiency rebound.

b.) *The agencies should take care in selecting studies to avoid features that would improperly inflate the estimates*

In addition, there are several features that could make fuel-efficiency rebound studies unreliable. The agencies need to consider these issues as well in selecting which studies to include:

Estimates of rebound that incorporate capital costs. The agencies should prefer elasticity estimates that account for the capital cost of the new vehicles. Because high capital costs reduce rebound by reducing consumers' income available to purchase other goods, such as driving (the "capital cost income effect"), analyses that omit capital costs will yield inflated estimates of

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596 Gillingham et al. (2016), at 69. Cost of driving rebound may also suffer from this problem to the extent that the cost of driving parameter fails to include an estimate of vehicle capital costs.

597 Dimitropoulos et al. (2018), Appendix D; Gillingham et al. (2016), at 68-69. Note however that a handful of studies of the elasticity of driving with respect to fuel price control for the capital cost and so would not suffer from this error. However, this still constitutes a minority of studies. Of the 1,142 rebound estimates in the Dimitropoulos et al. (2018) dataset, 236 estimates account for capital costs.

598 Sorrel et al., (2009), at 1359 n. 6; Sorrel and Dimitropoulos (2008), at 16-18.

599 Dimitropoulos et al. (2018), at 165.

rebound.[600] Only 14% of the studies on which the agencies relied account for capital costs,[601] we should expect this to bias a simple average upwards.

Estimates of rebound in the United States. U.S.-based estimates are far more relevant than foreign estimates for measuring the effects of a policy that would change the cost of driving for U.S. drivers. It is not merely that U.S. drivers and foreign drivers are culturally different. Rather, the U.S. differs substantially from other regions in terms of the price of gasoline, the density of the population, and income levels; each of which has been shown in various studies to affect the rebound effect.[602] The U.S. has characteristics that are generally associated with lower rebound in the academic literature: higher incomes, lower population densities, and lower fuel prices.[603] Many countries that are the subject of rebound studies—generally European countries—have higher income, population density, and fuel prices. Therefore, taking an average of both U.S. and foreign estimates will inflate the estimate of rebound that will occur in the U.S. In addition, studies at the national-scale are more relevant than studies of various states and subregions, as the latter only capture subsets of the relevant population. Because state studies are more likely to use reliable data sources such as odometer readings, state level studies should not be ignored. However, in developing a methodology to weight studies, the agencies should take into account the divergent characteristics of the state studied. Only 56% of estimates in the agencies' analysis are for the United States,[604] so we should expect the use of these estimates to bias a simple average upwards.

Estimates of rebound that will occur in 2020-2050. As discussed above, rebound is relevant in the context of the Proposed Rule only to the extent that improved fuel efficiency increases driving during the 2020-2050 period. The agencies should therefore use studies that can project the rebound effect of the 2020-2050 timeframe rather than assume that estimates of historic rebound can be directly applied to the baseline standards. More recent studies that look at more recent data will be more applicable than older studies. In other words, more recent studies are better predictors of future rebound because "behavioral responses are contingent upon technical, institutional, policy and demographic factors that vary widely between groups and over time."[605]

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[600] Dimitropoulos et al. (2018) at 171.

[601] *See id.*, Appendix D (listing studies). Dimitropoulos excluded three estimates that contain this feature: Waddud (2009), West and Pickrell (2011), and West et al. (2015).

[602] Dimitropoulos et al. (2018) at 172; EPA (2018), at 31; Gillingham et al. (2016), at 75.

[603] Dimitropoulos et al. (2018), at 171.

[604] *See id.*, Appendix D (listing studies). Specifically, the following recent studies use data from outside of the United States: De Borger (2016) (Denmark); Barla (2009) (Canada); Frondel and Vance (2012); Anajovic and Haas (2012); Weber and Farsi (2014); and Stapleton (2016, 2017). This other estimates using date from outside of the United States were not included in Dimitropoulos et al. (2018): Waddud (2009), West and Pickrell (2011), and West et al. (2015).

[605] Sorrel et al. (2009), at 1359.

In the Clean Car Standards, the agencies noted that "[w]hile some older studies provide valuable information on the potential magnitude of the rebound effect, those that include more recent information may provide more reliable estimates of how this rule will affect future driving behavior."[606] Now the agencies rely on many older studies, including a number of studies prior to 2008 when income was depressed, in calculating average rebound effects.[607] This reliance on older studies using data on older vehicles biases the estimate upwards.[608]

Studies using strong statistical methods and data. The agencies should only rely on, or should more heavily weight, studies with a strong statistical and methodological basis and reliable data.[609] Most importantly, reliable studies account for the fact that fuel efficiency is correlated with other attributes (that is, fuel efficiency is endogenous).[610] There is evidence that more fuel-efficient vehicles have a lower rebound effect.[611] Energy efficiency may be correlated with other vehicle attributes,[612] household attributes, and time; some of which are unobservable.[613] As such, the agencies should place greater weight on studies that address this endogeneity, usually using instrumental variables or simultaneous equations.[614] Failure to account for endogeneity means that the study is unable to disentangle to what extent VMT is rising because of fuel efficiency and to what extent it has risen due to changes in other factors (including reverse causality). In other words, studies that do not address issues with endogeneity may overstate the extent to

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606 NHTSA 2012 RIA at 848.

607 PRIA at 981 (Table 8-7).

608 Dimitropoulos et al. (2018), at 171.

609 Gillingham et al. (2016), at 74.

610 *Id.*; Small and Van Dender (2007), at 30; Sorrell et al. (2009), at 1363.

611 Gillingham et al. (2015), at 549.

612 Sorrell et al. (2009), at 1357; Gillingham et al. (2016), at 69.

613 Sorrell et al. (2009), at 1358.

614 The net effect of these trends is unclear. Dimitropoulos et al., (2018), at 171. GDP increases over time and will decrease the rebound effect. Congestion and density tend to increase over time and increasing congestion will decrease rebound, Hymel et al. (2010), while increased density has been shown to increase the rebound effect. As such, the agencies should also include a density adjustment to their VMT schedules to control for density. Similarly, the future direction of gasoline prices is relatively uncertain. The U.S. Energy Information Agency generally assumes a long-run upward trend in gasoline prices, which implies a higher rebound effect. But as with density, this suggests a need to adjust VMT schedules.

which fuel efficiency is the cause of extra VMT.[615] Only 28% of estimates in the agencies' analysis account for endogeneity,[616] and we should expect this to bias a simple average upwards.

Additionally, some estimation strategies are preferred to others. For example, cross-sectional studies should be given less weight (or dropped altogether) as they: disagree over appropriate specification;[617] suffer from omitted variable bias making them unreliable;[618] and are only as representative as the year the data was taken.[619] Time-series data may not be as reliable due to the fact that a limited number of data points are available.[620] Academic economists also disagree about how to properly construct models using this data.[621] These econometric issues led one careful survey of the literature to conclude that "estimates from many econometric studies appear vulnerable to bias, likely leading to an inflated estimate. The most likely effect of the latter is to lead the direct rebound effect to be overestimated."[622] Panel methods and experimental designs should be treated as preferred methodologies.[623]

Studies that use odometer data at the vehicle or household level are the most reliable. This is particularly the case because some micro-economic data are known to be problematic. For example, many cross-sectional microeconomic studies use data from the 2009 NHTSA household survey. Those estimates "should be interpreted with caution" since they present rebound estimates that range from 0% to 87% using identical datasets.[624] The 2009 NHTSA dataset is also problematic because it includes data from 2009, a highly non-representative year,

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[615] Small and Van Dender (2007), at 40; Dimitropoulos et al. (2018), at 172 & n. 23. Note that there is some evidence pointing to downward bias as well. *See* Small and Van Dender (2007), at 30. A meta-analysis by Dimitropoulos finds some downward bias. Dimitropoulos et al., (2018), at 172 & n. 23. However multi-collinearity raises questions about how to accurately interpret this result. The direction of the bias is not completely unclear.

[616] *See* Dimitropoulos et al. (2018), Appendix D (listing studies with this feature). Specifically, the following studies have this feature: West and Pickrell (2011), Su (2012), Linn (2013), Liu et. al (2014), Gillingham (2014), and West et. al. (2015). Dimitroupoulos excluded three estimates with this feature: Waddud (2009), West and Pickrell (2011), and West et al. (2015).

[617] Sorrell et al. (2009), at 1360.

[618] Gillingham et al. (2016), at 73-74.

[619] 83 Fed. Reg. at 43,089; PRIA at 966.

[620] Sorrel et al. (2009), at 1360.

[621] *Id.* (identifying disagreement regarding appropriate specification with respect serial correlation and lagged dependent variables).

[622] *Id.* at 1364. *But see* Dimitropoulos et al. (2018), at 169 (finding some evidence of negative bias).

[623] Gillingham et al., (2016), at 74 (recommending quasi-experimental approaches); *but see* Sorrel et al. (2009), at 1364 ("The methodological quality of many quasi-experimental studies is poor, while the estimates from many econometric studies appear vulnerable to bias. The most likely effect of the latter is to lead the direct rebound effect to be overestimated"). Advances in experimental design may explain some of the difference between Gillingham et al.'s 2016 conclusions and Sorrel et al.'s earlier conclusions.

[624] Sorrel et al. (2009), at 1360.

relies on self-reported odometer readings and has a poor sample size.[625] Alternatively, studies that rely on more aggregated data on travel demand can have significant measurement errors.[626] As shown in Table 4, 44% of the studies in the agencies' analysis are cross-sectional, of which 86% are based on the problematic NHTSA household surveys.

Medium-run elasticity estimates are more reliable. Academic studies of rebound often include different estimates for different timeframes, including rebound over the short-run, over the medium-run, and over the long-run. Generally, these estimates find that the rebound effect increases over time (i.e., driving is less elastic in the short-run than in the long-run) because households have more opportunities to take action that results in more driving over time (e.g., taking a new job further from home).[627] Currently, NHTSA relies exclusively on long-run estimates.

The agencies need to take a dynamic approach to rebound instead of disregarding short and medium-run estimates as in the current approach. Not only is the current approach incorrect but it is also inconsistent with the agencies' approach elsewhere. For instance, the agencies' scrappage model employs lagged variables that capture the shifts in behavior from short- to long-run.[628] At the very least, the agencies should incorporate the movement from short-run rebound effects to long-run rebound effects on VMT rather than apply a single rebound estimate to all vehicles in all years.

In addition, long-run rebound estimates do not have a strong statistical and methodological basis.[629] In an analysis of the rebound effect and related academic literature, which the agencies have inexplicably failed to consider, Ken Gillingham and coauthors note that

> Long-run elasticities are harder to estimate credibly and thus harder to come by. All [reliable studies also] provide either short-run or medium-run estimates. . . . . [W]e believe that short-run and medium-run estimates are more reliable.[630]

The agencies should consider reducing their reliance on long-run estimates by substituting them with the medium-run estimates available in the literature, by including both long-run and medium-run estimates, or by carefully selecting only those long-run estimates that were developed using methodologies that address the concerns identified above.

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[625] 83 Fed. Reg. at 43,089; PRIA at 966.

[626] Dimitropoulos et al. (2018), at 165 & n. 6.

[627] Gillingham et al. (2016), at 74.

[628] PRIA at 1044 (showing lagged variables in the scrappage model).

[629] Gillingham et al. (2016), at 74.

[630] Gillingham et al. (2016), at 74.

The agencies have ignored many relevant and recent studies of rebound in the academic literature and relied on several studies that contain problematic and non-representative data and findings, as summarized in Table 4. And the studies that they include in their calculations of average rebound estimates largely fail to meet the criteria of reliable and predictive estimates for the type of rebound at issue in the Proposed Rule. Moreover, these lower quality estimates tend to be biased in one direction: upwards.[631] As a result, the agencies' conclusions regarding the appropriate rebound estimate of 20% are, inappropriately biased upwards.

[631] Upward biases result from including studies that: estimate elasticities of VMT demand and fuel consumption with respect to driving cost and fuel price, forget capital costs, use data from non-US countries, and estimate the long-run effect. Other quality issues have an unclear effect. No approach that the agencies use clearly biases estimates downwards.

Table 4. Disfavored Features in the Post-2008 Rebound Studies Considered by Agencies[632]

Authors (Date)	Non-preferred rebound estimate [a]	Omitted Capital Costs[b]	Non-US Data	Non-representative period[c]	Ignores endogeneity[d]	Not panel data	2009 NHTSA Survey
Barla et al. (2009)	✓		✓		*		
Bento (2009)	✓				✓	✓	
Wadud (2009)	✓	✓		✓	✓	✓	
West and Pickrell (2011)	*	✓			✓	✓	✓
Anjovic and Haas (2012)	✓	✓	✓	✓	✓	✓	
Su (2012)	✓	✓			✓	✓	✓
Greene (2012)	*	✓		✓	✓	✓	
Linn (2013)	*	✓			*	✓	✓
Frondel and Vance (2013)	*	✓	✓		*		
Liu (2014)	*	✓				✓	✓
Gillingham (2014)	X	✓	State-level		*		
Weber and Farsi (2014)		✓	✓		*	✓	
Hymel & Small (2015)	✓						
West et al. (2015)		✓				✓	✓
DeBorger (2016)	*	✓	✓		*		
Stapleton et al. (2016, 2017)	*	✓	✓	✓	✓	✓	

**At least one estimate in the study avoids the problem. If a range is presented, some estimates that make up the range may suffer from the problem.*

[a] Wadud (2009) is the sole fuel consumption rebound estimate. (cont. on next page)

[b] West et al. (2015) accounts for the price of the vehicle. But the authors also look at groups that do and do not receive a vehicle subsidy. This is problematic because the subsidy group buys a cheaper vehicle and receives a subsidy. Therefore, the results of this study should be interpreted as supporting a negative rebound effect if capital costs are accounted for.

[c] We define a study as using data from a non-representative time period if it includes data from before the 1990s. Note that even if studies use data from a non-representative period, this issue can be explicitly addressed through updating explanatory variables (e.g., GDP per capita) ex-post in some cases.

[d] While West and Pickrell (2011) attempt to address simultaneity, the study did so inadequately according to the authors

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[632] The information in this table is derived from Dimitropoulos et al. (2018), Appendix D, with the exception of Wadud (2009), West and Pickrell (2011), and West, et al (2015).

2. The Agencies should follow EPA guidelines regarding how to draw valid conclusions from an academic literature that involves multiple estimates

EPA has developed guidelines on meta-analysis that provide best practices for how the agency should rigorously evaluate circumstances such as this where the academic literature is varied and contains a number of potentially relevant estimates.[633] EPA's guidelines are consistent with the best practices established in the academic literature.[634] By using a simple average of many studies of varying quality, the agencies have failed to follow EPA's own guidelines and so their conclusions regarding the appropriate rebound rate are not reliable.

In its guidelines, EPA identifies a number of types of meta-analysis methods.[635] EPA explicitly describes four types of meta-analysis in a 2016 update on its guidelines:

(1) **Closely Matched Studies:** "Develop independent estimates for relevant cases, using only studies that are closely matched on . . . individual characteristics."[636]
(2) **Weighted Average:** "Develop a baseline distribution of estimates . . . and a set of adjustment factors for . . . individual characteristics as warranted."[637]
(3) **Meta-regression:** "Develop a meta-regression model to estimate [rebound] as a function of . . . individual characteristics."[638]
(4) **Structural Model:** "Develop and estimate a structural preference function."[639]

By generally averaging studies without any specific weighting, the agencies have adopted none of these meta-analysis techniques.

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[633] EPA, *Report of the EPA Working Group on VSL Meta-Analyses*, Report EE-0494. (2006), http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0494-01.pdf/$file/EE-0494-01.pdf [hereafter "EPA Meta-Analysis Guidelines"]; *see also* EPA, *Valuing Mortality Risk Reductions for Environmental Policy: A White Paper* at 46-53 (2010), https://www.epa.gov/sites/production/files/2017-08/documents/ee-0563-1.pdf [hereafter "Meta-Analysis Guidelines 2010 Update"]; EPA, Valuing Mortality Risk Reductions for Policy: a Meta-Analytic Approach (2016), https://yosemite.epa.gov/sab/sabproduct.nsf/36a1ca3f683ae57a85256ce9006a32d0/0CA9E925C9A702F285257F380050C842/$File/VSL+white+paper_final_020516.pdf. [hereafter "Meta-Analysis Guidelines 2016 Update"].

[634] Several guidelines are available for meta-regression in the academic literature: Nelson, & Kennedy (2009); Rhodes (2012).

[635] EPA Meta-Analysis Guidelines at 19-24.

[636] *Id.* at 8.

[637] *Id.*

[638] *Id.*

[639] *Id.*

EPA's initial guidelines and subsequent application of those guidelines include direction for how the agencies should consider multiple studies to arrive at an individual value for use in a regulatory setting.[640] The agencies have failed to meet a number of these directives including:

- The need to establish *a priori* decision rules for which studies and individual values will be included or excluded or more heavily weighted;[641]
- The need to use a valid method for synthesizing the results of multiple studies in order to address econometric complications, including duplicate estimates, dependent errors (overlapping data and study authors), and heteroskedasticity (variance in precision of study);[642]
- The need to identify the population to be studied up-front (e.g., rebound *caused by fuel efficiency* among *U.S. households*);[643]
- The need to characterize and measure the uncertainty of combined estimates, such as through standard errors or confidence intervals;[644]
- The preference for analyses that incorporate several study characteristics together (e.g., meta-regression) over separate analyses of individual predictors of outcomes for different subsets of studies.[645]

The agencies' approach in the Proposed Rule—averaging estimates from a seemingly arbitrary subset of estimates in the literature—does not meet these criteria. The agencies have not identified any particular criteria for including or rejecting studies. Nor have they identified how exactly they synthesized the results from multiple studies. They have used studies that cover a wide range of populations (e.g., U.S. based studies and non-U.S. based studies, studies that measure elasticity of driving with respect to cost of driving and studies that measure elasticity of driving with respect to fuel efficiency, etc). Beyond reporting incredibly large ranges within the literature, the agencies do not discuss uncertainty in their preferred 20% rebound estimate. And by averaging all studies, the agencies incorporate different study characteristics but do so in a way that treats all characteristics equally.

The agencies should move away from the proposed approach and use one of the meta-analysis methodologies discussed in EPA's meta-analysis guidelines instead. Each option is discussed in turn.

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[640] The purpose of the meta-analysis guidance was for the construction of the Value of a Statistical Life (VSL). *Id.* However, the procedures and principles are broadly applicable.

[641] *Id.* at 9.

[642] *Id.* at 10.

[643] *Id.* at 19-20.

[644] *Id.* at 20.

[645] *Id.* at 22.

Meta-Regression. Meta-regression is a particularly valuable form of meta-analysis,[646] which uses econometric techniques to combine different studies and arrive at joint conclusions. Meta-regression allows analysts to adjust for factual and methodological causes of variation between different studies.[647] Specifically, it can control for many of the features of rebound studies that make them less relevant to the particular policy context of the Proposed Rule. Done correctly, meta-regression can address a variety of confounding issues including duplicate estimates, omitted variables, measurement error, dependent errors, and heteroskedasticity. EPA's guidelines provide detailed recommendations for the construction of a proper meta-regression.[648]

Only one academic study, by Alexandros Dimitropoulos and coauthors, has conducted a meta-regression of the rebound effect.[649] The study produces a variety of rebound estimates, including two estimates using two different preferred regression methods—fixed-effects regression and weighted-least squares regression.[650] While approximately one third of the data is not from the U.S., the study's meta-regression methodology at least partially addresses the issue of divergent geographic studies. This allows the authors to derive a long-run rebound effect of approximately 15% for a country approximately like the U.S.[651]

The study's methodology is sound. But the agencies should not rely on the study's rebound estimates for three reasons. First, the standard errors of the top-line regressions are so large that they limit the ability to make statistically significant claims about the magnitude of rebound for the purpose of setting policy.[652] Second, the two different preferred regression methods in the paper produce substantially different results about the overall magnitude of the rebound effect. Third, the results of the weighted-least squares regression demonstrate that very imprecise studies (i.e., studies with a very wide range of estimates) are driving up the rebound effect in the fixed effects regression.[653] These features of the study suggest that the specific estimates of the study are not reliable indicators of rebound.

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[646] Howard and Sterner (2017), at 205.

[647] *Id.* at 205-06.

[648] EPA Meta-Analysis Guidelines at 10-25 with specific focus on meta-regression at 23-25; Meta-Analysis Guidelines 2010 Update at 46-53; Meta-Analysis Guidelines 2016 Update at 20-25.

[649] Dimitropoulos et al. (2018), at 163, 166; *id.* at 170 (Table IV).

[650] The paper also reports results in its abstract. Dimitropoulos et al. (2018), at 163. However, these estimates are not the results of their sophisticated meta-regression.

[651] *Id.* at 172 (Table V).

[652] *Id.*

[653] Dimitropoulos et al. (2018) makes their data and code available in Appendix D. Applying the average sample size as weights within groups in the fixed effects regression also produces a negative estimate of -0.55 instead of -0.4 or 0.15. Additionally, variables for sample size and standard errors are statistically significant if included individually or jointly in the fixed effects regression, which indicates an upward bias. Furthermore, the increased capital cost of new vehicles is not accounted for and should further push down these rebound effect estimates.

While the study is not useful for making specific claims about rebound, it is nonetheless useful as evidence of the directional impact of particular estimate attributes. This meta-regression finds that rebound is lower for elasticities of fuel-efficiency than elasticities of fuel price and CPM; rebound is lower as income increases, rebound is lower over time and is generally lower in the U.S., and rebound is higher for single vehicle owners than multi-vehicle families.[654] These directional estimates can be taken into account through other meta-analysis methodologies, discussed above.

Closely Matched Studies. An alternative methodology to meta-regression would be for the agencies to use only studies that most closely match the context of the policy.[655] This can be accomplished by applying selection criteria to the available studies. In addition, because studies often contain multiple estimates or ranges of estimates based on different factors, the agencies should select the estimate within each study that most accurately reflects the rebound at issue in this Proposed Rule. For example, if a study provides rebound estimates for different countries, the estimate for U.S. households should be used rather than a range of estimates based on estimates from different geographies. Similarly, estimates with greater statistical precision (e.g., estimates with a larger number of observations) should be selected. And as the agencies explained when selecting the 10% rebound estimate for the Clean Car Standards, a rebound of 10% is better justified than 20% when the agencies clearly define selection criteria for the best estimates of the rebound effect.[656]

An approach that considers only rebound estimates that are highly relevant to the agencies' proposal would also be consistent with the recommendations that EPA provided to NHTSA as part of the interagency review of the Proposed Rule. As part of that interagency process, EPA recommended that NHTSA not use an average, but instead critically examine which studies are most likely to reflect rebound from fuel economy standards.[657] And EPA explained that of the 18 studies (12 U.S. and 6 international) in the last decade, EPA identified two that most clearly meet its criteria: Hymel and Small (2015), which estimates a rebound effect of 4% to 18%, and Greene (2012), which estimates a rebound effect of 10%. As EPA explained, "recent U.S. aggregate, time series studies find a rebound effect lower than 20%."[658] The agencies should follow this more careful and accurate approach in analyzing the rebound effect in this Proposed Rule. In

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[654] *Id.* at 170 (Table IV).

[655] Meta-Analysis Guidelines 2016 Update at 8.

[656] 77 Fed. Reg. at 62,924 (identifying criteria that led the agencies to put less emphasis on certain studies including those that measure the elasticity of demand for gasoline and studies of rebound outside the US).

[657] EPA, Review of CAFE model with "GHG" settings (08-Mar ver.), at 31-33, attached to Email from William Charmley to Chandana Achanta regarding Material for today's Light-duty GHG NPRM discussion, June 18, 2018, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (5th attachment, pdf pages 120-122).

[658] *Id.*

addition, many of the peer reviewed papers that are discussed above but that are largely ignored by the agencies attempt to do just this.[659] Using criteria to select for only high quality and relevant studies, these literature syntheses arrive at a common value of 10% for the long-run rebound effect. These consensus values are far below the 20% selected by the agencies in the Proposed Rule.

Two other approaches to meta-analysis discussed in EPA's guidelines would not be optimal to estimate rebound:

Weighted Average. While not preferred, the agencies could develop an approach that weights studies by their quality and relevance to the policy context of the Proposed Rule (rebound caused by fuel efficiency increases in the U.S. during the 2020-2050 period). Lower-quality and less precise studies would be given less weight in line with our recommendations in these comments and so would have less influence over the weighted-average rebound value. However, it is not clear what weights would be appropriate for studies of different populations or of different types of effects. For this reason, using closely matched studies or a more sophisticated meta-regression would likely be preferable approaches to this type of meta-analysis.

Structural Model. Instead of relying on existing estimates of rebound in the academic literature, the agencies could build a structural model to estimate rebound, similar to how the agencies constructed models to estimate new vehicle sales and scrappage. For this approach to be valid, the agencies would have to be careful to avoid the structural and econometric criticisms raised throughout these comments. For example, the agencies would have to appropriately address the fact that VMT, including due to rebound, is simultaneously determined with fleet size. This type of approach would be a significant undertaking and should be subject to peer review and other validation.

[659] Sorrell et al. (2009), at 1360-1361; Gillingham et al (2016), at 73-78.

D. The agencies' rebound analysis is inconsistent with other parts of the Proposed Rule

In addition to the discussion above, the agencies' use of a 20% rebound effect is arbitrary and capricious because the assumptions underlying that value are inconsistent with the agencies' analysis regarding other issues in the Proposed Rule.

The Proposed Rule assumes both higher new vehicle costs associated with compliance with baseline standards and a higher rebound effect than were previously used when promulgating and evaluating the Clean Car Standards. However, higher new vehicle purchase prices for the same level of fuel efficiency should result in a reduction in the rebound effect. Specifically, higher vehicle purchase prices will increase the "capital cost income effect," (the C in the third component of the rebound effect defined in the introduction of this section (i.e., $\frac{\partial q}{\partial I}C$)).This will reduce (or even reverse) the level of rebound caused by the baseline standards attributable to the income and substitution effects. The agencies have wholly failed to acknowledge any relationship between increasing their assumptions about new vehicle prices under the baseline standards and, simultaneously, increasing estimates of rebound from the same level of fuel efficiency.

In addition, the agencies fail to acknowledge the inconsistency between their assumptions about rebound and their assumptions about, and costs attributable to, congestion. The agencies' analysis concludes that the baseline standards will result in higher levels of congestion than would occur under the Proposed Rule.[660] However, rising congestion over time should decrease the rebound effect.[661] The agencies have ignored the relationship between congestion and rebound. The agencies' assumptions that congestion (and its underlying costs) will increase under the baseline standards compared to the Propose Rule, without also changing the magnitude of the rebound effect under the baseline standards relative to the Proposed Rule is internally inconsistent.

Finally, the Proposed Rule is inconsistent in its modeling of short-run and long-run effects. Specifically, ignoring short and medium-run estimates of rebound is inconsistent with the agencies' approach to other dynamic effects that change over time. For example, the agencies' new vehicle sales model and scrappage model employ lagged variables in order to capture the shifts in behavior from short- to long-run.[662]

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[660] PRIA at 977-978

[661] Hymel et al. (2010), at 1235.

[662] PRIA at 949 (showing lagged variables in the sales model); *id.* at 1044 (showing lagged variables in the scrappage model).

VII. THE AGENCIES SHOULD NOT RELY ON THE SAFETY CONSEQUENCES OF MASS

The agencies claim that the impact of the baseline standards on vehicle mass justifies the Proposed Rule. According to the agencies, the baseline standards will cause manufacturers to reduce the weight of new cars and light trucks.[663] In the agencies' analysis, that weight reduction has the potential to increase the risk of injury for the occupants of those lighter vehicles.[664] According to the agencies, under the baseline standards, the mass issue will lead to approximately 160-468[665]of additional fatalities when compared to the Proposed Rule.[666] And the agencies assert that the emissions reductions and lost fuel-savings that the Proposed Rule will cause are justified because of the safety concerns associated with this mass issue, along with the rebound and fleet composition concerns (addressed in Sections V and VI).[667]

The agencies' reliance on the mass-related fatalities is flawed because as the agencies' own analysis shows, there is no relationship between vehicle mass and safety. As the agencies explain, the effect of mass reductions in light duty vehicles is not statistically significant at the 95th percent confidence level.[668] In other words, the effect of mass reduction on safety cannot be reliably distinguished from zero. Only once the agency calculates the impact at the 85th percent confidence level do the results for two out of the five categories of vehicles show any statistical significance.[669] But anything lower than the 90th percent confidence interval is likely not reliable.[670]

Notably, the impact of mass is even less significant now than it was when the Clean Car Standards were issued. In 2012 and 2016, the agencies found minimal evidence of any relationship between mass and safety, and that evidence was statistically significant only at the

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[663] 83 Fed. Reg. at 42,991.

[664] *Id.* at 43,067 (line 6).

[665] *Id.* at 43,149-158; PRIA at 1411-1418. The agencies do not provide any information about the timeframe for this loss.

[666] 83 Fed. Reg. at 43,152 (estimating total fatalities attributed to mass from a rollback of the fuel efficiency standards); *id.* at 43,157 (estimating total fatalities attributed to mass from a rollback of the GHG emission standards).

[667] *Id.* at 42,995.

[668] *Id.* at 43,111.

[669] *Id.* at 43,111.

[670] *See* Wooldridge (2009), at 137 (explaining that reliance on variables that are statistically significant below 90% requires further study). Ninety-five percent is the default confidence interval in commonly used statistical programs like STATA, SAS, and MATLAB. *See* https://www.stata.com/manuals13/rregress.pdf; http://support.sas.com/documentation/cdl/en/procstat/67528/HTML/default/viewer.htm#procstat_univariate_examples09.htm; https://www.mathworks.com/help/stats/prob.normaldistribution.paramci.html; http://repec.org/bocode/o/outreg2.html.

90th confidence interval, which is weak evidence.[671] Now the agencies are not even able to say that much. The fact that the mass effects are not statistically significant even at the 90th confidence interval now is consistent with the most recent literature on this topic. In a recent paper, Wenzel reviewed NHTSA's data and concluded that the "effect of mass reduction while maintaining footprint on societal U.S. fatality risk is small, and not statistically significant at the 95% or 90% confidence level for all vehicle types."[672] According to the study, "[r]educing vehicle mass does not consistently increase risk across all footprint deciles for any combination of vehicle type and crash type."[673] In fact, after running a decline analysis, Wenzel finds that reducing mass increases safety more than decreases safety for the vast majority of crash and vehicle combinations:

> Reducing vehicle mass does not consistently increase risk across all footprint deciles for any combination of vehicle type and crash type. Risk increases with decreasing mass in a majority of footprint deciles for only 6 of the 27 crash and vehicle combinations, but few of these increases are statistically significant. On the other hand, risk decreases with decreasing mass in a majority of footprint deciles for 16 of the 27 crash and vehicle combinations; in some cases these risk reductions are large and statistically significant. If reducing vehicle mass while maintaining footprint inherently leads to an increase in risk, the coefficients on mass reduction should be more consistently positive, and with a larger R2, across the 27 vehicle/crash combinations, than shown in the analysis.[674]

Wenzel found that the impact of mass was insignificant even as the weight of trucks has trended upwards over time.[675]

Indeed, the research and analysis actually supports a conclusion that reducing mass improves safety if anything.[676] For example, Bento et al. looked at impacts of CAFE standards on weight distribution and mean weight and found that pre-footprint standards actually decreased fatalities on net by reducing weight of vehicles (even as it spread out the distribution). Specifically, he found that pre-footprint regulations saved 393 lives nationally.[677] Given that the agencies' results showing fatalities associated with changes in vehicle mass due to the baseline standards are not statistically significant, Bento's results are not outside the range of possibility even under NHTSA's own analysis.

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[671] Draft TAR at 8-21, 8-22, 8-27 and 8-31; 77 Fed. Reg. at 62,747-48.

[672] Wenzel (2018), at x.

[673] *Id.* at v.

[674] Id.

[675] *See* 83 Fed. Reg. at 43,111-12 (describing trend upward trend in vehicle mass).

[676] See, e.g., Wenzel (2018), at 110.

[677] Bento et al, (2017), at 24-25.

Moreover, footprint-based standards were introduced in 2012 to mitigate the potential negative effects of decreasing the mass of vehicles (i.e., by creating crumple space). And when footprint is held fixed, "no judicious combination of mass reductions in the various classes of vehicles results in a statistically significant fatality increase and many potential combinations are safety-neutral as point estimates."[678] Similarly, a 2015 study by the National Academy of Sciences found that "a reduction in the weight of vehicles is not generally associated with greater societal safety risks" as long as the size mix of vehicles remains roughly the same.[679] Similarly, in a 2013 study, Jacobsen found no evidence that footprint standards affect fatalities.[680]

There may be several reasons other than the fact that standards are footprint-based, to explain the evidence showing that mass reductions do not affect safety.

First, other independent factors likely reduce the impact of mass on safety. For example, as the agencies concede, the "designs and materials of more recent model year vehicles may have weakened the historical statistical relationships between mass, size, and safety."[681] Additionally, fuel efficiency and safety ratings may be positively related via production decisions.[682]

Second, recent work by Tolouei also supports the findings that narrowing the weight distribution of vehicles will save lives.[683]

Third, as the National Academy of Sciences has explained, manufacturers will reduce mass "across all vehicle sizes, with proportionately more mass removed from heavier vehicles."[684] This decreases any negative effect that mass reductions would have on safety.[685]

Due to this factor, in the 2016 Draft TAR, EPA analyzed the impact of mass by adding weight reduction constraints.[686] Ignoring all of this research, the agencies' current analysis applies mass

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678 Wenzel (2018), at x.

679 NAS (2015), at 363-364 (finding 10.2); *see also* Anderson, et al. (2011), at 6-7 (concluding that "the impact of fuel economy standards on road safety is less clear. . . based on the available literature, it is difficult to draw definitive conclusions about the direction, let alone the magnitude, of the link between external accident costs and fuel economy regulations").

680 Jacobsen (2013), at 2.

681 PRIA at 1333.

682 Chen & Run (2010), at 114.

683 Tolouei (2015), at 267.

684 NAS (2015), at 240.

685 *Id.*; Wenzel (2018), at 110.

686 Draft TAR at 8-58, 8-59.

reductions without regard to the size of the vehicle.[687] If nothing else, the agencies should use the same constraints that EPA used in the Draft TAR when analyzing the Proposed Rule.

As a last point, NHTSA had LBNL analyze its mass results and LBNL found that mass reductions may increase the number of accidents but that each crash results in fewer fatalities.[688] That unexpected result demonstrates that the agencies' conclusions are incorrect.

As the evidence shows, there is no negative safety impact due to mass changes. EPA is on record reaching a similar conclusion. In 2017, EPA explained in the Final Determination that the fleet can absorb modest levels of mass reduction without any net increase in fatalities.[689] The agencies have failed to explain their changed conclusion now and have presented no new evidence that would justify the change. The agencies' reliance on those fatalities despite their statistical insignificance is arbitrary and capricious.

VIII. THE AGENCIES' EMPLOYMENT ANALYSIS IS INCOMPLETE

The agencies' employment analysis does not provide any justification for the Proposed Rule either. The agencies introduce the Proposed Rule by explaining that the proposal follows the President's promise to change the standards if they threaten automotive sector jobs.[690] But the actual analysis conducted by the agencies shows that this concern does not support the Proposed Repeal at all. To the contrary, according to the agencies' own numbers, the Proposed Repeal would *reduce* auto-sector jobs due to the decision to eliminate the mandate to use fuel-efficient technologies, with 50 to 60 thousand jobs lost between 2020 and 2030.[691]

The agencies' jobs analysis is incomplete. In particular, the agencies' analysis focuses on the automotive sector only and does not investigate the job losses in the long-term or with reference to other job sectors.[692] As even the agencies acknowledge, total economy-wide employment effects might be very different from those found within the regulated sector.[693] A proper methodology should thus look at the economy-wide effects, including all relevant general equilibrium channels.[694]

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687 *See* 83 Fed. Reg. at 43,113 (explaining how the agencies calculated fatalities as a function of mass without any discussion of footprint); *id.* at 43,110 (discussing correlation between mass and footprint but then arguing that correlation has decreased over time).

688 PRIA at 1336-1337.

689 Final Determination at 26-27.

690 83 Fed. Reg. at 42,987.

691 *Id.* at 43,436-37 (Table VIII-39).

692 *Id.* at 43,078-79, 43,436.

693 *Id.* at 43,078-79.

694 In their annual reports on the costs and benefits of federal regulations, OMB has repeatedly advised agencies not to fall into the "pitfall" of ignoring long-run and economy-wide effects. *See*

Additionally, employment effects should be part of traditional cost-benefit analysis and should be conducted in a way that makes it easy for both decisionmakers and the public to assess how the employment effects compare to other effects of the proposed regulatory change. Therefore, instead of simply reporting the number of jobs affected, the agencies should focus on the associated welfare effects and use a recognized cost-benefit methodology to quantify the respective employment welfare impacts.[695]

IX. THE AGENCIES' EMISSIONS' ANALYSIS IS INACCURATE AND INCOMPLETE

The agencies have inaccurately and incompletely quantified the increases in both greenhouse gas emissions and emissions of criteria and toxic pollutants that will result from the Proposed Rule. As detailed more thoroughly in our separate comments that were submitted jointly with other organizations on the social cost of greenhouse gases,[696] at least the following serious problems cause significant underestimates of the Proposed Rule's health and welfare effects:

- The myriad modeling problems, especially with the rebound, scrappage, and sales modules, cause the agencies to underestimate the increase in fuel consumption—and so underestimate the increase in upstream and downstream emissions associated with fuel consumption—that will result from the proposed rollback.
- The agencies have assumed that 50% of the increase in fuel consumption from the Proposed Rule will be met by increased imports of refined gasoline, and that 45% will be met by increased domestic refining of imported crude oil. Yet the agencies arbitrarily ignore all upstream emissions associated with fuel production that occur abroad, even though all foreign emissions of greenhouse gases, and some foreign emissions of other pollutants, will have direct effects on the United States. Additionally, those assumptions on imports are completely inconsistent with other parts of the agencies' model.
- The agencies overestimate upstream emissions from electric vehicles by arbitrarily applying a national average to upstream electricity emissions, instead of accounting for cleaner regional mixes.
- The agencies' treatment of emissions associated with refueling trips is unclear, and so those emissions may be undercounted.
- The inconsistency between the total emissions tallies in the preliminary regulatory impact analysis and the draft environmental impact statement is unexplained.

Additionally, the agencies fixate on alleged on-road fatality effects while arbitrarily ignoring the mortalities, morbidities, and other welfare effects associated with emissions. The agencies

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https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/2015_cb/2015-cost- benefit-report.pdf at 42. *See also* SAB Advice on the Use of Economy-Wide Models in Evaluating the Social Costs, Benefits, and Economic Impacts of Air Regulations, Environmental Protection Agency Science Advisory Board Economy-Wide Modeling Panel, EPA-SAP-17-012 (2017).

[695] *See* Bartik (2012); Bartik (2015).

[696] *See* https://policyintegrity.org/what-we-do/update/3190.

misleadingly tout figures on how many lives the Proposed Rule will allegedly save from traffic accidents, without assessing any of the real-world impacts from the increase in greenhouse gas emissions, criteria pollutant emissions, and toxic pollutant emissions, which will include: climate-related deaths and illnesses from excessive heat, excessive cold, extreme weather events, diarrhea, vector-borne diseases, food- and water-borne diseases, cardiovascular and respiratory effects, food scarcity, water scarcity, and conflict;[697] as well as mortalities and morbidities from increases in particulate matter and other pollutants, including premature adult and infant mortality, acute bronchitis, respiratory emergency room visits, non-fatal heart attacks, asthma exacerbations, strokes, reproductive and developmental effects, cancer and genotoxicity effects, and work-loss days.[698] In the entire Proposed Rule, ocean acidification—a major environmental impact from increased carbon dioxide emissions—is never mentioned, and a host of other climate- and pollution-related effects are arbitrarily omitted or given short shrift.

As our separate comments on the social cost of greenhouse gases explain, the agencies must more accurately and fully monetize climate damages by applying the Interagency Working Group's estimates of the social cost of greenhouse gases. The agencies' so-called "interim" estimates have manipulated and decimated the valuation of the full costs of climate damages in ways at odds with the best available science, the best practices for economic analysis, and the legal standards for rational decisionmaking. The "interim" values ignore the real costs of climate change by arbitrarily attempting to limit the valuation to purportedly domestic-only effects; by arbitrarily discounting future climate effects at a 7% discount rate that is inappropriate for long-term climate effects; and by arbitrarily failing to address uncertainty over catastrophic damages, tipping points, option value, and risk aversion.

X. MISSING DOCKET INFORMATION

Finally, we submitted comments flagging important information that was missing from the docket and so impeding public review.[699] That information has still not been provided. The missing information frustrates the opportunity for meaningful public comment.

Respectfully,

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Bethany Davis Noll
Peter Howard
Richard Revesz
Jason Schwartz
Avi Zevin

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[697] Carleton et al. (2018); Howard (2014); SAFE Rule Draft EIS at S-21.

[698] SAFE Rule Draft EIS at S-9, 2-27, 4-24 (listing the human health and welfare impacts from the increased particulate matter emissions under the proposed rollbacks).

[699] https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0899.

REFERENCES

Many of these documents were either cited by the agencies or submitted to the record by other parties. As such, they are already part of the record. To the extent that the articles are not already in the record, the agencies should include them in the record. Where possible, we have included a links for ease of reference. We cannot submit our own copy of these articles because of copyright concerns.

Shortcite	Article
Ahmad & Greene (2005)	Sanjana Ahmad & David Greene, *Effect of Fuel Economy on Automobile Safety: A Reexamination*, 1941 Transp. Res. Rec. (2005). https://www.researchgate.net/profile/David_Greene6/publication/228986491_Effect_of_Fuel_Economy_on_Automobile_Safety_A_Reexamination/links/00b7d5277accf4115f000000/Effect-of-Fuel-Economy-on-Automobile-Safety-A-Reexamination.pdf
Allcott & Knittel (2017)	Hunt Allcott & Christopher R. Knittel, *Are Consumers Poorly-Informed about Fuel Economy? Evidence from Two Experiments* 1-61 (Nat'l Bureau of Econ. Res., Working Paper No. 23076, 2018). https://www.nber.org/papers/w23076.pdf
Allcott & Sunstein (2015)	Hunt Alcott & Cass R. Sunstein, *Regulating Internalities*, 34 Journal of Policy Analysis and Management 698 (2015). https://doi.org/10.1002/pam.21843
Allcott & Wozny (2014)	Hunt Allcott & Nathan Wozny, *Gasoline Prices, Fuel Economy, and the Energy Paradox*, 96 The Rev. of Econ. & Stat. 779 (2014). https://www.mitpressjournals.org/doi/pdfplus/10.1162/REST_a_00419 **[cited by the agencies in the Proposed Rule]**
Alpizar et al. (2005)	Francisco Alpizar, Fredrik Carlsson & Olof Johansson-Stenman, *How Much Do We Care About Absolute Versus Relative Income and Consumption?*, 56 Journal of Economic Behavior & Organization 405 (2005). https://doi.org/10.1016/j.jebo.2002.10.007
Anderson et al. (1997)	Patrick L. Anderson, Richard D. McLellan, Joseph P. Overton & Gary L. Wolfram, *Price Elasticity of Demand*, (1997). http://scholar.harvard.edu/files/alada/files/price_elasticity_of_demand_handout.pdf
Anderson et al. (2011)	Soren T. Anderson, Ian W. H. Parry, James M. Sallee & Carolyn Fischer, *Automobile Fuel Economy Standards: Impacts, Efficiency, and Alternatives*, 5 Rev. of Envtl. Econ. & Pol'y 89 (2011). https://academic.oup.com/reep/article-pdf/5/1/89/4470610/req021.pdf
Anderson & Auffhammer (2013)	Michael L. Anderson & Maximilian Auffhammer, *Pounds That Kill: The External Costs of Vehicle Weight*, 81 Rev. of Econ. Stud. 535 (2014). https://academic.oup.com/restud/article-pdf/81/2/535/18387399/rdt035.pdf

Shortcite	Article
Anderson & Sallee (2011)	Soren T. Anderson & James M. Sallee, *Using Loopholes to Reveal the Marginal Cost of Regulation: The Case of Fuel-Economy Standards*, 101 Am. Econ. Rev. 1375 (2011). https://www.jstor.org/stable/pdf/23045902.pdf
Anderson, et al. (2013)	Soren T. Anderson, Ryan Kellogg & James M. Sallee, *What do consumers believe about future gasoline prices?*, J. Environ. Econ. Manage. 1 (2013). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1820086
Anderson & Searson (2015)	R.W.G. Anderson & D.J. Searson, *Use of Age–Period–Cohort Models to Estimate Effects of Vehicle Age, Year of Crash and Year of Vehicle Manufacture on Driver Injury and Fatality Rates in Single Vehicle Crashes in New South Wales, 2003–2010*, 75 Accident Analysis and Prevention 202 (2015). https://ac.els-cdn.com/S0001457514003492/1-s2.0-S0001457514003492-main.pdf?_tid=4b0b484a-23b5-4893-baec-2637f317fc87&acdnat=1539789599_6a404fdc2af1269fc50072d69d7cb612
Anthoff & Tol (2012)	David Anthoff & Richard S.J. Tol, Th*e Climate Framework For Uncertainty, Negotiation and Distribution (FUND), Technical Description, Version 3.6,* (2012). http://www.fund-model.org/versions
Anthoff & Tol (2013)	David Anthoff & Richard S.J. Tol, *The Uncertainty about the Social Cost of Carbon: A Decomposition Analysis Using FUND*, 177 Climatic Change 515 (2013). https://link.springer.com/article/10.1007/s10584-013-0706-7 **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
Arrow et al. (1996)	Kenneth J. Arrow, Maureen L. Cropper, George C. Eads, Robert W. Hahn, Lester B. Lave, Roger G. Noll, Paul R. Portney, Milton Russell, Richard Schmalensee, V. Kerry Smith & Robert N. Stavins, *Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation?*, 272 Science 221 (1996). http://science.sciencemag.org/content/sci/272/5259/221.full.pdf
Arrow & Fisher (1974)	Kenneth J Arrow & Anthony C. Fisher*, Environmental preservation, uncertainty, and irreversibility*, 88 The Quarterly Journal of Economics 312 (1974). http://bin.t.u-tokyo.ac.jp/rzemi13/test/%E5%85%90%E7%8E%891.pdf

Shortcite	Article
Austin & Dinan (2005)	David Austin & Terry Dinan, *Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline Taxes*, 50 Journal of Environmental Economics and Management 562 (2005). https://ac.els-cdn.com/S0095069605000550/1-s2.0-S0095069605000550-main.pdf?_tid=44f1b8cf-9c72-4277-97f8-0ef9228e4a37&acdnat=1539789738_6da979b63fe274d7e7fcd00e10bc43b4
Azevedo (2014)	Ines M.L. Azevedo, *Consumer End-Use Energy Efficiency and Rebound Effects*, 39 Annual Review of Environment and Resources 393 (2014). https://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-021913-153558
Bailo et al (2018)	Carla Bailo et al., Ctr. for Automotive Res., The Great Divide 9 (2018). https://www.cargroup.org/publication/great-divide-automotive-consumers-buying-vs-auto-supplier-investments-future-technologies-products-business-models/
Barla et al. (2009)	Philippe Barla, Bernard Lamonde, Luis F. Miranda-Moreno & Nathalie Boucher, *Traveled Distance, Stock and Fuel Efficiency of Private Vehicles in Canada: Price Elasticities and Rebound Effect*, 36 Transportation 389 (2009). https://link.springer.com/content/pdf/10.1007%2Fs11116-009-9211-2.pdf **[cited by the agencies in the Proposed Rule]**
Bartik (2012)	Timothy J. Bartik, *Including Jobs in Benefit-Cost Analysis*, 4 ANNU. REV. RESOUR. ECON. 55–73 (2012) https://research.upjohn.org/jrnlarticles/158/
Bartik (2015)	Timothy J. Bartik, *The Social Value of Job Loss and its Effect on the Costs of U.S. Environmental Regulations*, 9 REV. ENVIRON. ECON. POLICY 179–197 (2015) https://academic.oup.com/reep/article/9/2/179/1623963
Bento et al. (2016)	Antonio Bento, Kevin Roth & Yiou Zuo, *Vehicle Lifetime Trends and Scrappage Behavior in the U.S. Used Car Market*, (Nat'l Bureau of Econ. Res., Working Paper No. 23340, 2017). http://faculty.sites.uci.edu/kevinroth/files/2011/03/Scrappage_18Jan2016.pdf **[cited by the agencies in the Proposed Rule]**
Bento et al. (2017)	Antonio Bento, Kenneth Gillingham & Kevin Roth, *The Effect of Fuel Economy Standards on Vehicle Weight Dispersion and Accident Fatalities*, (2017). http://environment.yale.edu/gillingham/Bentoetal_CAFEAttributesAccidents.pdf **[cited by the agencies in the Proposed Rule]**

Shortcite	Article
Bento et al. (2018)	Antonio Bento, Kevin Roth & Yiou Zuo, *Vehicle Lifetime Trends and Scrappage Behavior: Trends in the U.S. Used Car Market*, 39 The Energy Journal 159 (2018). http://www.iaee.org/en/publications/init2.aspx?id=0
Berry et al. (1995)	Steven Berry, James Levinsohn & Ariel Pakes, *Automobile Prices in Market Equilibrium*, 63 Econometrica 841 (1995). https://www.jstor.org/stable/pdf/2171802.pdf **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
Blows et al. (2003)	Stephanie Blows, R. Q. Ivers, M. Woodward, J. Connor, S. Ameratunga & R. Norton, *Vehicle Year and the Risk of Car Crash Injury*, 9 Injury Prevention 353 (2003). https://injuryprevention.bmj.com/content/injuryprev/9/4/353.full.pdf
Borenstein (2015)	Severin Borenstein, *A Microeconomic Framework for Evaluating Energy Efficiency Rebound and Some Implications*, 36 The Energy Journal 1 (2015). http://206.183.31.94/documents/sample_ej.pdf
Busse et al. (2013)	Meghan R. Busse, Christopher R. Knittel & Florian Zettelmeyer, *Are Consumers Myopic? Evidence from New and Used Car Purchases*, 103 American Economic Review 220 (2013). https://www.jstor.org/stable/pdf/23469641.pdf **[cited by the agencies in the Proposed Rule]**
CARB (2004)	California Environmental Protection Agency Air Resources Board ("CARB"), *Technical Support Document for Staff Proposal Regarding Reduction of Greenhouse Gas Emissions from Motor Vehicles Economic Impacts of the Climate Change Regulations*, (2004). https://www.arb.ca.gov/cc/ccms/documents/august_tsd/economics_august.doc
Carlson (2000)	Curtis Carlson et al., *Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?*, 108 J. Polit. Econ. 1292–1326 (2000) https://www.journals.uchicago.edu/doi/10.1086/317681
Cameron & Trivedi (2005)	A. Colin Cameron & Pravin K. Trivedi, *Microeconometrics: Methods and Applications*, (2005). http://www.newbooks-services.de/MediaFiles/Texts/3/9780521848053_Intro_001.pdf

Shortcite	Article
Carleton et al. (2018)	Tamma Carleton, Michael Delgado, Michael Greenstone, Trevor Houser, Solomon Hsiang, Andrew Hultgren, Amir Jina, Robert Kopp, Kelly McCusker, Ishan Nath, James Rising, Ashwin Rode, Samuel Seo, Justin Simcock, Arvid Viaene, Jiacan Yuan & Alice Zhang, *Valuing the Global Mortality Consequences of Climate Change Accounting for Adaptation Costs and Benefits*, (University of Chicago, Becker Friedman Institute for Economics Working Paper No. 2018-51, 2018). https://ssrn.com/abstract=3224365
Carlsson et al. (2007)	Fredrik Carlsson, Olof Johansson-Stenman & Peter Martinsson, *Do You Enjoy Having More than Others? Survey Evidence of Positional Goods*, 74 Economica 586 (2007). https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1468-0335.2006.00571.x
Chan & Gillingham (2015)	Nathan W. Chan & Kenneth Gillingham, *The Microeconomic Theory of the Rebound Effect and Its Welfare Implications*, 2 Journal of the Association of Environmental and Resource Economists 133 (2015). https://www.journals.uchicago.edu/doi/pdfplus/10.1086/680256
Chen & Lin (2006)	Cynthia Chen & Jie (Jane) Lin, *Making an Informed Vehicle Scrappage Decision*, 26 Transport Reviews 731 (2006). https://www.tandfonline.com/doi/pdf/10.1080/01441640600752545?needAccess=true
Chen (2017)	Yen Chen, Ctr. for Automotive Res., *The Party is Over- U.S. Automotive Outlooks* 18 (2017)
Chen & Ren (2010)	Chialin Chen & Yu Ren, *Exploring the Relationship Between Vehicle Safety and Fuel Efficiency in Automotive Design*, 15 Transportation Research Part D 112 (2010). https://ac.els-cdn.com/S1361920909001266/1-s2.0-S1361920909001266-main.pdf?_tid=dd8ac13a-3277-4b00-8ffd-875696a884c8&acdnat=1539792053_ab3e358649c775d16272a19c0999f30b
Colson & Cooke (2018)	Abigail R Colson & Roger M Cooke, *Expert Elicitation: Using the Classical Model to Validate Experts' Judgments*, 12 Review of Environmental Economics and Policy 113 (2018). https://doi.org/10.1093/reep/rex022
Comings & Allison (2017)	Tyler Comings & Avi Allison, *More Mileage for Your Money: Fuel Economy Increases While Vehicle Prices Remain Stable*, (2017). https://consumersunion.org/wp-content/uploads/2017/03/Synapse-CU-Affordability-Report-3-15-corrected-1.pdf

Shortcite	Article
Cooper et al. (2001)	Ben Cooper, Cecilia Garcia-Penalosa & Peter Funk, *Status Effects and Negative Utility Growth*, 111 The Economic Journal 642 (2001). https://onlinelibrary.wiley.com/doi/pdf/10.1111/1468-0297.00654
Cooper et al. (2010)	P. J. Cooper, J. Osborn & W. Meckle, *Estimating the Effect of the Vehicle Model Year on Crash and Injury Involvement*, 224 Proceedings of the Institution of Mechanical Engineers, Part D: Journal of automobile engineering 1527 (2010). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.974.1356&rep=rep1&type=pdf
Crandall & Graham (1989)	Robert W. Crandall & John D. Graham, *The Effect of Fuel Economy Standards on Automobile Safety*, 32 The Journal of Law & Economics 97 (1989). https://www.jstor.org/stable/pdf/725381.pdf
Cropper (2012)	Maureen Cropper, *How Should Benefits and Costs Be Discounted in an Intergenerational Context?*, 183 Resources 30 (2012). http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-12-42.pdf
Dana (2009)	David A. Dana, *Valuing Foreign Lives and Civilizations in Cost-Benefit Analysis: The Case of the United States and Climate Change Policy* (Northwestern Faculty Working Paper No. 196, 2009). http://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=1195&context=facultyworkingpapers
Davis (2008)	Lucas W. Davis, *Durable Goods and Residential Demand for Energy and Water: Evidence from a Field Trial*, 39 RAND Journal of Economics 530 (2008). https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.0741-6261.2008.00026.x
Diaz & Keller (2016)	Delavane Diaz & Klaus Keller, *A Potential Disintegration of the West Antarctic Ice Sheet: Implications for Economic Analyses of Climate Policy*, 106 *The American Economic Review* 607 (2016). http://www3.geosc.psu.edu/~kzk10/Diaz_Keller_AER_sub_2016.pdf
Dep't of Energy (2016)	Dept. of Energy, *Long-Term Strategic Review of the U.S. Strategic Petroleum Reserve: Report to Congress* 64 (2016) https://www.energy.gov/sites/prod/files/2016/09/f33/Long-Term%20Strategic%20Review%20of%20the%20U.%20S.%20Strategic%20Petroleum%20Reserve%20Report%20to%20Congress_0.pdf
Dillon et al. (2015)	Harya S. Dillon, Saphores, Jean-Daniel Saphores & Marlon G. Boarnet, *The Impact of Urban Form and Gasoline Prices on Vehicle Usage: Evidence from the 2009 National Household Travel Survey*, 52 Research in Transportation Economics 23 (2015). https://doi.org/10.1016/j.retrec.2015.10.006

Shortcite	Article
DOT (2016)	United States Department of Transportation ("DOT"), *The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations*, (2016). https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf
Drupp et al. 2015	Moritz Drupp, Mark Freeman, Ben Groom & Frikk Nesje, *Discounting Disentangled: An Expert Survey on the Determinants of the Long-Term Social Discount Rate*, (Centre for Climate Change Economics and Policy Working Paper No. 195; Grantham Research Institute on Climate Change and the Environment Working Paper No. 172, 2015). http://piketty.pse.ens.fr/files/DruppFreeman2015.pdf
Dubin & McFadden (1984)	Jeffrey A. Dubin & Daniel L. McFadden, *An Econometric Analysis of Residential Electric Appliance Holdings and Consumption*, 52 Econometrica 345 (1984). https://www.jstor.org/stable/pdf/1911493.pdf
Dimitropoulos (2016)	Alexandros Dimitropoulos, Walid Oueslati & Christina Sinek, *The Rebound Effect in Road Transport: A Meta-Analysis of Empirical Studies*, (OECD Environment Working Papers, Working Paper No. 113, 2016). https://search.proquest.com/docview/1854180635/fulltextPDF/4C53E31155054885PQ/1?accountid=12768
EIA (2018a)	United States Energy Information Administration ("EIA"), *Annual Energy Outlook 2018: With Projections to 2050*, (2018). https://www.eia.gov/outlooks/aeo/pdf/AEO2018.pdf **[cited by the agencies in the Proposed Rule]**
EIA (2018b)	United States Energy Information Administration ("EIA"), *Summary of Legislation and Regulations included in the Annual Energy Outlook 2018*, (2018). https://www.eia.gov/outlooks/aeo/assumptions/pdf/summary.pdf
EIA (2018c)	United States Energy Information Administration ("EIA"), *Energy-Related Carbon Dioxide Emissions by State, 2000-2015*, (2018). https://www.eia.gov/environment/emissions/state/analysis/
EIA (2018d)	United States Energy Information Administration ("EIA"), *U.S. Imports by Country of Origin*, (2018). https://www.eia.gov/dnav/pet/pet_move_impcus_d_nus_Z00_mbbl_a.htm
EPA (2010a)	United States Environmental Protection Agency ("EPA"), *Guidelines for Preparing Economic Analyses*, (2010). https://www.epa.gov/sites/production/files/2017-08/documents/ee-0568-50.pdf

Shortcite	Article
EPA (2010b)	United States Environmental Protection Agency ("EPA"), *How Consumers Value Fuel Economy: A Literature Review*, (EPA-420-R-10-008, 2010). https://nepis.epa.gov/Exe/ZyPDF.cgi/P1006V0O.PDF?Dockey=P1006V0O.PDF **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
EPA (2016a)	United States Environmental Protection Agency ("EPA"), *Proposed Determination on the Appropriateness of the Model year 2025-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation*, (EPA-420-R-16-020, 2016). https://nepis.epa.gov/Exe/ZyPDF.cgi/P100Q3DO.PDF?Dockey=P100Q3DO.PDF
EPA (2016b)	United States Environmental Protection Agency ("EPA"), *Proposed Determination on the Appropriateness of the Model year 2025-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards under the Midterm Evaluation: Technical Support Document*, (EPA-420-R-16-021, 2016). https://nepis.epa.gov/Exe/ZyPDF.cgi/P100Q3L4.PDF?Dockey=P100Q3L4.PDF
EPA (2016c)	United States Environmental Protection Agency ("EPA"), United States Department of Transportation National Highway Traffic Safety Administration & California Air Resources Board, *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*, (EPA-420-D-16-900, 2016). https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
EPA (2016d)	United States Environmental Protection Agency ("EPA"), United States Department of Transportation National Highway Traffic Safety Administration & California Air Resources Board, *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: Executive Summary*, (EPA-420-D-16-901, 2016). https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OYFR.PDF?Dockey=P100OYFR.PDF

Shortcite	Article
EPA (2017a)	United States Environmental Protection Agency ("EPA"), *Final Determination on the Appropriateness of the Model Year 2022-2025 Light Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation*, (EPA-420-R-17-001, 2017). https://nepis.epa.gov/Exe/ZyPDF.cgi/P100QQ91.PDF?Dockey=P100QQ91.PDF
EPA (2017b)	United States Environmental Protection Agency ("EPA"), *Final Determination on the Appropriateness of the Model Year 2022-2025 Light Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation*, (EPA-420-R-17-002, 2017). https://nepis.epa.gov/Exe/ZyPDF.cgi/P100QQ9Y.PDF?Dockey=P100QQ9Y.PDF
EPA (2018a)	United States Environmental Protection Agency ("EPA"), *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2017*, (EPA-420-R-18-001, 2018). https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100TGDW.pdf
EPA (2018b)	United States Environmental Protection Agency ("EPA"), *Review Materials for The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks NPRM*, (RIN 2060-AU09, 2018). https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453
Farmer & Lund (2006)	Charles M. Farmer & Adrian K. Lund, *Trends Over Time in the Risk of Driver Death: What If Vehicle Designs Had Not Improved?*, 7 Traffic Injury Prevention 335 (2006). https://doi.org/10.1080/15389580600943369
Farmer & Lund (2015)	Charles M. Farmer & Adrian K. Lund, *The Effects of Vehicle Redesign on the Risk of Driver Death*, 16 Traffic Injury Prevention 684 (2015). https://doi.org/10.1080/15389588.2015.1012584
Feeney & Cardebring (1988)	Bernard P. Feeney & Peter Cardebring, *Car Longevity in Sweden: A Revised Estimate*, 22 Transportation Research Part A 455 (1988). http://www.diva-portal.org/smash/get/diva2:671712/FULLTEXT01.pdf **[cited by the agencies in the Proposed Rule]**
Frank (1985)	Robert H. Frank, *The Demand for Unobservable and Other Nonpositional Goods*, 75 The American Economic Review 101 (1985). https://www.jstor.org/stable/pdf/1812706.pdf
Frank (2005)	Robert H. Frank, *Positional Externalities Cause Large and Preventable Welfare Losses*, 95 Am. Econ. Rev. 137 (2005). https://www.jstor.org/stable/pdf/4132805.pdf

Shortcite	Article
Frank & Sunstein (2001)	Robert H. Frank & Cass R. Sunstein, *Cost-Benefit Analysis and Relative Position*, 68 The University of Chicago Law Review 323 (2001). https://www.jstor.org/stable/pdf/1600376.pdf
Freeman et al. (2015)	Mark C. Freeman, Ben Groom, Ekaterini Panopoulou, & Theologos Pantelidis, *Declining Discount Rates and the Fisher Effect: Inflated Past, Discounted Future?*, 73 J. Environ. Econ. Manage. 32 (2015). https://www.sciencedirect.com/science/article/pii/S0095069615000492
Freeman & Guzman (2009)	Jody Freeman & Andrew Guzman, *Climate Change and U.S. Interests*, 109 Columbia L. Rev. 1531 (2009). https://scholarship.law.berkeley.edu/facpubs/36/
Gayer & Viscusi (2016)	Ted Gayer & W. Kip Viscusi, *Determining the Proper Scope of Climate Change Policy Benefits in U.S. Regulatory Analyses: Domestic versus Global Approaches*, 10 Rev. Envtl. Econ. & Pol'y 245 (2016). https://academic.oup.com/reep/article-pdf/10/2/245/6868840/rew002.pdf
Gillingham (2011)	Kenneth Gillingham, *How Do Consumers Respond to Gasoline Price Shocks? Heterogeneity in Vehicle Choice and Driving Behavior*, (2011). https://www.ethz.ch/content/dam/ethz/special-interest/mtec/cepe/cepe-dam/documents/education/lunch-seminar/2012-spring/Gillingham_ConsumerResponseGasPrices.pdf
Gillingham et al. (2013)	Kenneth Gillingham, Matthew J. Kotchen, David S. Rapson & Gernot Wagner, *The Rebound Effect is Overplayed*, 493 Nature 475 (2013). http://environment.yale.edu/kotchen/pubs/rebound.pdf
Gillingham (2014a)	Kenneth Gillingham, *Identifying the Elasticity of Driving: Evidence from a Gasoline Price Shock in California*, 47 Regional Science and Urban Economics 13 (2014). https://ac.els-cdn.com/S0166046213000653/1-s2.0-S0166046213000653-main.pdf?_tid=e66d5ad1-1855-4a6a-ae66-70e52337bf40&acdnat=1539803554_3af5baaed3e191ac4eb867b4760ad937 **[cited by the agencies in the Proposed Rule]**
Gillingham (2014b)	Kenneth Gillingham, *Rebound Effects*, in *The New Palgrave Dictionary of Economics*, (Palgrave Macmillan eds., 2014). https://doi.org/10.1057/978-1-349-95121-5_2875-1
Gillingham et al. (2015)	Kenneth Gillingham, Alan Jenn & Ines M.L. Azevedo, *Heterogeneity in Response to Gasoline Prices: Evidence from Pennsylvania and Implications for the Rebound Effect*, 52 Energy Economics S41 (2015). https://ac.els-cdn.com/S0140988315002340/1-s2.0-S0140988315002340-main.pdf?_tid=36023ccd-ab34-429e-b4a2-35edf47bb21f&acdnat=1539803763_8c466695c874552bbd2f697ebd734d78

Shortcite	Article
Gillingham et al. (2016)	Kenneth Gillingham, David Rapson & Gernot Wagner, *The Rebound Effect and Energy Efficiency Policy*, 10 Review of Environmental Economics and Policy 68 (2016). https://academic.oup.com/reep/article-pdf/10/1/68/7969937/rev017.pdf
Gillingham & Palmer (2014)	Kenneth Gillingham & Karen Palmer, *Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence*, 8 Review of Environmental Economics and Policy 18 (2014). https://academic.oup.com/reep/article-pdf/8/1/18/4506981/ret021.pdf
Goldberg (1998)	Pinelopi Koujianou Goldberg, *The Effects of the Corporate Average Fuel Efficiency Standards in the US*, 46 The Journal of Industrial Economics 1 (1998). https://onlinelibrary.wiley.com/doi/pdf/10.1111/1467-6451.00059
Golub et al. (2014)	Alexander Golub, Daiju Narita & Matthias G. W. Schmidt, *Uncertainty in Integrated Assessment Models of Climate Change: Alternative Analytical Approaches*, 19 Environmental Modeling & Assessment 99 (2014). https://link.springer.com/article/10.1007/s10666-013-9386-y
Golub & Brody (2017)	Alexander Golub & Michael Brody, *Uncertainty, Climate Change, and Irreversible Environmental Effects: Application of Real Options to Environmental Benefit-Cost Analysis*, 7 Journal of Environmental Studies and Sciences 7 519 (2017). https://link.springer.com/article/10.1007/s13412-017-0436-7
Greene (1998)	David L. Greene, *Why CAFE Worked*, 26 Energy Policy 595 (1998). https://ac.els-cdn.com/S0301421598000160/1-s2.0-S0301421598000160-main.pdf?_tid=d2381f2e-915f-402a-8fe2-8fb36f9037b1&acdnat=1539804518_36d696045140e7f619587d40fc5d5a47
Greene (2012)	David L. Greene, *Rebound 2007: Analysis of U.S. Light-Duty Vehicle Travel Statistics*, 41 Energy Policy 14 (2012). https://ac.els-cdn.com/S0301421510002739/1-s2.0-S0301421510002739-main.pdf?_tid=97418b40-15e6-4521-89d2-16a807a88d2b&acdnat=1539804578_2f9cbf3fb91f1c013d7b7ab700a41a54 **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
Greene et al. (2018)	David Greene, Anushah Hossain, Julia Hofmann, Gloria Helfand & Robert Beach, *Consumer Willingness to Pay for Vehicle Attributes: What Do We Know?*, 118 Transp. Res. 258 (2018). https://doi.org/10.1016/j.tra.2018.09.013

Shortcite	Article
Greene & Chen (1981)	David L. Greene & C. K. Eric Chen, *Scrappage and Survival Rates of Passenger Cars and Light Trucks in the U.S., 1966-77*, 15 Transportation Research Part A 383 (1981). https://ac.els-cdn.com/0191260781901448/1-s2.0-0191260781901448-main.pdf?_tid=bf72c510-8222-48a4-8c47-9a89ed876b63&acdnat=1539804689_fe2eadbbfb68ae0749b636a65dbab595 **[cited by the agencies in the Proposed Rule]**
Greene & Welch (2017)	David L. Greene & Jilleah G. Welch, *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the U.S.: A Retrospective and Prospective Analysis*, (Howard H. Baker Jr. Ctr. for Public Pol'y Working Paper No. 2:17, 2017). http://bakercenter.utk.edu/wp-content/uploads/2017/03/WhitePaper2-2017.pdf
Greenspan & Cohen (1999)	Alan Greenspan & Darrel Cohen, *Motor Vehicle Stocks, Scrappage, and Sales*, 81 The Review of Economics and Statistics 369 (1999). https://www.mitpressjournals.org/doi/pdfplus/10.1162/003465399558300 **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
Gron & Swenson (2000)	Anne Gron and Deborah L. Swenson, *Cost Pass-Through in the U.S. Automobile Market*, The Review of Economics and Statistic (82) 2000
Gruber (2010)	Jonathan Grueber, *Public Finance and Public Policy* (3rd ed. 2010).
Glassbrenner (2012)	Donna Glassbrenner, *An Analysis of Recent Improvements to Vehicle Safety*, (DOT HS 811 572, 2012). https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811572 **[cited by the agencies in the Proposed Rule]**
Gleick (2014)	Peter H. Gleick, *Water, Drought, Climate Change, and Conflict in Syria*, 6 Weather, Climate & Society 331 (2014). https://journals.ametsoc.org/doi/pdf/10.1175/WCAS-D-13-00059.1
Gollier & Hammitt (2014)	Christian Gollier & James K. Hammitt, *The Long-Run Discount Rate Controversy*, 6 Annu. Rev. Resour. Econ. 273 (2014). https://www.researchgate.net/profile/Christian_Gollier/publication/271049113_The_Long-Run_Discount_Rate_Controversy/links/574309f308ae9ace8418bf29/The-Long-Run-Discount-Rate-Controversy.pdf
Grinblatt et al. (2004)	Mark Grinblatt, Matti Keloharju & Seppo Ikaheimo, *Interpersonal Effects in Consumption: Evidence from the Automobile Purchases of Neighbors* (Yale ICF Working Paper No. 04-10, 2004). https://escholarship.org/uc/item/69h2f7cv

Shortcite	Article
Gruenspecht (1982a)	Howard K. Gruenspecht, *Differentiated Regulation: A Theory with Applications to Automobile Emissions Control*, (1982). https://policyintegrity.org/documents/Gruenspecht_%281982a%29.pdf
Gruenspecht (1982b)	Howard K. Gruenspecht, *Differentiated Regulation: The Case of Auto Emissions Standards*, 72 The American Economic Review 328 (1982). https://www.jstor.org/stable/pdf/1802352.pdf **[cited by the agencies in the Proposed Rule]**
Hahn (1995)	Robert W. Hahn, *An Economic Analysis of Scrappage*, 26 RAND Journal of Economics 222 (1995). https://www.jstor.org/stable/pdf/2555914.pdf
Havranek et al. (2015)	Tomas Havranek, Zuzana Irsova, Karel Janda & David Zilberman, *Selective Reporting and the Social Cost of Carbon*, 51 Energy Econ. 394 (2015). https://doi.org/10.1016/j.eneco.2015.08.009
Helfand & Wolverton (2011)	Gloria Helfand & Ann Wolverton, *Evaluating the Consumer Response to Fuel Economy: A Review of Literature*, 5 International Review of Environmental and Resource Economics 103 (2011). https://www.nowpublishers.com/article/Details/IRERE-0040 **[cited by the agencies in the Proposed Rule]**
Hamilton & Macauley (1999)	Bruce W. Hamilton & Molly K. Macauley, *Heredity or Environment: Why is Automobile Longevity Increasing*, 47 The Journal of Industrial Economics 251 (1999). https://onlinelibrary.wiley.com/doi/pdf/10.1111/1467-6451.00100 **[cited by the agencies in the Proposed Rule]**
Hardin (1968)	Garrett Hardin, *The Tragedy of the Commons*, 162 Science 1243 (1968). http://science.sciencemag.org/content/sci/162/3859/1243.full.pdf
Heal & Millner (2014)	Geoffrey M. Heal & Antony Millner, *Agreeing to Disagree on Climate Policy*, 111 Proc. Natl. Acad. Sci. 3695 (2014). http://www.pnas.org/content/pnas/111/10/3695.full.pdf
Heal & Millner (2014)	Geoffrey M. Heal & Antony Millner, *Reflections: Uncertainty and Decision Making in Climate Change Economics*, 8 Review of Environmental Economics and Policy 120 (2014). https://academic.oup.com/reep/article/8/1/120/1590265
Heffetz (2011)	Ori Heffetz, *A Test of Conspicuous Consumption: Visibility and Income Elasticities*, 93 Review of Economics and Statistics 1101 (2011). https://www.mitpressjournals.org/doi/pdfplus/10.1162/REST_a_00116
Hoen & Geurs (2011)	Anco Hoen & Karst T. Geurs, *The influence of positionality in car-purchasing behaviour on the downsizing of new cars*, 16 TRANSP. RES. PART D TRANSP. ENVIRON. 402–408 (2011) https://www.sciencedirect.com/science/article/pii/S1361920911000423

Shortcite	Article
Hope (2006)	Chris W. Hope, *The Marginal Impact of CO_2 from PAGE2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons for Concern*, 6 Integrated assessment J. 19 (2006). http://78.47.223.121:8080/index.php/iaj/article/viewFile/227/190
Hope (2011)	Chris W. Hope, *The Social Cost of CO2 from the PAGE09 Model*, (Economics Discussion Papers No. 2011-39, 2011). https://www.econstor.eu/bitstream/10419/49936/1/668556455.pdf
Hopkins & Kornienko (2004)	Ed Hopkins & Tatiana Kornienko, *Running to Keep in the Same Place: Consumer Choice as a Game of Status*, 94 AM. ECON. REV. 1085 (2004). https://pdfs.semanticscholar.org/3a63/7d2e3a38909eaf01533b9a99aa307b3c9069.pdf
Hourcade (2007)	Hourcade, J.-C., D. Demailly, K. Neuhoff, M. Sato, M. Grubb, F. Matthes and V. Graichen (2007), Differentiation and dynamics of EU-ETS industrial competitiveness impacts: Final Report, Climate Strategies, Cambridge. https://climatestrategies.org/publication/differentiation-and-dynamics-of-eu-ets-industrial-competitiveness-impacts-final-report/
Howard (2014)	Peter Howard, *Omitted Damages: What's Missing from the Social Cost of Carbon*, (2014). https://costofcarbon.org/files/Omitted_Damages_Whats_Missing_From_the_Social_Cost_of_Carbon.pdf
Howard & Schwartz (2017)	Peter Howard & Jason Schwartz, *Think Global: International Reciprocity as Justification for a Global Social Cost of Carbon*, 42 Columbia J. Envtl. L. 203 (2017). https://policyintegrity.org/files/publications/Think_Global.pdf
Hsiang et al. (2017)	Solomon Hsiang, Robert Kopp, Amir Jina, James Rising, Michael Delgado, Shashank Mohan, D. J. Rasmussen, Robert Muir-Wood, Paul Wilson, Michael Oppenheimer, Kate Larsen & Trevor Houser, *Estimating Economic Damage from Climate Change in the United States*, 356 Science 1362 (2017). http://science.sciencemag.org/content/356/6345/1362
Huang et al. (2018)	Hsing-Hsiang Huang, Gloria Helfand, Kevin Bolon, Robert Beach, Mandy Sha & Amanda Smith, *Re-Searching for Hidden Costs: Evidence from the Adoption of Fuel-Saving Technologies in Light-Duty Vehicles*, 65 Transp. Res. 194 (2018). https://doi.org/10.1016/j.trd.2018.08.009
Hughes et al. (2008)	Jonathan Hughes, Christopher Knittel & Daniel Sperling, *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand*, 29 The Energy Journal 113 (2008). https://EconPapers.repec.org/RePEc:aen:journl:2008v29-01-a06

Shortcite	Article
Hymel et al. (2010)	Kent M. Hymel, Kenneth A. Small & Kurt Van Dender, *Induced Demand and Rebound Effects in Road Transport*, 44 Transportation Research Part B 1220 (2010). https://doi.org/10.1016/j.trb.2010.02.007 **[cited by the agencies in the Proposed Rule]**
Hymel & Small (2015)	Kent M. Hymel & Kenneth A. Small, *The Rebound Effect for Automobile Travel: Asymmetric Response to Price Changes and Novel Features of the 2000s*, 49 Energy Economics 93 (2015). https://doi.org/10.1016/j.eneco.2014.12.016 **[cited by the agencies in the Proposed Rule]**
Infante (2017)	Peter F. Infante, *Residential Proximity to Gasoline Stations and Risk of Childhood Leukemia*, 185 Am. J. Epidemiology 1 (2017). https://doi.org/10.1093/aje/kww130
Interagency Working Group on Social Cost of Carbon (2010)	Interagency Working Group on Social Cost of Carbon, United States Government, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, (2010). https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf
Interagency Working Group on Social Cost of Carbon (2016)	Interagency Working Group on Social Cost of Carbon, United States Government, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, (2016). https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf
Ito & Sallee (2018)	Koichiro Ito & James M. Sallee, *The Economics of Attribute-Based Regulation: Theory and Evidence from Fuel Economy Standards*, 100 Review of Economics & Statistics 319 (2018). https://www.mitpressjournals.org/doi/pdf/10.1162/REST_a_00704
Jacobsen (2013a)	Mark R. Jacobsen, *Evaluating US Fuel Economy Standards in a Model with Producer and Household Heterogeneity*, 5 American Economic Journal: Economic Policy 148 (2013). https://www.jstor.org/stable/pdf/43189331.pdf
Jacobsen (2013b)	Mark R. Jacobsen, *Fuel Economy and Safety: The Influences of Vehicle Class and Driver Behavior*, 5 American Economic Journal: Applied Economics 1 (2013). https://www.jstor.org/stable/pdf/43189439.pdf

Shortcite	Article
Jacobsen & van Benthem (2015)	Mark R. Jacobsen & Arthur A. van Benthem, *Vehicle Scrappage and Gasoline Policy*, 3 American Economic Review 1312 (2015). https://www.jstor.org/stable/pdf/43495418.pdf **[cited by the agencies in the Proposed Rule]**
	Henry D. Jacoby & A. Denny Ellerman, *The safety valve and climate policy*, 32 Energy Policy 481 (2004)
Jouini & Napp (2014)	Elyès Jouini, & Clotilde Napp, *How to Aggregate Experts' Discount Rates: An Equilibrium Approach*, 36 Econ. Modelling 235 (2014). https://halshs.archives-ouvertes.fr/halshs-00927269/document
Keeler et al. (2016)	Bonnie L. Keeler, Jesse D. Gourevitch, Stephen Polasky, Forest Isbell, Chris W. Tessum, Jason D. Hill & Julian D. Marshall, *The Social Costs of Nitrogen*, 2 Science Advances e1600219 (2016). http://advances.sciencemag.org/content/2/10/e1600219
Kahneman et al. (1999)	Daniel Kagneman, Ilana Ritov & David Schkade, *Economic Preferences or Attitude Expressions?: An Analysis of Dollar Responses*, 19 Journal of Risk and Uncertainty 203 (1999). https://link.springer.com/content/pdf/10.1007%2F978-94-017-1406-8.pdf
Kavalec & Setiawan (1997)	Chris Kavalec & Winardi Setiawan, *An Analysis of Accelerated Vehicle Retirement Programs Using a Discrete Choice Personal Vehicle Model*, 4 Transport Policy 95 (1997). https://doi.org/10.1016/S0967-070X(97)00009-7
Kelley et al. (2015)	Colin P. Kelley, Shahrzad Mohtadi, Mark A. Cane, Richard Seager & Yochanan Kushnir, *Climate Change in the Fertile Crescent and Implications of the Recent Syrian Drought*, 112 Proc. Nat'l Acad. Sci. 3241 (2015). http://www.pnas.org/content/112/11/3241
Kilian (2008)	Lutz Kilian, *The Economic Effects of Energy Price Shocks*, 46 Journal of Economic Literature 871 (2008). https://www.jstor.org/stable/pdf/27647084.pdf
Kilian & Sims (2006)	Lutz Kilian & Eric R. Sims (2006), *The Effects of Real Gasoline Prices on Automobile Demand: A Structural Analysis Using Micro Data*, (2006). https://www3.nd.edu/~esims1/Gasoline%20Price%20Shocks%20and%20the%20Automobile%20Market.pdf
Klier & Linn (2012)	Thomas Klier & Joshua Linn, *New-Vehicle Characteristics and the Cost of the Corporate Average Fuel Economy Standard*, 43 RAND Journal of Economics 186 (2012). https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1756-2171.2012.00162.x **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**

Shortcite	Article
Kopp et al. (2016)	Robert E. Kopp, Rachael L. Shwom, Gernot Wagner & Jiacan Yuan, *Tipping Elements and Climate–Economic Shocks: Pathways Toward Integrated Assessment*, 4 Earth's Future 346 (2016). https://arxiv.org/abs/1603.00850
Kopp & Mignone (2013)	Robert E. Kopp & Bryan K. Mignone, *Circumspection, Reciprocity, and Optimal Carbon Prices*, 120 Climate Change 831 (2013). http://www.bobkopp.net/papers/pubs/KoppMignone2013-CircumspectionReciprocity.pdf
Kotchen (2016)	Matthew J. Kotchen, *Which Social Cost of Carbon? A Theoretical Perspective*, (NBER Working Paper No. 22246, 2016). http://www.nber.org/papers/w22246
Kriegler et al. (2009)	Elmar Kriegler, Jim W. Hall, Hermann Held, Richard Dawson & Hans Joachim Schellnhuber, *Imprecise Probability Assessment of Tipping Points in the Climate System*, 106 *Proceedings of the national Academy of Sciences* 5041 (2009). http://www.pnas.org/content/106/13/5041
Leard & McConnell (2017)	Benjamin Leard & Virginia McConnell, *New Markets for Credit Trading under U.S. Automobile Greenhouse Gsa and Fuel Economy Standards* (RFF, May 2017), http://www.rff.org/files/document/file/RFF-Rpt-AutoCreditTrading.pdf
Leard et al. (2017)	Benjamin Leard, Joshua Linn & Yichen Christy Zhou, *How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adoption*, Resources for the Future Report (2017). http://www.rff.org/files/document/file/RFF-Rpt-WTP_FuelEconomy&Performance.pdf
Lemoine & Rudik (2017)	Derek Lemoine & Ivan Rudik, *Managing Climate Change Under Uncertainty: Recursive Integrated Assessment at an Inflection Point*, 9 Annual Review of Resource Economics 117 (2017). https://www.annualreviews.org/doi/abs/10.1146/annurev-resource-100516-053516
Lemoine & Traeger (2016)	Derek Lemoine & Christian P. Traeger, *Ambiguous Tipping Points*, 132 Journal of Economic Behavior & Organization 5 (2016). http://www.sciencedirect.com/science/article/pii/S0167268116300221
Levy et al. (2018)	Helen Levy, Edward C. Norton & Jeffrey A. Smith, *Tobacco Regulation and Cost-Benefit Analysis: How Should We Value Foregone Consumer Surplus?*, 4 American Journal of Health Economics 1 (2018). https://www.mitpressjournals.org/doi/full/10.1162/ajhe_a_00091

Shortcite	**Article**
Li et al. (2009)	Shanjun Li, Christopher Timmins & Roger H. von Haefen, *How Do Gasoline Prices Affect Fleet Fuel Economy?*, 1 American Economic Journal: Economic Policy 113 (2009). https://www.jstor.org/stable/pdf/25760042.pdf **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
Li et al. (2010)	Shi Li, Stuart Batterman, Elizabeth Wasilevich, Huda Elasaad, Robert Wahl & Bhramar Mukherjee, *Asthma Exacerbation and Proximity of Residence to Major Roads: A Population-Based Matched Case-Control Study Among the Pediatric Medicaid Population in Detroit, Michigan*, 10 Environmental Health (2011). https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-10-34
Li (2012)	Shanjun Li, *Traffic Safety and Vehicle Choice: Quantifying the Effects of the 'Arms Race' on American Roads*, 27 Journal of Applied Econometrics 34 (2012). https://onlinelibrary.wiley.com/doi/pdf/10.1002/jae.1161
Liu (2017)	Yizao Liu, *Safer or Cheaper? Traffic Safety, Vehicle Choices and the Effect of New Corporate Average Fuel Economy Standards*, 49 Resource and Energy Economics 99 (2017). https://doi.org/10.1016/j.reseneeco.2017.04.002
Lucas (1976)	Robert E. Lucas, Jr., *Econometric Policy Evaluation: A Critique*, 1 Carnegie-Rochester Conference Series on Public Policy 19 (1976). https://doi.org/10.1016/S0167-2231(76)80003-6
Luk et al (2016)	Jason M. Luk, Bradley A. Saville & Heather L. MacLean, *Vehicle Attribute Trade-Offs to Meet The 2025 CAFE Fuel Economy Target*, 49 Transp. Res. Part D Transp. Environ. 154–171 (2016) https://www.sciencedirect.com/science/article/pii/S1361920915302959
Mastrandrea (2009)	Michael D. Mastrandrea, *Calculating the Benefits of Climate Policy: Examining the Assumptions of Integrated Assessment Models*, Pew Center on Global Climate Change Report (2009). http://www.environmentportal.in/files/mastrandrea-calculating-benefits-climate-policy-12-22-09.pdf
McCartt & Teoh (2014)	Anne T. McCartt & Eric R. Teoh, *Type, Size and Age of Vehicles Driven by Teenage Drivers Killed in Crashes During 2008-2012*, 21 Inj. Prev. 133 (2015). https://injuryprevention.bmj.com/content/injuryprev/21/2/133.full.pdf
Moay & Neeman (2009)	Omer Moav & Zvika Neeman, *Savings Rates and Poverty: The Role of Conspicuous Consumption and Human Capital* (2009), available at http://www.hecer.fi/Seminars/Papers/moav_paper.pdf.

Shortcite	Article
Moore et al. (2017)	Frances C. Moore, Uris Baldos, Thomas Hertel & Delavane Diaz, *New Science of Climate Change Impacts on Agriculture Implies Higher Social Cost of Carbon*, 8 Nature Communications 1607 (2017). https://www.nature.com/articles/s41467-017-01792-x.pdf
Moore & Diaz (2015)	Frances C. Moore & Delavane B. Diaz, *Temperature Impacts on Economic Growth Warrant Stringent Mitigation Policy*, 5 Nature Climate Change 127 (2015). https://www.nature.com/articles/nclimate2481.pdf
Morgan (2014)	M. Granger Morgan, *Use (and Abuse) of Expert Elicitation in Support of Decision Making for Public Policy*, 111 PNAS 7176 (2014). http://www.pnas.org/content/111/20/7176.long
NAS (2015)	National Research Council ("NAS"), *Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles*, (2015). https://books.google.com/books?hl=en&lr=&id=bEvgCgAAQBAJ&oi=fnd&pg=PT33&dq=+%5BNAS,+2015%5D+National+Research+Council.+(2015).+Cost,+effectiveness,+and+deployment+of+fuel+economy+technologies+for+light-duty+vehicles.+National+Academies+Press.&ots=lzZxdfFGCq&sig=4SuXO0qT3qT2FkhtqIVv7RPVTm0#v=onepage&q&f=false **[cited by the agencies in the Proposed Rule]**
Nelson & Kennedy (2009)	Jon P. Nelson & Peter E. Kennedy, *The Use (and Abuse) of Meta-Analysis in Environmental and Natural Resource Economics: An Assessment*, 42 Environmental and Resource Economics 345 (2009). https://link.springer.com/content/pdf/10.1007%2Fs10640-008-9253-5.pdf
Newell & Stavins (2003)	Richard G. Newell & Robert N. Stavins, *Cost Heterogeneity and the Potential Savings from Market-Based Policies*, 23 J. Regul. Econ. 43-59, 56 (2003) https://link.springer.com/article/10.1023/A:1021879330491
Newell et al. (2014)	Richard G. Newell, William A. Pizer & Daniel Raimi, *Carbon Market Lessons and Global Policy Outlook*, 343 Science 1316 (2014). http://applcc.org/plan-design/climate-context/cc-resources/ClimateSciPDFs/Science2014Newell13167.pdf/at_download/file
NHTSA (2012)	United States Department of Transportation National Highway Traffic Safety Administration ("NHTSA"), *Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY 2025 Passenger Cars and Light Trucks*, (2012). https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/fria_2017-2025.pdf **[cited by the agencies in the Proposed Rule]**

Shortcite	Article
NHTSA (2013a)	United States Department of Transportation National Highway Traffic Safety Administration ("NHTSA"), *Relationships between Fatality Risk, Mass, and Footprint in Model Year 2000-2007 and in Future Passenger Cars and LTVs*, (2013). https://policyintegrity.org/documents/NHTSA_%282013%29_slide.pdf **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
NHTSA (2013b)	United States Department of Transportation National Highway Traffic Safety Administration ("NHTSA"), *How Vehicle Age and Model Year Relate to Driver Injury Severity in Fatal Crashes*, (2013). https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811825 **[cited by the agencies in the Proposed Rule]**
NHTSA (2017)	United States Department of Transportation National Highway Traffic Safety Administration ("NHTSA"), *2011 Tire Pressure Monitoring Systems Special Study: User's Coding Manual*, (2017). https://crashstats.nhtsa.dot.gov/Api/Public/Publication/812410
NHTSA (2018)	United States Department of Transportation National Highway Traffic Safety Administration ("NHTSA"), *Passenger Vehicle Occupant Injury Severity by Vehicle Age and Model Year in Fatal Crashes*, (2018). https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812528 **[cited by the agencies in the Proposed Rule]**
Nocera et al. (2015)	Silvio Nocera, Stefania Tonin & Frederico Cavallaro, *The Economic Impact of Greenhouse Gas Abatement through a Meta-Analysis: Valuation, Consequences and Implications in terms of Transport Policy*. 37 Transport Policy 31 (2015). http://www.sciencedirect.com/science/article/pii/S0967070X14002030
Noland (2004)	Robert B. Noland, *Motor Vehicle Fuel Efficiency and Traffic Fatalities*, 25 The Energy Journal 1 (2004). https://www.jstor.org/stable/pdf/41323355.pdf
Nordhaus (2014)	William D. Nordhaus, *Estimates of the Social Cost of Carbon: Concepts and Results from the DICE-2013R Model and Alternative Approaches*, 1 Journal of the Association of Environmental and Resource Economists 273 (2014). https://www.jstor.org/stable/pdf/10.1086/676035.pdf **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
Nordhaus (2017)	William D. Nordhaus, *Revisiting the Social Cost of Carbon*, 114 PNAS 1518 (2017). http://www.pnas.org/content/114/7/1518 **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**

Shortcite	Article
OMB (2003)	United States Office of Management and Budget ("OMB"), *Circular A-4*, (2003). https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A4/a-4.pdf **[cited by the agencies in the Proposed Rule]**
Oviedo-Trespalacios & Scott-Parker (2018)	Oscar Oviedo-Trespalacios & Bridie Scott-Parker, *Young Drivers and Their Cars: Safe and Sound or the Perfect Storm?*, 110 Accident Analysis & Prevention 18 (2018). https://doi.org/10.1016/j.aap.2017.09.008
Parks (1977)	Richard W. Parks, *Determinants of Scrapping Rates for Postwar Vintage Automobiles*, 45 Econometrica 1099 (1977). https://www.jstor.org/stable/pdf/1914061.pdf **[cited by the agencies in the Proposed Rule]**
Peterson (2006)	Sonja Peterson, *Uncertainty and Economic Analysis of Climate Change: A Survey of Approaches and Findings*, 11 Environmental Modeling & Assessment 1 (2006). https://link.springer.com/article/10.1007/s10666-005-9014-6
Pindyck (2007)	Robert S. Pindyck, *Uncertainty in Environmental Economics*, 1 Review of environmental economics and policy 45 (2007). http://web.mit.edu/rpindyck/www/Papers/UncertEnvironEconPrinted_version.pdf
Pindyck (2011)	Robert S. Pindyck, *Fat Tails, Thin Tails, and Climate Change Policy*, 5 Review of Environmental Economics and Policy 258 (2011). https://academic.oup.com/reep/article/5/2/258/1564926
Pindyck (2013)	Robert S. Pindyck, *Climate Change Policy: What Do the Models Tell Us?*, 51 Journal of Economic Literature 860 (2013). http://web.mit.edu/rpindyck/www/Papers/PindyckClimateModelsJELSept2013.pdf
Pindyck (2016)	Robert S. Pindyck, *The Social Cost of Carbon Revisited*, (National Bureau of Economic Research Working Paper No. 22807, 2016). http://web.mit.edu/rpindyck/www/Papers/SCCRevisitedNov2016.pdf
	William A. Pizer, *Combining price and quantity controls to mitigate global climate change*, 85 J. Public Econ. 431 (2002)

Shortcite	Article
Puckett & Kindelberger (2016)	Sean M. Puckett & John C. Kindelberger, *Relationships between Fatality Risk, Mass, and Footprint in Model Year 2003-2010 Passenger Cars and LTVs – Preliminary Report*, (Docket No. NHTSA-2016-0068, 2016). https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/2016-prelim-relationship-fatalityrisk-mass-footprint-2003-10.pdf **[cited by the agencies in the Proposed Rule]**
Rao et al. (2006)	Shilpa Rao, Ilkka Keppo & Keywan Riahi, *Importance of Technological Change and Spillovers in Long-Term Climate Policy*, 27 The Energy Journal, 123 (2006). https://www.jstor.org/stable/pdf/23297059.pdf
Rekhadevi (2010)	Perumalla Rekhadevi, *Genotoxicity in Filling Station Attendants Exposed to Petroleum Hydrocarbons*, 54 Annals Occupational Hygiene 944 (2010). https://academic.oup.com/annweh/article/54/8/944/170263
Revesz et al. (2014)	Richard L. Revesz, Peter H. Howard, Kenneth Arrow, Lawrence H. Goulder, Robert E. Kopp, Michael A. Livermore, Michael Oppenheimer & Thomas Sterner, *Global Warming: Improve Economic Models of Climate Change*, 508 Nature 173 (2014). http://www.homepages.ed.ac.uk/shs/Climatechange/Geo-politics/Revesz%20economic%20models.pdf
Revesz (2014)	Richard L. Revesz, *Quantifying Regulatory Benefits*, 102 Calif. L. Rev. 1423 (2014). https://scholarship.law.berkeley.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=4266&context=californialawreview
Revesz et al. (2017)	Richard L. Revesz, M. Greenstone, M. Hanemann, Michael Livermore, T. Sterner, Denise Grab, Peter Howard & Jason Schwartz, *Best Cost Estimate of Greenhouse Gases*, 357 Science 6352 (2017). http://science.sciencemag.org/content/sci/357/6352/655.full.pdf
Revesz et al. (2017)	Richard L. Revesz, Jason A. Schwartz, Peter H. Howard, Kenneth Arrow, Michael A. Livermore, Michael Oppenheimer & Thomas Sterner, *The Social Cost of Carbon: A Global Imperative*, 11 REEP 172 (2017). https://academic.oup.com/reep/article/11/1/172/3066310
Reyna & Brainerd (2008)	Valerie F. Reyna & Charles J. Brainerd, *Numeracy, Ratio Bias, and Denominator Neglect in Judgements of Risk and Probability*, 18 Learning and Individual Differences 89 (2008). https://doi.org/10.1016/j.lindif.2007.03.011
Rhodes (2012)	William Rhodes, *Meta-Analysis: An Introduction Using Regression Models*, 36 Evaluation review 24 (2012). http://journals.sagepub.com/doi/pdf/10.1177/0193841X12442673

Shortcite	Article
Roberts & Spence (1976)	Marc J. Roberts & Michael Spence, *Effluent charges and licences under uncertainty*, 5 J. Public Econ. 203 (1976)
Rowell (2015)	Arden Rowell, *Foreign Impacts and Climate Change*, 39 Harvard Environmental Law Rev. 371 (2015). http://harvardelr.wpengine.com/wp-content/uploads/2015/07/Rowell-39-HELR-371.pdf
Rubin, et al. (2009)	Jonathan Rubin, Paul N. Leiby & David L. Greene, *Tradable Fuel Economy Credits: Competition and Oligopoly*, 58 J. Environ. Econ. Manage. 315–328 (2009) https://www.sciencedirect.com/science/article/pii/S0095069609000539
Ryb et al. (2013)	Gabriel E. Ryb, Patricia C. Dischinger, Michael Kleinberger, Gerald McGwin & Ruseell L. Griffin, *Aortic Injuries in Newer Vehicles*, 59 Accident Analysis & Prevention 253 (2013). https://doi.org/10.1016/j.aap.2013.06.007
Sallee (2014)	James M. Sallee, *Rational Inattention and Energy Efficiency*, 57 J. Law & Econ. 781 (2014). http://www.journals.uchicago.edu/doi/pdfplus/10.1086/676964
Sallee et al. (2016)	James M. Sallee, Sarah E. West & Wei Fan, *Do Consumers Recognize the Value of Fuel Economy? Evidence from Used Car Prices and Gasoline Price Fluctuations*, 135 Journal of Public Economics 61 (2016). https://doi.org/10.1016/j.jpubeco.2016.01.003 **[cited by the agencies in the Proposed Rule]**
Sandler (2012)	Ryan Sandler, *Clunkers or Junkers? Adverse Selection in a Vehicle Retirement Program*, 4 American Economic Journal: Economic Policy 253 (2012). https://www.jstor.org/stable/pdf/23358252.pdf
Sargent (1987)	Thomas Sargent, *Lucas's Critique*, in *Macroeconomic Theory* (1987).
Schimek (1996)	Paul Schimek, *Gasoline and Travel Demand Models Using Time Series and Cross-Section Data from United States*, 1558 Transportation Research Record 83 (1996). https://doi.org/10.1177/0361198196155800112
Schwarcz (2008)	Steven L. Schwarcz, *Systemic Risk*, 97 Geo. L.J. 193, 249 (2008). http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2549&context=faculty_scholarship
Schwartz (2017)	Jason A. Schwartz, *Marketable Permits: Recommendations on Applications and Management*, (Consultant Report to ACUS, 2017). https://www.acus.gov/sites/default/files/documents/Marketable%20Permits%20Report-final.pdf

Shortcite	Article
Small & van Dender (2007)	Kenneth A. Small & Kurt van Dender, *Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect*, 28 The Energy Journal 25 (2007). https://www.jstor.org/stable/pdf/41323081.pdf **[cited by the agencies in the Proposed Rule]**
Sorrell et al. (2009)	Steve Sorrell, John Dimitropoulos & Matt Sommerville, *Empirical Estimates of the Direct Rebound Effect: A Review*, 37 Energy Policy 1356 (2009). https://www.sciencedirect.com/science/article/pii/S0301421508007131
Sorrell & Dimitropoulos (2008)	Steve Sorrell & John Dimitropoulos, *The Rebound Effect: Microeconomic Definitions, Limitations and Extensions*, 65 Ecological Economics 636 (2008). https://www.sciencedirect.com/science/article/pii/S0921800907004405
Steinmaus & Smith (2017)	Chraig Steinmaus & Martyn Smith, Response to *Proximity to Gasoline Stations and Childhood Leukemia*, 185 Am. J. Epidemiology 5 (2017). https://doi.org/10.1093/aje/kww133
Stock & Watson (2007)	James H. Stock & Mark Watson, Introduction to Econometrics (2nd ed. 2007).
Stranlund (2016)	John K Stranlund, *The Economics of Enforcing Emissions Markets: A Review of the Literature*, 11 Rev. Environ. Econ. Policy 227–246 (2016) https://www.semanticscholar.org/paper/The-Economics-of-Enforcing-Emissions-Markets-%3A-A-of-Stranlund/bb1487cdd332520d5142d5de1142373e02209906
Sunstein (2002)	Cass R. Sunstein, *Probability Neglect: Emotions, Worst Cases, and Law*, 112 Yale L. J. 61 (2002). https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=12421&context=journal_articles
Thureson (2016)	Disa Thureson, *Temporal Aspects of the Social Cost of Greenhouse Gases* (Örebro University-Swedish Business School Working Paper No. 3/2012, 2016). http://www.diva-portal.org/smash/get/diva2:952359/FULLTEXT01.pdf
Tierney & Hibbard (2018)	Susan F. Tierney & Paul J. Hibbard, *Vehicle Fuel-Economy and AirPollution Standards: A Literature Review of the Rebound Effect*, Analysis Group (2018). http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/ag_fuel_economy_rebound_effect_june_2018.pdf
Tol (1999)	Richard S.J. Tol, *Safe Policies in an Uncertain Climate: An Application of FUND*, 9 Global Environmental Change 221 (1999). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.175.5862&rep=rep1&type=pdf

Shortcite	Article
Tol (2012)	Richard S.J. Tol, On the Uncertainty About the Total Economic Impact of Climate Change, 53 Environmental and Resource Economics 97 (2012). https://link.springer.com/article/10.1007/s10640-012-9549-3
Tol (2013)	Richard S.J. Tol, *Targets for Global Climate Policy*: *An Overview*, 37 Journal of Economic Dynamics & Control 911 (2013). https://www.parisschoolofeconomics.eu/IMG/pdf/tol_paper.pdf
Tol (2015)	Richard S.J. Tol, *Economic Impacts of Climate Change*, (University of Sussex Department of Economics Working Paper No. 7515, 2015). https://ideas.repec.org/p/sus/susewp/7515.html
Tolouei (2015)	Reza Tolouei, *Carbon Policies Targeting Road Transport: Is There a Safety Consequence?*, 8 Transportation Research Procedia 259 (2015). https://doi.org/10.1016/j.trpro.2015.06.060
Traeger (2014)	Christian P. Traeger, *On Option Values in Environmental and Resource Economics*, 37 Resource and Energy Economics 242 (2014). https://ideas.repec.org/a/eee/resene/v37y2014icp242-252.html
van Wee et al. (2011)	Bert van Wee, Gerard De Jong & Hans Nijland, *Accelerating Car Scrappage: A Review of Research into the Environmental Impacts*, 31 Transport Reviews 549 (2011). https://www.tandfonline.com/doi/full/10.1080/01441647.2011.564331
Verhoef (2000)	Erik Verhoef & Bert van Wee, *Car Ownership and Statu* (Tinbergen Institute Discussion Paper No. 00-076/3, 2000). https://www.econstor.eu/bitstream/10419/85634/1/00076.pdf
Verhoef & Wee (2000)	Erik Verhoef & Bert van Wee, *Car Ownership and Status: Implications for Fuel Efficiency Policies from the Viewpoint of Theories of Happiness and Welfare Economics* 4 (Tinbergen Institute Discussion Paper TI 2000-076/3, 2000) https://www.tudelft.nl/tbm/over-de-faculteit/afdelingen/engineering-systems-and-services/research/ejtir/back-issues/volume0-2000/
Walker (1968)	Franklin V. Walker, *Determinants of Auto Scrappage*, 50 The Review of Economics and Statistics 503 (1968). https://www.jstor.org/stable/pdf/1926820.pdf **[cited by the agencies in the Proposed Rule]**
Wang & Chen (2014)	Tingting Wang & Cynthia Chen, *Impact of Fuel Price on Vehicle Miles Traveled (VMT): Do the Poor Respond in the Same Way as the Rich?*, 41 Transportation 91 (2014). https://link.springer.com/article/10.1007%2Fs11116-013-9478-1

Shortcite	Article
Weiss & Fershtman (1998)	Yoram Weiss & Chaim Fershtman, *Social Status and Economic Performance: A Survey*, 42 Euro. Econ. Rev 801 (1998). http://tau.ac.il/~fersht/Papers/1998%20Social%20status%20and%20economic%20performance%20-%20A%20survey.pdf
Weitzman (2001)	Martin L. Weitzman, *Gamma Discounting*, 91 Am. Econ. Rev. 260 (2001). https://scholar.harvard.edu/files/weitzman/files/gamma_discounting.pdf
Weitzman (2009)	Martin L. Weitzman, *On Modeling and Interpreting the Economics of Catastrophic Climate Change*, 91 The Review of Economics and Statistics 1 (2009). https://dash.harvard.edu/handle/1/3693423
Weitzman (2011)	Martin L. Weitzman, *Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change*, 5 Review of Environmental Economics and Policy 275 (2011). https://scholar.harvard.edu/files/weitzman/files/fattaileduncertaintyeconomics.pdf
Wenzel (2012)	Tom Wenzel, *Assessment of NHTSA's Report "Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2000-2007 Passenger Cars and LTVs"*, (2012). https://pubarchive.lbl.gov/islandora/object/ir%3A5698E **[cited by the agencies in the Proposed Rule]**
Wenzel (2013a)	Tom Wenzel, *The Effect of Recent Trends in Vehicle Design on US Societal Fatality Risk Per Vehicle Mile Traveled, and Their Projected Future Relationship with Vehicle Mass*, 56 Accident Analysis & Prevention 71 (2013). https://www.sciencedirect.com/science/article/pii/S0001457513001176
Wenzel (2013b)	Tom Wenzel, *The Estimated Effect of Mass or Footprint Reduction in Recent Light-Duty Vehicles on U.S. Societal Fatality Risk per Vehicle Mile Traveled*, 59 Accident Analysis & Prevention 267 (2013). https://www.sciencedirect.com/science/article/pii/S0001457513002467
Wenzel (2016a)	Tom Wenzel, *Effect of Using Different Vehicle Weight Groups on the Estimated Relationship between Mass Reduction and U.S. Societal Fatality Risk per Vehicle Miles of Travel*, (LBNL Report No. LBNL-1006317, 2016). https://escholarship.org/uc/item/1wv8396d
Wenzel (2016b)	Tom Wenzel, *Assessment of DRI's Two-Stage Logistic Regression Model Used to Simultaneously Estimate the Relationship between Vehicle Mass or Size Reduction and U.S. Fatality Risk, Crashworthiness/Compatibility, and Crash Avoidance*, (LBNL Report No. LBNL-1005830, 2016). https://escholarship.org/uc/item/277776rs

Shortcite	Article
Wenzel (2016c)	Tom Wenzel, *Sensitivity of Light-Duty Vehicle Crash Frequency per Vehicle Mile of Travel to Additional Vehicle and Driver Variables*, (LBNL Report No. LBNL- 1005831, 2016). https://escholarship.org/uc/item/70h04326
Wenzel (2016d)	Tom Wenzel, *Relationship between US Societal Fatality Risk per Vehicle Miles of Travel and Mass, for Individual Vehicle Models over Time (Model Year)*, (LBNL Report No. LBNL- 1006316, 2016). https://escholarship.org/uc/item/6jk2r1pq
Wenzel (2016e)	Tom Wenzel, *Effect of Accounting for Crash Severity on the Relationship between Mass Reduction and Crash Frequency and Risk per Crash*, (LBNL Report No. LBNL- 1005832, 2016). https://pubarchive.lbl.gov/islandora/object/ir%3A1005832
Wenzel (2018)	Tom Wenzel, *Assessment of NHTSA's Report "Relationships Between Fatality Risk, Mass, and Footprint in Model Year 2004-2011 Passenger Cars and LTVs"*, (LBNL Phase 1, 2018). https://escholarship.org/uc/item/4726g6jq **[cited by the agencies in the Preliminary Regulatory Impact Analysis]**
Wenzel & Fujita (2018)	Tom Wenzel & K. Sydny Fujita, *Elasticity of Vehicle Miles of Travel to Changes in the Price of Gasoline and the Cost of Driving in Texas*, (LBNL Report No. LBNL- 2001138, 2018). https://escholarship.org/uc/item/3pr533kp
West (2004)	Sarah E. West, *Distributional Effects of Alternative Vehicle Pollution Control Policies*, 88 Journal of Public Economics 735 (2004). https://doi.org/10.1016/S0047-2727(02)00186-X
Whittington & MacRae (1986)	Dale Whittington & Duncan MacRae, Jr., *The Issue of Standing in Cost-Benefit Analysis*, 5 J. Pol'y Analysis & Mgmt. 665 (1986). https://doi.org/10.1002/pam.4050050401
Wooldridge (2009)	Jeffrey M. Wooldridge, *Introductory Econometrics*, 4 South-Western Cengage Learning 137 (2009).
Yonyang et al. (2016)	Cai Yongyang, Timothy M. Lenton & Thomas S. Lontzek, *Risk of Multiple Interacting Tipping Points Should Encourage Rapid CO2 Emission Reduction*, 6 Nature Climate Change 520 (2016). https://www.nature.com/articles/nclimate2964
Youngs (2006)	Jeff Youngs, *2007 APEAL Study Results*, (2006). https://web.archive.org/web/20160514230140/http://www.jdpower.com/cars/articles/jd-power-studies/2007-apeal-study-results
Zuo (2015)	Yiou Zuo, *Three Essays on Urban Transportation and the Environment*, (2015). https://hdl.handle.net/1813/39439

<u>ORAL ARGUMENT NOT YET SCHEDULED</u>

IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT
No. 20-1145 (and consolidated cases)

COMPETITIVE ENTERPRISE INSTITUTE et al.,

Petitioners,

v.

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION et al.,

Respondents.

On Petition for Review of Final Action by the National Highway Traffic Safety Administration and Environmental Protection Agency
85 Fed. Reg. 24,174 (Apr. 30, 2020)

BRIEF OF THE INSTITUTE FOR POLICY INTEGRITY AT NEW YORK UNIVERSITY SCHOOL OF LAW AS AMICUS CURIAE IN SUPPORT OF STATE AND LOCAL GOVERNMENT, PUBLIC INTEREST ORGANIZATION, AND ADVANCED ENERGY AND TRANSPORTATION PETITIONERS

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January 21, 2021

CERTIFICATE AS TO PARTIES, RULINGS, AND RELATED CASES

As required by Circuit Rule 28(a)(1), counsel for the Institute for Policy Integrity at New York University School of Law certifies as follows:

1) All parties, amici, and intervenors appearing in this case are listed in the Opening Brief of Public Interest Organization Petitioners, except for the following amici curiae who noticed their intention to participate in this case after January 14, 2021: Coalition to Protect America's National Parks, National Parks Conservation Association, and New Mexico Wilderness Alliance; American Thoracic Society, American Lung Association, American Medical Association, and Medical Society of the District of Columbia; National League of Cities, U.S. Conference of Mayors, Annapolis, Boulder County, Glen Rock, Harris County, Tx., Houston, Minneapolis, Pittsburgh, Providence, Saint Paul, Salt Lake City, Santa Fe, and the Mayors of Durham, Fayetteville, Las Cruces, and Phoenix; Andrew Dessler, Philip Duffy, Michael MacCracken, James McWilliams, Noelle Eckley Selin, Drew Shindell, James Stock, Kevin Trenberth, and Gernot Wagner; Michael Greenstone; Consumer Reports; and the Institute for Policy Integrity.

2) References to the final agency action under review and related and consolidated cases appear in the Opening Brief of Public Interest Organization Petitioners.

RULE 26.1 DISCLOSURE STATEMENT

The Institute for Policy Integrity ("Policy Integrity") is a nonpartisan, not-for-profit organization at New York University School of Law.[i] Policy Integrity has no parent companies. No publicly held entity owns an interest in Policy Integrity. Policy Integrity does not have any members who have issued shares or debt securities to the public.

[i] This brief does not purport to represent the views, if any, of New York University School of Law.

STATEMENT REGARDING SEPARATE BRIEFING, AUTHORSHIP, AND MONETARY CONTRIBUTIONS

Because a single joint brief of all amici is not practicable in this case given the numerous factual and legal issues at stake, the Institute for Policy Integrity files this separate amicus brief in compliance with the word limits set forth in this Court's Order of October 19, 2020. All parties granted blanket consent to amicus filings by notice dated December 21, 2020.

Under Federal Rule of Appellate Procedure 29(a)(4)(E), Policy Integrity states that no party's counsel authored this brief in whole or in part, and no party or party's counsel contributed money intended to fund the preparation or submission of this brief. No person contributed money intended to fund the preparation or submission of this brief.

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

Pursuant to Circuit Rule 28(a)(3), the following is a glossary of acronyms and abbreviations used in this brief:

EPA	Environmental Protection Agency
EPCA	Energy Policy and Conservation Act
Final Rule	The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 85 Fed. Reg. 24,174 (Apr. 30, 2020)
GHG	Greenhouse Gas
NHTSA	National Highway Traffic Safety Administration

INTEREST OF AMICUS CURIAE AND AUTHORITY TO FILE

The Institute for Policy Integrity at New York University School of Law ("Policy Integrity") submits this amicus curiae brief in support of the challenges by Coordinating Petitioners to The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 85 Fed. Reg. 24,174 (Apr. 30, 2020) ("Final Rule").

The Final Rule was promulgated by the Environmental Protection Agency and National Highway Traffic Safety Administration ("EPA" and "NHTSA" or, collectively, "the agencies"), and reduces the stringency of greenhouse gas ("GHG") standards and fuel-economy standards that were promulgated in the 2012 rule, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 15, 2012) ("pre-existing standards"), while also setting new fuel-economy standards for model years 2022–2026. All parties consent to this filing, pursuant to the blanket consent filed on December 21, 2020.

Policy Integrity is a nonpartisan, not-for-profit think tank dedicated to improving the quality of government decisionmaking through advocacy and scholarship in the fields of administrative law, economics, and public policy, with a primary focus on environmental issues. Our economists and lawyers have produced extensive scholarship on the use of economic analysis in regulatory decisionmaking, including on the balanced consideration of costs and benefits. Our director, Professor Richard L. Revesz, has published over eighty articles and books on environmental and administrative law, including many on the legal and economic principles informing rational regulatory decisions.[1] And our staff has written extensively on important considerations in regulatory impact analysis including consumer valuation, discounting, and the role of regulators in promoting societal benefits.

Most relevant for this proceeding, Policy Integrity has submitted extensive comments and published scholarship on both the proposed and finalized versions of the Final Rule. Policy Integrity submitted several sets of comments on the regulatory proposal for the Final Rule criticizing the agencies' disregard for key forgone benefits and explaining that their economic justifications for the rule were fundamentally flawed.[2] And since the rule was finalized, Policy Integrity has authored several reports highlighting critical errors in the agencies' economic justifications.[3] As those comments and reports explain, the agencies not only understate critical economic, health, and environmental harms resulting from the Final Rule, but also fail to supply a reasoned explanation for the rule that justifies

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[1] A full list of publications is on Prof. Revesz's profile, https://its.law.nyu.edu/facultyprofiles/index.cfm?fuseaction=profile.publications&personid=20228.

[2] *Available at* https://policyintegrity.org/projects/update/comments-on-vehicle-emissions-standards.

[3] *Available at* https://policyintegrity.org/projects/update/report-series-the-flawed-analysis-underlying-the-rollback-of-the-clean-car-standards.

the harms they do acknowledge—which, as explained herein, outweigh the rule's purported benefits under the agencies' own analysis.

In this case, Coordinating Petitioners contend that the agencies fail to provide a reasoned explanation for this rollback, as they do not adequately consider or reasonably weigh critical harms such as increases in pollution and fuel usage. *See, e.g.*, Brief of State and Local Government Petitioners 87–91 ("State Br.") (explaining that the Final Rule "would impose substantial net costs"); *id.* at 50–95 (detailing numerous errors in agencies' cost-benefit analysis); Brief of Public Interest Organization Petitioners 8–40 ("Pub. Inter. Br.") (explaining how agencies undervalue pollution harms and overvalue cost savings and other impacts). Policy Integrity's experience with the Final Rule and expertise in the assessment of regulatory impacts give it a unique perspective on these arguments.

SUMMARY OF ARGUMENT

As Coordinating Petitioners and other amici argue, the agencies consistently elevate unsound assumptions over empirical evidence to understate the harms and inflate the benefits of the Final Rule. But even setting aside those fatal errors, the agencies' analysis of regulatory costs and benefits still does not justify the Final Rule, and in fact contradicts the rationales that the agencies proffer in several key respects. This brief focuses on the agencies' decision to adopt a net-costly rule and on economic problems with their justifications for that decision.

The agencies' own analysis concludes that the Final Rule causes more economic, health, and environmental costs than benefits, *infra* at pp. 7–9, making it a regulation that does "significantly more harm than good," which the Supreme Court has characterized as inappropriate, *Michigan v. EPA*, 576 U.S. 743, 752 (2015). Yet the agencies obfuscate this conclusion, sweep it aside, and proceed anyway under the vague and unsubstantiated theory that upfront costs to comply with the pre-existing standards were "too high," 85 Fed. Reg. at 24,176. In doing so, they unreasonably dismiss the fact that costs under the rollback—such as forgone fuel savings and health benefits that are of critical significance under the governing statutes—are, according to the agencies' own analysis, even greater. By "rely[ing] on considerations beyond net benefits" in this manner, *id.* at 25,172—that is, arbitrarily prioritizing smaller purported regulatory benefits over larger costs—the agencies fail to "reasonabl[y] balance" regulatory impacts as they purport to do, *id.* at 24,176, 24,181.

Moreover, while the agencies emphasize several purported regulatory impacts to support their outsized focus on upfront cost savings, their rationales are unavailing and frequently belied by their own analysis. For instance, while the agencies suggest that "the $26.1 billion in private losses to consumers" from the Final Rule can be dismissed because impacts such as fuel expenses are felt over time and consumers "may have time preferences that cause them to discount the future" at extremely high rates, *id.* at 24,612, this claim violates not only common sense and voluminous regulatory precedent but also the agencies' own analysis, which concludes that consumers benefit from long-term fuel savings and are thus greatly harmed by the excess costs imposed by this rule, *id.* at 24,201–08 (counting full "retail fuel savings" as a forgone benefit). Likewise, while the agencies tout the possibility that the Final Rule will enable "more consumers . . . to afford new vehicles, which will result in a quicker fleet turnover to safer, more efficient vehicles," *id*. at 25,111, that assertion disregards their own conclusion that the rule's countervailing harms will have a far greater effect, *see, e.g.*, *id.* at 24,203 (showing that rule is net costly).

With only unsupported and one-sided rationales to buttress a net-costly rule, the agencies fail to provide a "reasoned explanation" for rolling back the pre-existing standards. *Fed. Commc'ns Comm'n v. Fox Television Stations, Inc.*, 556 U.S. 502, 516 (2009). For this reason, the Final Rule violates the Administrative Procedure Act's and Clean Air Act's standards of rationality and must be vacated.

ARGUMENT

THE AGENCIES IRRATIONALLY PROMULGATE A RULE THAT CAUSES MORE HARM THAN GOOD

Final agency actions are arbitrary and capricious under the Administrative Procedure Act, 5 U.S.C. § 706(2), if the agency fails to "examine the relevant data," "consider an important aspect of the problem," or "articulate a satisfactory explanation for its action including a rational connection between the facts found and the choice made." *Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983) (internal quotation marks omitted).[4]

Under that standard, a failure to adequately consider the costs of a rulemaking can be fatal. Cost—meaning "any disadvantage" resulting from a rule, including "harms that regulation might do to human health or the environment"—is typically a "centrally relevant factor when deciding whether to regulate." *Michigan*, 576 U.S. at 752–53. Failing to sufficiently "account for" harms that are "matter[s] of importance under the statute," *Gresham v. Azar*, 950 F.3d 93, 102 (D.C. Cir. 2020), *cert. granted* (Dec. 4, 2020), and forgone benefits in a regulatory rollback, *see Air All. Houston v. EPA*, 906 F.3d 1049, 1068 (D.C. Cir. 2018), is especially problematic.

The agencies violate these principles in the Final Rule, as despite their own finding that the costs of the rollback exceed the benefits, the agencies puzzlingly "plac[e] greater weight" on those supposed benefits in deciding to roll back the pre-existing standards, 85 Fed. Reg. at 25,114, and attempt to bolster them with theories that are contradicted by their own analysis. This lopsided approach to regulation—

[4] EPA promulgates the Final Rule under the Clean Air Act, which supplies its own arbitrary-and-capricious requirement, 42 U.S.C. § 7607(d)(9)(A). This Court "appl[ies] the same standard of review under the Clean Air Act as [it] do[es] under the Administrative Procedure Act." *Maryland v. EPA*, 958 F.3d 1185, 1196 (D.C. Cir. 2020) (internal quotation marks omitted).

relying on smaller and unsupported benefits as the basis to incur larger and substantiated costs—is irrational.

A. The Agencies' Own Analysis Shows That the Final Rule Is Net Costly

As is standard practice for major rulemakings, the agencies prepare a regulatory impact analysis of the Final Rule in which they quantify expected regulatory costs and compare them to the rule's purported benefits. EPA & NHTSA, Final Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks (2020) ("Final Rule RIA"). As detailed herein, this analysis concludes that the Final Rule's costs likely exceed its benefits by billions of dollars.

As noted above, costs in a regulatory analysis encompass not only "adverse effects on the efficient functioning of the economy [and] private markets" but also harms to "health, safety, and the natural environment." Exec. Order No. 12,866, § 6(a)(3)(C), 58 Fed. Reg. 51,735 (Oct. 4, 1993). In their analysis, therefore, the agencies assess, quantify, and compare various "good and bad" regulatory impacts—consumer purchase-price savings against increased fuel usage, alleged safety benefits against health damage from greater pollution, to name a few—to determine if "the benefits of [the Final Rule] are likely to justify the costs." Office of Mgmt. & Budget, Circular A-4 on Regulatory Analysis 2 (2003) ("Circular A-4"). The agencies then hold up their analysis as "supporting" the Final Rule, 85 Fed. Reg. at

24,613, and repeatedly showcase its various findings, *see, e.g.*, *id.* at 24,178–81 (detailing results at top of preamble).

The analysis's ultimate takeaway is that the Final Rule's costs exceed its benefits. For instance, the agencies project that the rule's GHG standards will result in $22 billion in net costs when analyzed at a 3% discount rate (*i.e.*, the annual rate of converting future impacts to present value). *Id*. at 24,181 tbl.I-6. This is very problematic, given that longstanding executive guidance directs agencies to regulate in a manner that "maximize[s] net benefits." Exec. Order No. 12,866, § 1(a).

To be sure, the agencies find that the GHG standards result in net benefits of $6 billion when assessed at a 7% discount rate. 85 Fed. Reg. at 24,181 tbl.I-6. The rule appears more beneficial at that discount rate because its harms, such as fuel costs and environmental impacts, occur, on average, later in time than its purported benefits, so applying a higher discount rate decreases the costs estimate more than the benefits estimate. In addition, as Coordinating Petitioners argue, the agencies only find net benefits under the higher discount rate due to analytical errors. State Br. 88; Pub. Inter. Br. 32 & n.15. In any event, even if their analysis were accurate, the agencies express no preference for that higher rate, and acknowledge that discount rates of 3% or lower are appropriate for rulemakings like this one that impose long-term climate harm. 85 Fed. Reg. at 24,735.

Even setting aside that concession and assuming that the agencies are agnostic about the proper discount rate, longstanding guidance counsels agencies to assess "the average or the expected value of benefits and costs" when key parameters are uncertain. Circular A-4 at 42. Indeed, when assessing regulatory impacts of the Final Rule that are uncertain, such as alleged effects on purchase prices and fuel economy, the agencies repeatedly use averaging. *See, e.g.*, 85 Fed. Reg. at 24,186 (referring to averaging numerous times). Here, as noted above, there is alleged uncertainty about the direction of net impacts because the agencies' projections show that the rule is net costly at a 3% discount rate, but not under a 7% discount rate. And averaging the results at both discount rates makes clear that the Final Rule is net costly, with costs of the GHG standards that exceed purported benefits by $8 billion.[5]

A closer look at the agencies' analysis reveals the severity of these costs. The agencies project that the Final Rule will increase gasoline consumption by 78 to 84 billion gallons by pushing consumers into less-efficient vehicles, costing the average driver $1,110 to $1,461 in excess fuel costs per vehicle. *Id.* at 24,180–81 tbls.I-5 &

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[5] This figure represents an average of the purported net benefits of the GHG standards at the 3% (-$22 billion) and 7% (+$6 billion) discount rates. 85 Fed. Reg. at 24,181 tbl.I-6. Using this same methodology, the fuel-economy standards purportedly result in net benefits of $1.5 billion. *See id*. at 24,180 tbl.I-5 (reporting net benefits of -$13 billion at 3% discount rate and +$16 billion at 7% rate). But the fact that the average net costs of the GHG standards ($8 billion) greatly exceed, in absolute terms, the purported average net benefits of the fuel-economy standards ($1.5 billion) strongly indicates that the Final Rule is net costly on the whole, and the agencies offer nothing to doubt that conclusion.

I-6.[6] Pollution impacts are similarly jarring, as the agencies project that the rule will result in 867 to 923 million additional metric tons of carbon dioxide emissions, *id*. at 24,176, causing more than $40 billion in total climate harm, Final Rule RIA at 1803 (projecting global climate damages at 3% discount rate), along with increases in local pollution causing "premature deaths, asthma exacerbation, respiratory symptoms, non-fatal heart attacks, and a wide range of other health impacts," 85 Fed. Reg. at 25,112.[7]

In short, the agencies conclude that the Final Rule causes significantly more harm than good. And as detailed below, they fail to provide any rationale that can reasonably justify this net-costly rule.

B. The Agencies Fail to Provide a Reasoned Explanation for Issuing a Net-Costly Rule

Despite projecting that the Final Rule is net costly, the agencies nonetheless claim that the rule is desirable because upfront costs—that is, the "costs to both industry and automotive consumers" of the pre-existing standards—were "too high"

[6] The agencies project an additional 78 billion gallons of fuel consumption for the GHG standards, 85 Fed. Reg at 24,181 tbl.I-6, and 84 billion for the corporate average fuel economy standards, *id.* at 24,180 tbl.I-5. For the sake of simplicity, this brief reports divergent effects between the two standards as ranges.

[7] As Coordinating Petitioners explain, these emissions and forgone fuel savings projections are likely underestimates. *See, e.g.*, State Br. 51–57 (explaining how agencies overstate the transition to newer, cleaner fleet due to Final Rule's alleged cost savings); *id.* at 91–94 (explaining how agencies overstate the "rebound" effect of pre-existing standards).

and that lowering those costs produces alleged emissions and safety benefits. *Id*. at 24,176. But this explanation overlooks the agencies' own finding that the Final Rule's purported cost savings are outweighed by its economic and social harms. In justifying the Final Rule by those alleged cost savings in spite of that finding, the agencies effectively double-count those benefits, and thereby "inconsistently and opportunistically frame[] the costs and benefits of the rule." *Bus. Roundtable v. Secs. & Exch. Comm'n*, 647 F.3d 1144, 1148–49 (D.C. Cir. 2011).

The agencies' approach is irrational. As the Supreme Court has explained, normally "[n]o regulation is 'appropriate' if it does significantly more harm than good." *Michigan*, 576 U.S. at 752 (defining "appropriate" in statutory provision). A "reasonable regulation" thus entails meaningfully considering a rule's "advantages *and* . . . disadvantages." *Id.* at 753. Accordingly, "agencies are ordinarily required to consider the relative costs and benefits of a regulation," *Cooling Water Intake Structure Coal. v. EPA*, 905 F.3d 49, 67 (2d Cir. 2018), and courts strike down regulations when the agency "does not explain why the costs saved were worth the benefits sacrificed," *Pub. Citizen v. Mineta*, 340 F.3d 39, 58 (2d Cir. 2003).

Executive guidance reflects these principles. For instance, the primary Executive Order on regulatory impact analysis, which has been in effect for over twenty-five years, instructs agencies to quantify regulatory impacts and, "unless a statute requires another regulatory approach," to "adopt a regulation only upon a reasoned determination that the benefits . . . justify its costs." Exec. Order No. 12,866, §§ 1(a), (b)(6). And guidance from the Office of Management and Budget on best practices for cost-benefit analysis, which dates to the George W. Bush administration and was endorsed by the Trump administration,[8] similarly advises agencies to regulate in a manner that "generates the largest net benefits to society." Circular A-4 at 2.

By promulgating the Final Rule despite the conclusion of their own analysis that the rule is net costly, the agencies disregard that guidance. Making matters worse, the principal costs of the Final Rule—namely forgone fuel savings and climate benefits—are of critical "importance under the statute[s]" at issue. *Gresham*, 950 F.3d at 102. For instance, "pollution prevention" is the "primary goal" of the Clean Air Act. 42 U.S.C. § 7401(c). And "the need . . . to conserve energy" is a critical factor in setting standards under NHTSA's national fuel-economy program, 49 U.S.C. § 32902(f), which was enacted as part of the Energy Policy and Conservation Act ("EPCA") to preserve "energy supply" following the 1970s energy crisis, *see* 42 U.S.C. § 6201(2).

[8] Office of Mgmt. & Budget, Guidance Implementing Executive Order 13771, at 9 (Apr. 5, 2017).

In light of the fact that the Final Rule "does significantly more harm than good" according to their own analysis, *Michigan*, 576 U.S. at 752, the agencies must at minimum provide "a satisfactory explanation" for the rule that duly considers this "relevant factor[]," *State Farm,* 463 U.S. at 42–43. But the agencies repeatedly muddle their own finding that the Final Rule is net costly. And their justification for the rule—which focuses on upfront cost savings—arbitrarily "put[s] a thumb on the scale" by prioritizing these benefits over the rule's larger costs. *Ctr. for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1198 (9th Cir. 2008). To boot, several of the supposed benefits that the agencies claim justify focusing on upfront cost savings do not find support in their own analysis.

1. The Agencies Repeatedly Obfuscate the Bottom-Line Conclusion of Their Own Analysis

The agencies obscure their presentation of the net costs of this rule in several ways, undermining any attempt to acknowledge or meaningfully assess them.

As detailed above, basic arithmetic (averaging) reveals that the agencies' analysis finds the Final Rule to be net costly. But the agencies never perform that arithmetic, nor clearly acknowledge that the rule is net costly on average. In fact, the phrase "net costly" does not appear in the Final Rule.

Instead, the agencies provide a series of explanations that obfuscate the key takeaway of their cost-benefit analysis. First, they emphasize that the rule's net benefits allegedly "straddle zero," 85 Fed. Reg. at 24,176—a reference to the fact that the rule is purportedly net beneficial at a 7% discount rate but net costly at 3%. *Id.* at 25,172. But "[r]egulators by nature work under conditions of serious uncertainty," and "[t]he mere fact that" that the rule's net impacts are allegedly "uncertain is no justification for disregarding" the cost-benefit analysis's bottom-line findings. *Pub. Citizen v. Fed. Motor Carrier Safety Admin.*, 374 F.3d 1209, 1219, 1221 (D.C. Cir. 2004) (emphasis omitted). Instead of throwing their hands up, the agencies should have "analyze[d] uncertainty," Circular A-4 at 39, and as detailed above, doing so through averaging, *see id.* at 42—a method the agencies otherwise apply to examine the Final Rule's effects—shows that the rule is net costly.

The agencies next suggest that any net costs that may result from the Final Rule are insignificant because they "are very small relative to" certain regulatory effects such as "reduced retail fuel savings." 85 Fed. Reg. at 24,176. But the mere fact that the Final Rule's average net costs are a small fraction of its "$108.6 billion to $185.1 billion" in forgone fuel savings, *id.*, does not mitigate the fact that the rule likely imposes "significantly more harm than good," *Michigan*, 576 U.S. at 752. Indeed, the analysis's average net cost of $8 billion for the GHG standards is a "gargantuan . . . [cost] on its own terms." *Sw. Elec. Power Co. v. EPA*, 920 F.3d 999, 1032 (5th Cir. 2019). And the presence of that substantial net cost is particularly telling in light of the fact that the cost-benefit analysis repeatedly undervalues the rule's harms, as otherwise the agencies would find net costs to be even higher. *See, e.g.*, Pub. Inter. Br. 26–37; State Br. 50–95.

Additionally, while the agencies' own analysis shows that more stringent standards produce greater net benefits (when averaging results at the two discount rates), 85 Fed. Reg. at 24,179 tbls.I-3 & I-4, the agencies obscure that finding too, as they claim that all alternatives have "small" net impacts "ranging from $18.4 billion to -$31.1 billion," without further analysis, *id.* at 24,176–77. But executive guidance instructs agencies to "select those approaches that maximize net benefits" when "choosing among alternative regulatory approaches." Exec. Order No. 12,866, § 1(a). The agencies contradict that guidance by analyzing a limited range of alternatives, *see* 85 Fed. Reg. at 24,179 (most stringent alternative assessed is itself a substantial rollback), not meaningfully assessing their own analysis showing that more stringent alternatives are more beneficial, and failing to provide a rational basis to choose the Final Rule's standards over these alternatives.

By obscuring the finding of their own analysis that the Final Rule is net costly—in violation of regulatory precedent and executive guidance instructing agencies to promote and maximize net benefits—the agencies do not "deal with" the bottom-line finding of their cost-benefit analysis "in a meaningful way." *City & Cty. of San Francisco v. U.S. Citizenship & Immigr. Servs.*, 981 F.3d 742, 760 (9th Cir. 2020).

2. The Agencies Arbitrarily Prioritize Upfront Cost Savings Over More Substantial Regulatory Impacts

While muddling their finding that the Final Rule is net costly, the agencies also seek to justify the rule by claiming that "costs to both industry and automotive consumers would have been too high under the [pre-existing] standards," 85 Fed. Reg. at 24,176. But this is not supported by the record and displays a fundamentally imbalanced approach.

As an initial matter, justifying the Final Rule based on "costs to . . . automotive consumers" blatantly ignores the agencies' own conclusion that consumers would have *saved* money under the pre-existing standards—and thus the Final Rule will result in more consumer cost, not less. This is because, as noted above, while the agencies project that the pre-existing standards would have increased the purchase price of new vehicles, their analysis shows it would also have reduced consumer fuel costs by an even greater amount through efficiency improvements. *Id*. at 24,180–81 tbls.I-5 & I-6 (projecting that Final Rule will lower average purchase price by $977–$1,083 while increasing fuel costs by $1,110–$1,461 per vehicle). In total, the Final Rule thus costs the average consumer between $110 and $678, according to the agencies' estimates, *id.*, resulting in at least "$26.1 billion in private losses to consumers" nationwide, *id.* at 24,612.[9]

[9] The $26.1 billion figure discounts future fuel savings at an annual rate of

Nor are the agencies correct to suggest that most consumers will save much in "upfront purchase prices" through the Final Rule, *id.* at 25,103. This is because, as the agencies acknowledge, the vast majority of vehicle purchases—about 85%—are financed through loans, with an "average finance term length . . . [of] 68 months." *Id.* at 24,706–07. For the vast majority of consumers, therefore, any purchase-price savings from the Final Rule will be spread out over years—during which time they will face increased fuel costs as they drive less-efficient vehicles. The agencies' focus on upfront cost savings effectively disregards the Final Rule's effects on these consumers. By suggesting that all consumers experience upfront cost savings—and not just the 15% of non-financing consumers to whom this rationale is applicable—the agencies "[r]el[y] on facts that [they] know[] are false." *Mo. Pub. Serv. Comm'n v. FERC*, 337 F.3d 1066, 1075 (D.C. Cir. 2003).

The agencies' assertion that the pre-existing standards produced "costs to . . . industry" that were "too high" to remain in effect, 85 Fed. Reg. at 24,176, also fails to supply a rational justification for the Final Rule. For one, the agencies "assume all regulatory [compliance] costs are passed through" from automakers to consumers. *Id.* at 24,596. In any event, the Supreme Court has recognized that an agency's assessment of "whether it is 'reasonable' to bear a particular cost" should

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7%. 85 Fed. Reg. at 24,612. When using a 3% discount rate, the agencies find that private consumer losses total $78.6–$84.8 billion. Final Rule RIA at 49–50.

"depend on the resulting benefits" rather than some arbitrary threshold. *Entergy Corp. v. Riverkeeper, Inc.*, 556 U.S. 208, 225–26 (2009); *see also Competitive Enter. Inst. v. NHTSA*, 956 F.2d 321, 327 (D.C. Cir. 1992) (to set fuel-economy standards, NHTSA must "conduct[] a serious analysis of the data" to determine whether benefits "are worth" the costs). And here, as previously detailed, the agencies' own analysis finds that any costs to manufacturers to comply with the pre-existing standards yielded greater economic and social benefits. Thus, the agencies' own analysis reveals that manufacturer costs to comply with the pre-existing standards were reasonable, not "too high," 85 Fed. Reg. at 24,176.

While the agencies seek to avoid this fundamental fact by asserting that "additional incremental fuel savings, emissions reductions, and environmental benefits of higher standards [are] not significant enough to outweigh the immediate economic costs," *id.* at 25,185, their analysis shows the opposite. In their cost-benefit analysis, the agencies compare future effects like long-term "fuel savings" against more "immediate economic costs," *id.*, by applying a discount rate, which translates future costs and benefits into present-day value so that all effects can be compared on equal footing. Specifically, as noted above, the agencies use discount rates of 3% and 7%, consistent with longstanding White House guidance, Circular A-4 at 33–34, and find that the rule on average produces more costs than benefits, *see* 85 Fed. Reg. at 24,180–81 tbls.I-5 & I-6.

Their insistence that, despite this analysis, future benefits do not actually "outweigh the immediate economic costs" of the pre-existing standards, *id.* at 25,185, can be justified only through the implicit application of discount rates higher than the 3% and 7% figures used in their analysis, since only higher rates could justify the Final Rule's prioritization of upfront price effects over long-term fuel costs and environmental harms. But as explained above, executive guidance has long endorsed the lower 3% and 7% discount rates, and the agencies in fact apply those rates in their analysis without attempting to justify higher rates. Under the agencies' approach, current savings, no matter how small, could justify future harms, no matter how large. Such an approach is obviously irrational. *See Entergy Corp.*, 556 U.S. at 234 (Breyer, J., concurring in part) (recognizing that it is not "reasonable[] . . . to impose massive costs far in excess of any benefit").

Thus, keying in narrowly on upfront cost savings as justification for the Final Rule rather than larger economic and social costs "inconsistently and opportunistically frame[s] the costs and benefits of the rule." *Bus. Roundtable*, 647 F.3d at 1148–49. And as detailed further below, none of the purported benefits from upfront cost savings justifies this one-sided treatment.

3. The Agencies' Attempts to Justify Their Reliance on Upfront Cost Savings Are Unavailing

Although upfront cost savings clearly cannot justify the Final Rule's forgone benefits, the agencies nonetheless espouse several theories in an attempt to rationalize their conclusion, suggesting at times that consumers hardly value long-term fuel savings, that more stringent standards may prevent automakers from investing in other vehicle attributes, and that the Final Rule's purported safety benefits justify its substantial economic and health costs.

But these scattershot and unsupported theories cannot justify a singular focus on upfront cost savings. In fact, as detailed below, the agencies frequently relegate these theories to alternative "sensitivity analyses" that they acknowledge do not "reflect the[ir] best judgments." Final Rule RIA at 1766. Thus, these three rationales are contradicted by the agencies' own analysis.

a. Suggesting That Consumer Fuel Savings Have Little Value Belies the Agencies' Own Analysis and Longstanding Practice

As one way to justify a focus on upfront cost savings, the agencies suggest that the added "costs of new vehicles" from the pre-existing standards—despite being lower than long-term fuel savings from those standards—nonetheless "would outweigh, for many consumers, the additional fuel costs." 85 Fed. Reg. at 25,171. To make this claim, the agencies suggest that drivers "may have time preferences that cause them to discount" future fuel savings at unusually high rates. *Id.* at 24,612. The agencies suggest, in other words, that consumers barely value long-term fuel savings, and so those forgone savings merit little attention.

But this theory is as baseless as it sounds, and the agencies contradict it in their own analysis. While the agencies hypothesize in the preamble that consumers may discount future fuel savings by as much as 24% annually, *id.* at 24,605, their regulatory analysis rejects that suggestion and instead—consistent with longstanding guidance informed by considerable economic research, *see* Circular A-4 at 33–34—fully values fuel savings and discounts them at the modest rates (3% and 7%) that they apply to other regulatory impacts.[10] Instead, the agencies relegate their theories about consumer valuation to a "sensitivity" analysis that they recognize is not sufficiently robust to provide a "justification" for the rule. Final Rule RIA at 1767. By fully valuing future fuel savings and discounting them at rates recommended by federal guidance, the agencies adopt the same approach that they have consistently used since the Carter administration. *See* Inst. for Pol'y Integrity, Supplemental Comments on Proposed Rule 5–13 (Dec. 21, 2018).[11] Neither now nor

[10] The effects of applying a 24% discount rate are considerable. At a 24% discount rate, a $1,000 savings in five years is worth only $254 in present value. By contrast, at a 3% rate, that same $1,000 savings is worth $859 in present value. In effect, therefore, by suggesting such a high discount rate for consumer fuel savings, the agencies propose to disregard most of the Final Rule's economic harms.

[11] *Available at* https://www.regulations.gov/document?D=NHTSA-2018-0067-12362 (first attachment). Starting in 1972, federal guidance recommended a discount rate of 10% in regulatory analysis. Office of Mgmt. & Budget, Circular A-94 on Discount Rate to Be Used in Evaluating Time-Distributed Costs and Benefits 4 (1972). Recommended discount rates dropped over time, and since 2003's publication of Circular A-4, federal guidance has recommended discount rates of 3% and 7%.

ever, therefore, have the agencies stood behind the conjecture that consumers barely value long-term fuel savings.

Nor should they. While consumers often irrationally undervalue fuel-efficient vehicles, research demonstrates, and the agencies have previously acknowledged, that this is the result of market failures such as a lack of "full information, perfect foresight, [and] perfect competition," not a genuine apathy toward long-term savings. 75 Fed. Reg. 25,324, 25,510 (May 7, 2010). For instance, consumers "might lack . . . a full appreciation of information" about long-term fuel savings, the agencies have explained, or be "especially averse to the short-term losses associated with the higher prices of energy efficient products relative to the uncertain future fuel savings." *Id.* at 25,511. Indeed, a key purpose animating EPCA is that purchasers irrationally undervalue the "energy efficiency of motor vehicles," *see* 42 U.S.C. § 6201(5)—a market failure that the agencies now attempt to assume away, *see* 85 Fed. Reg. at 24,612–13 (failing to recognize that the "fuel efficiency gap exists or constitutes a failure of private markets").

Moreover, the agencies' speculation that consumers may not "place as much weight on fuel savings that will be realized by subsequent owners" fails to justify the "greater weight" they place on "the up-front vehicle cost savings to consumers." *id*. at 25,114. As the agencies elsewhere recognize, initial purchasers directly benefit from the fuel savings of subsequent owners even when they resell the car before the end of its expected lifespan, because "fuel savings are capitalized into sales prices in the used car market." Final Rule RIA at 1012; *see also* 77 Fed. Reg. at 62,947 (explaining that "the price of used cars" should "increase" if cars are more efficient). And in any event, regardless of whether the initial purchaser is fully compensated, the fuel savings for subsequent owners represents a "benefit[] to society" meriting full consideration. Circular A-4 at 2.

In short, the agencies' speculative suggestion that long-term fuel savings may have little value is belied by economic theory, decades of agency practice, and the agencies' own analysis for the Final Rule. Relying on that explanation to justify the rule evinces "a complete failure to reasonably reflect upon the information contained in the record and grapple with contrary evidence—disregarding entirely the need for reasoned decisionmaking" in a manner that this Court disallows. *Fred Meyer Stores, Inc. v. Nat'l Labor Rel. Bd.*, 865 F.3d 630, 638 (D.C. Cir. 2017).

b. Focusing on Speculative Opportunity Costs Also Contradicts the Agencies' Own Analysis

The agencies also attempt to bolster their emphasis on upfront cost savings by speculating that "other vehicle features . . . may be sacrificed for costly technologies that improve fuel economy," 85 Fed. Reg. at 24,177, positing this "opportunity cost" as a key reason why upfront cost savings may "outweigh, for many consumers, the additional fuel costs" incurred under the Final Rule, *id.* at 25,171. Yet once again, the agencies' analysis does not support this conjecture.

Specifically, the agencies' central analysis assumes the opposite of the agencies' speculation: that investments in fuel savings do *not* come at the expense of other vehicle attributes. *See id.* at 24,612.[12] Evidence that energy-efficiency improvements come at the expense of other vehicle attributes is quite limited, and in fact, as the agencies have recognized, many technologies that improve fuel efficiency also improve other attributes such as engine performance. *See* EPA et al., 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, at 4-26 to 4-36 (2016); *see also* Final Rule RIA at 326 (recognizing that "technology can provide both improved fuel economy and performance" and highlighting examples). Indeed, the agencies acknowledge that "extraordinarily efficient models are available in nearly every vehicle class or market segment," 85 Fed. Reg. at 24,612, "including in the luxury and performance segments," *id.* at 24,611—belying the theory that fuel-economy improvements could come at the expense of these other attributes.

The agencies also suggest that improvements in other vehicle attributes could be costless, as they simultaneously tout both the full savings in "upfront purchase prices" from reduced investment in fuel-economy, *id.* at 25,103, and the possibility

[12] Indeed, the agencies hold vehicle attributes "at constant levels" when modeling the Final Rule's effects to "maintain performance neutrality." Final Rule RIA at 303, 318.

that "other vehicle features" may provide "consumer benefits," *id.* at 24,177. But these two assumptions are "internally inconsistent." *Gen. Chem. Corp. v. United States*, 817 F.2d 844, 857 (D.C. Cir. 1987). In reality, insofar as there is any merit to the agencies' occasional suggestion that the Final Rule permits investment in other vehicle attributes, those hypothetical improvements would come at an expense to consumers.

Given the lack of empirical foundation and inconsistency with other analytical assumptions, the agencies relegate their assessment of potential opportunity costs to a "sensitivity analysis," 85 Fed. Reg. at 24,612—that is, one of numerous alternative analyses that "explore[s] a range of potential inputs" for "uncertain" assumptions, Final Rule RIA at 1766. The agencies conduct dozens of sensitivity analyses adjusting different parameters, *id.* at 1767–71 tbl.VII-471, and recognize that "[n]one of these sensitivity cases is more likely than . . . the central analysis," which "represents [the agencies'] best estimate of each individual assumption" regarding the Final Rule's impacts, *id.* at 1767.

In other words, the agencies' "best estimate," *id.*, concludes that the Final Rule does not forgo opportunity costs from hypothetical tradeoffs between vehicle performance and efficiency. Suggesting otherwise in seeking to justify the rule "is inaccurate and thus unreasonable." *Clean Air Council v. Pruitt*, 862 F.3d 1, 10 (D.C. Cir. 2017).

c. Emphasizing Turnover and Safety Benefits Overlooks Larger Economic and Social Costs

Finally, while the agencies repeatedly tout the purported turnover and safety benefits stemming from a reduction in upfront costs, those claims too cannot justify the Final Rule.

The agencies offer as a justification for the rule their theory that through a "reduction in per-vehicle costs to consumers, the standards enhance the ability of the fleet to turn over to newer, cleaner and safer vehicles." 85 Fed. Reg. at 24,176. Yet their analysis still concludes, after accounting for the Final Rule's purported turnover and safety benefits, that those benefits are outweighed by the rule's economic, environmental, and health costs. By disregarding that conclusion and "placing greater weight" on safety and turnover impacts, *id.* at 25,114, the agencies essentially double-count these benefits and thereby improperly "put [their] thumb on the scale" in favor of weaker standards, *Ctr. for Biological Diversity*, 538 F.3d at 1198.

Moreover, the agencies inflate the Final Rule's turnover and safety benefits through numerous methodological errors. For instance, as detailed by the State and Local Government Petitioners, the agencies' attempt to model fleet turnover relies on speculation and produces inconsistent and inexplicable results. State Br. 54–55. Compounding the issue, the agencies' "fleet turnover fatality estimates are exaggerated because they rely on sales projections that are themselves exaggerated"—namely because the agencies assume an unrealistically strong relationship between price changes and new vehicle sales. *Id*. 55–57. All told, the result is that the Final Rule's turnover and safety benefits are far lower than the agencies project, making the agencies' reliance on these benefits to justify the rule all the more unfounded.

*   *   *

In sum, the limited explanations that the agencies offer to justify a net-costly rule are unsupported and illogical, and are dismissed by the agencies' own central analysis and relegated to alternative analyses that the agencies recognize are less robust. Because the Final Rule is "not supported by the reasons that the agencies adduce," it is not "logical and rational" and must be struck down. *Tripoli Rocketry Ass'n, Inc. v. Bureau of Alcohol, Tobacco, Firearms, & Explosives*, 437 F.3d 75, 77 (D.C. Cir. 2006) (internal quotation marks omitted).

CONCLUSION

For the foregoing reasons, this Court should grant the petitions for review of the Coordinating Petitioners.

DATED: January 21, 2021

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE WITH WORD LIMITATION

Counsel hereby certifies that, in accordance with Federal Rule of Appellate Procedure 32(a)(7)(C), the foregoing brief contains 6,455 words, as counted by counsel's word processing system, and this complies with the applicable word limit established by the Court.

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CERTIFICATE OF FILING AND SERVICE

I hereby certify that on this 21st day of January 2021, a true and correct copy of the foregoing amicus curiae brief was filed with the Clerk of the United States Court of Appeals for the District of Columbia Circuit via the Court's CM/ECF system. Counsel for all parties are registered CM/ECF users and will be served by the appellate CM/ECF system.

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Overinflated

The SAFE Rule's Overstated Estimates of Vehicle-Price Impacts

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Executive Summary

This report is part of a series that documents how the assumptions underlying The Safer Affordable Fuel Efficient (SAFE) Vehicles Final Rule for Model Years 2021–2026 Passenger Cars and Light Trucks ("SAFE Rule"),[1] are skewed to make the rule look less harmful than it actually is. In the SAFE Rule, the Environmental Protection Agency and the National Highway Traffic Safety Administration ("the agencies")[2] have significantly rolled back the greenhouse gas emission and fuel-economy standards for light vehicles established under the Obama Administration for the vehicle Model Years 2021 to 2025 ("baseline standards").[3]

To justify the SAFE Rule, the agencies make assumptions about how automakers' costs of compliance with fuel-economy and greenhouse gas emission standards translate into changes in vehicle prices that consumers face. The agencies then rely on those price changes to justify their decisions to roll back the baseline standards.

But those assumptions allow the agencies to inflate the effect of the baseline standards on vehicle prices, artificially mask key costs of the SAFE Rule, and thus create the illusion that rolling back the baseline standards is less socially harmful than it truly is. Accordingly, while the agencies conclude that the SAFE Rule is net costly using a consumption discount rate[4]—and ultimately conclude that the benefits "straddle zero" upon looking at the impacts using a private capital discount rate[5]—a proper

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[1] 85 Fed. Reg. 24,174 (Apr. 30, 2020).

[2] Policy Integrity previously published a report detailing the errors in the agencies' suggestion that higher fuel economy requires a trade-off with other vehicle features such as horsepower and towing capacity as well as a report analyzing trends in fuel prices, vehicle sales, automaker compliance, and safety to show that the baseline standards can be met at low cost while delivering large benefits to consumers and the economy. *See* Bethany Davis Noll, Peter Howard, Jason A. Schwartz & Avi Zevin, *Shortchanged: How the Trump Administration's Rollback of the Clean Car Standards Deprives Consumers of Fuel Savings* (June 4, 2020), https://policyintegrity.org/publications/detail/shortchanged-the-trump-administrations-rollback-of-the-clean-car-standards; Bethany Davis Noll, Peter Howard, & Jeffrey Shrader, *Analyzing EPA's Vehicle-Emissions Decisions. Why Withdrawing the 2022-2025 Standards Is Economically Flawed* (May 1, 2018), https://policyintegrity.org/publications/detail/analyzing-epas-fuel-efficiency-decisions1. Other reports are forthcoming.

[3] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 15, 2012).

[4] 85 Fed. Reg. at 24,176 (concluding that the SAFE Rule's costs exceed benefits by $13.1 billion (CAFE program) and $22 billion (GHG program), assuming a 3 percent discount rate). The consumption discount rate refers to "the rate at which society discounts future consumption flows to their present value," and is typically valued at 3 percent in regulatory impact analyses. Office of Mgmt. & Budget, Circular A-4 on Regulatory Analysis 33 (2003). This discount rate is appropriate for regulations that "primarily and directly affects private consumption," including most environmental regulations. *Id.*

[5] *Id.* The private capital discount rate, typically valued at 7 percent, reflects "an estimate of the average before-tax rate of return to private capital in the U.S. economy" and is appropriate for regulations that primarily impact "the allocation of capital." Circular A-4 at 33. As Policy Integrity is explaining in a forthcoming report, the private discount rate is not the proper rate to use for the SAFE Rule because the rule primarily impacts private consumption rather than capital allocation, and so the lower consumption discount rate is appropriate. Moreover, while the agencies find that the SAFE Rule has net benefits at a 7 percent discount rate, those benefits are only $6.4 billion (GHG program) and $16.1 billion (CAFE program)—much smaller than the projected net costs using a 3 percent discount rate. 85 Fed. Reg. at 24,176.

analysis of the SAFE Rule's sales effects would reveal that the rule is much more costly and socially detrimental than the agencies acknowledge.

This report highlights three critical problems in the agencies' assumptions about vehicle prices. First, when assessing automaker compliance-cost savings from the SAFE Rule, the agencies inflate the non-technology compliance-cost savings (such as marketing, additional guarantees, and overhead) through a controversial and unsound methodology known as "retail price equivalents." Second, the agencies overstate the degree to which automakers pass compliance costs through to consumers, thereby further overstating the SAFE Rule's impacts on vehicle prices. And third, when modeling how the passed-through costs are spread across the vehicle mix, the agencies disregard the impact of "sales mixing"—that is, the strategic dispersion of vehicle price increases across an automaker's fleet—leading to an even further exaggeration of the SAFE Rule's impacts on vehicle prices.

By vastly overestimating the SAFE Rule's impacts on vehicle prices, the agencies in turn overstate the rule's impacts on consumer welfare and purchasing decisions. This is because, through the agencies' inflated conclusions about the SAFE Rule's impacts on vehicle prices, the agencies conclude that many consumers who would forego purchasing a new vehicle under the baseline standards will now purchase a vehicle following the rollback. In reality, this effect is far smaller than the agencies project.[6]

These three errors also have key implications for the SAFE Rule's projected scrappage impacts. Under the agencies' false conclusion that many more people would have kept their cars longer before scrapping them under the baseline standards, the agencies' analysis shows that rolling back the standards would lead to a newer vehicle fleet, unjustifiably decreasing the emissions damages of the rollback. Even taking the agencies' deeply flawed scrappage model at face value, the inflated compliance cost estimates improperly increase the size of this effect.

When this chain of errors in the agencies' compliance-cost and vehicle-pricing assumptions is corrected, the agencies' proffered justification for the SAFE Rule (insofar as it made any sense to begin with) evaporates. Indeed, while the agencies adopt the SAFE Rule upon concluding that the costs of compliance with the baseline standards were "too high,"[7] a proper accounting of vehicle prices reveals that the upfront compliance costs of the baseline standards were vastly lower than the agencies project, undermining the justification for the SAFE Rule.

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[6] While this report focuses only on errors that the agencies make in projecting the sticker price of new vehicles, the agencies make other substantial errors in their sales and scrappage models that further inflate the rule's sales impacts and call into question their conclusion that the rule will lead to a total increase in new vehicle sales. For instance, the agencies exaggerate the relationship between prices and sales, known as "price elasticity." *See* Ctr. for Biological Diversity et al., Petition for Reconsideration of EPA's Final Rule—The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks 39–45 (June 29, 2020) (Docket No. EPA-HQ-OAR-2018-0283), https://ago.vermont.gov/wp-content/uploads/2020/08/20200629-UCS-et-al-SAFE-Part-II-Petition-for-Reconsideration_Print_Copy.pdf. The agencies' sales and scrappage modeling as well as data manipulation have also been criticized heavily for underestimating the social costs of the SAFE Rule, among numerous other errors. *See*, *e.g.*, Dave Cooke, *EPA Made So Many Mistakes with Clean Cars Rollback, Even Its Own Lawyers Want to Know What's Up*. Union of Concerned Scientists (July 30, 2020) https://blog.ucsusa.org/dave-cooke/epa-made-so-many-mistakes-with-clean-cars-rollback-even-its-own-lawyers-want-to-know-whats-up (providing a broad overview of the issues); Robinson Meyer, *Trump's New Auto Rollback Is an Economic Disaster*, The Atlantic (Apr. 13, 2020) (criticizing inclusion of years 2018-20 in the analyses).

[7] *Id*.

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I. The Agencies Inflate Total Automaker Compliance-Cost Savings Through the Controversial Methodology of Retail Price Equivalents

Summary of Retail Price Equivalents

- In the SAFE Rule, the agencies model the compliance costs of the baseline standards to help assess the purported cost savings of the rollback. To do so, they multiply the direct cost of compliance technologies with a constant—known as the Retail Price Equivalent ("RPE")—meant to represent non-technological costs such as overhead and marketing.
- In their primary analysis, the agencies assume an RPE of 1.5. In other words, the agencies assume that indirect, non-technological compliance costs are equal to half of technological costs across all producers and technologies.
- Yet in prior rulemakings, the agencies have accounted for indirect costs through another approach—the Indirect Cost Multiplier ("ICM")—or by using lower values of RPE. There is strong evidence that these prior approaches, rather than the agencies' approach in the SAFE Rule, are conceptually correct. The agencies did not provide a satisfactory explanation for disregarding the ICM methodology.
- Analyses included in the SAFE Rule show that under the ICM approach or a lower value of RPE, the savings in total compliance costs driven by rolling back the baseline standards would be almost 20% lower than under an RPE of 1.5, thus demonstrating that the SAFE Rule's supposed cost savings may be much smaller than the agencies have estimated.

Background

To predict the effects of this rollback, the agencies need, among other things, to calculate vehicle costs under both the baseline standards and the SAFE Rule. To do that, they run a model that predicts what fuel-economy and emission-reduction technologies vehicle manufacturers choose under the relevant regulatory scenario. The engineering costs of installing those technologies is then multiplied by a retail price equivalent.

The logic behind RPEs is to reflect the indirect costs that manufacturers incur in addition to direct production costs, such as corporate operations, marketing, and sales. The indirect costs also include a typical rate of profit. Conceptually, RPE can be calculated as a ratio of revenue from vehicle sales to direct costs of producing the vehicles. The RPE multiplier is constant across all producers and technologies.[8]

Under their primary analysis of the SAFE Rule, the agencies assume an RPE multiplier of 1.5.[9] This multiplier is important for the analysis of the SAFE Rule, as it is a key input in determining the costs of compliance and thus, ultimately, the rule's sales and scrappage effects. With a higher RPE, the analysis

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[8] *See* 77 Fed. Reg. at 62,708 (explaining that RPE "includes all forms of indirect costs for a manufacturer and assumes that the ratio applies equally for all technologies").

[9] 85 Fed. Reg. at 24,351.

would show that the baseline standards were more expensive to comply with, making their rollback seem more socially desirable than it would with a lower RPE. Under the RPE of 1.5 that the agencies use, for instance, the sales difference between the baseline CAFE standards and the weakened standards in the SAFE Rule is 2.7 million new vehicles from Model Years 2019 to 2029.[10]

In addition to their primary analysis, the agencies also conduct sensitivity analyses examining the impacts of the SAFE Rule at RPEs of 1.1, 1.24, and 2.0. With an RPE of 1.1, the projected sales boost from the SAFE Rule's CAFE standards decreases to 1.8 million. Yet with the RPE value set at 2.0, the rollback results in 4.5 million additional cars sold.[11] The sales effects are closely interlinked with the ultimate findings about the rule's costs and benefits: Net benefits of the SAFE Rule's CAFE standards switch from -$52.7 billion under an RPE of 1.1 to +$50.5 billion with an RPE markup of 2.0.[12]

That wide range of sales effects under alternative multiplier values demonstrates that the evaluations of the SAFE Rule are extremely sensitive to the choice of RPE, making the assessment of indirect costs incredibly significant.

The Agencies' Controversial Methodological Choice Likely Produces an Inflated Estimate of Cost Savings

While the use of the RPE approach and the exact RPE value have a huge impact on the analysis of the SAFE Rule, the agencies do not sufficiently justify their decision to rely on an RPE of 1.5. For one, the proper value of the RPE is controversial, and many believe a lower value is appropriate.[13] Moreover, there are questions about whether RPE is conceptually correct, and using an alternative approach that the agencies have previously relied upon would also reduce the SAFE Rule's projected cost savings.

Conceptually, indirect costs might be different among various car makes and models, undercutting the rationale for a constant RPE. For instance, van Velzen et al. (2019) argue that electric vehicles are commonly sold at or below production costs in the early years of sales given the high initial investment (and given that once market share has increased by offering a low price, standardization efficiencies kick in and this lowers the production cost). Therefore, they estimate the RPE of battery electric vehicles to be around 1.0, and claim that producers will need to increase the RPE at some point in the future in order to recoup investments.[14]

Indirect costs may also differ substantially across different technologies. As Rogozhin et al. (2010) explained: "A concern in using the RPE multiplier in cost analysis for individual technologies is that the indirect costs of vehicle modifications are not likely to be the same for different technologies. For example, less complex technologies could require less retooling or research and development . . .

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[10] *Id*. at 24,925.

[11] At the RPE of 1.24, the agencies project that the SAFE Rule will increase vehicle sales by 2.1 million, a difference of 600,000 from the primary analysis. Final Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021–2026 Passenger Cars and Light Trucks 1790 tbl. VII-478 (updated July 1, 2020) (hereinafter "FRIA"). The FRIA refers to these RPEs as "Technology Cost Markup."

[12] *Id.* at 375 tbl. VI-33 (projecting impacts of various RPEs on the CAFE program at a 3 percent discount rate).

[13] *See* National Research Council, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards* (2002), https://doi.org/10.17226/10172. *See also* Jack Faucett Associates, *Update of EPA's Motor Vehicle Emission Control Equipment Retail Price Equivalent (RPE) Calculation Formula* (1985).

[14] Arjan van Velzen, Jan Anne Annema, Geerten van de Kaa & Bert van Wee, *Proposing a More Comprehensive Future Total Cost of Ownership Estimation Framework for Electric Vehicles*, 129 Energy Policy 1034 (2019).

efforts than more complex technologies."[15] Likewise, as the agencies have recognized, "the indirect costs of new technologies vary, both with the complexity of the technology and with the time frame."[16] In the case of the specific technology improvements at issue here, such as vehicle electrification, engine improvements, and aerodynamic improvements, there is thus little reason to believe that the share of indirect costs should be reasonably captured by RPE, which represents the estimated share of indirect costs across all technologies.

And indeed, past analyses prepared by the agencies for Model Years 2012-2016 and 2017-2025 relied heavily on another methodology, called indirect cost markup (ICM). While this methodology also scales up the direct technology costs by a factor, that scaling factor varies depending on the particular technology and the applicable timeframe (i.e., short-run vs. long-run effects).[17] The indirect cost multiplier attempts to assign costs to products based on the activities they require.[18] Although assigning specific cost multipliers to individual technologies can be somewhat tricky and is subject to dispute,[19] the agencies have developed reasonable methods to do so in their prior analyses.[20]

As the agencies explained in 2017, "EPA considers the ICM approach to be the more appropriate approach and . . . this position is supported by many stakeholders."[21] Indeed, comments submitted to the agencies by distinguished scientific organizations have broadly supported the ICM methodology.[22] In

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[15] Alex Rogozhin, Michael Gallaher, Gloria Helfand & Walter McManus, *Using Indirect Cost Multipliers to Estimate the Total Cost of Adding New Technology in the Automobile Industry*, 124 Int'l J. Production Econ. 360 (2010).

[16] Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks 176 (2010) (hereinafter, "2010 FRIA"); *see also* 85 Fed. Reg. at 24,352–53 ("[T]he indirect cost multipliers increase with the complexity of the technology and decrease over time.").

[17] *See, e.g.*, 2010 FRIA at 176–78.

[18] RTI International and Transportation Research Institute (University of Michigan), *Automobile Industry Retail Price Equivalent and Indirect Cost Multipliers* (2009) (prepared for EPA).

[19] Nat'l Acads. of Scis., *Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles* 248 (2015) ("In theory, this [ICM] approach seems clearly superior to assuming identical impacts for all technologies regardless of their nature. However, attribution can be ambiguous, especially for future costs."); *see also id.* at 259 ("The committee conceptually agrees with the Agencies' method of using an indirect cost multiplier instead of a retail price equivalent to estimate the costs of each technology since ICM takes into account design challenges and the activities required to implement each technology. In the absence of empirical data, however, the committee was unable to determine the accuracy of the Agencies' ICMs.").

[20] *See* 2010 FRIA at 178–80 (estimating indirect cost multipliers depending on technology complexity).

[21] Response to Comments: Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards Under the Midterm Evaluation 104 (2017). For the rules for model years 2012-2016 and 2017-2025, the RPE was used only as a sensitivity check, and for the Draft Technical Assessment Report ("Draft TAR") produced as part of the agencies' 2016 mid-term evaluation of the baseline standards, the two methods were used in parallel to acknowledge the uncertainty surrounding both methods.

[22] Numerous commenters have supported the use of ICM in prior fuel-efficiency rulemakings. *See, e.g.*, *id.* at 44 ("In commenting on the Draft TAR, multiple comments from NGOs (American Council for an Energy-Efficient Economy (ACEEE), Union of Concerned Scientists (UCS), and Environmental Defense Fund (EDF)) supported EPA's use of Indirect Cost Multipliers (ICMs) rather than retail price equivalents (RPEs) as a means of estimating indirect costs."). The same is true of this rulemaking. *See* 85 Fed. Reg. at 24,365 ("Several responders submitted comments on the issue of indirect costs. The International Council on Clean Transportation (ICCT) stated that 'The agencies abandoned their previously-used indirect cost multiplier method for estimating total costs, which was vetted with peer review, and more complexly handled differing technologies with different supply chain and manufacturing aspects. The agencies have, at this point, opted to use a simplistic retail price equivalent method, which crudely

short, while the exact valuations for the ICM methodology are subject to some dispute, there is broad recognition that the methodology is conceptually superior to RPE and that its results merit genuine consideration.

Yet despite the fact that both the commenters here and the agencies in previous proceedings have touted the ICM methodology, the main analysis and scenarios in assessing the SAFE Rule rely solely on the RPE methodology. Attempting to justify their methodological change, the agencies acknowledge that ICM has "conceptual merit" yet claim that "data to support such estimates is scant and, in some cases, nonexistent."[23] But while there is admittedly some uncertainty over the proper ICM estimates, the agencies are incorrect that adequate data does not exist and lack sufficient justification to entirely disregard the ICM approach in their primary analysis.

In fact, in the SAFE Rule the agencies provide an estimate of costs computed based on ICM (with ICM values slightly increased compared to values used by the agencies previously)—which the agencies bury in the text and surround by claims about substantial uncertainty around the ICM method.[24] Critically, in that analysis the agencies find that the ICM value produces similar results as the RPE value of 1.24—and therefore use that RPE value as a proxy for the ICM approach in their sensitivity analyses.[25] And as discussed above, because the RPE of 1.24 is considerably lower than the RPE value of 1.5 used in the primary analysis, the agencies have no choice but to conclude that the rollback looks substantially worse when an RPE of 1.24—standing in for the ICM method—is applied.

For instance, in their analysis of the SAFE Rule, the agencies find that while "the relative effects of ICMs may vary somewhat by scenario," in one case "the application of ICMs produces total technology cost estimates roughly 18 percent lower than those that would result from applying a single RPE factor to all technologies, or, conversely, the RPE produces [cost] estimates that averaged 21 percent higher than the ICM."[26] And by projecting lower cost savings from the rollback, the ICM method also reduces the sales impacts and overall net benefits of the SAFE Rule. Specifically, the agencies project that with an RPE of 1.24 (which, again, they use as a proxy for the ICM method) the rule will cause a far lower sales boost

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assumes all technologies have a 50 percent markup from the direct manufacturing technology cost. We recommend the agencies revert back to the previously-used and better substantiated ICM approach.' . . . A private commenter, Thomas Stephens, noted that 'In Section II. Technical Foundation for NPRM Analysis, under 1. Data Sources and Processes for Developing Individual Technology Assumptions, the agencies state that indirect costs are estimated using a Retail Price Equivalent (RPE) factor. Concerns with RPE factors and the difficulty of accounting for differences in indirect costs of different technologies when using this approach were identified by the EPA (Rogozhin et al., Using indirect cost multipliers to estimate the total cost of adding new technology in the automobile industry, International Journal of Production Economics 124, 360-368, 2010), which suggested using indirect cost (IC) multipliers instead of RPE factors. The EPA developed and updated [indirect cost] multipliers for relevant vehicle technologies with automotive industry input and review. The agencies should consider using these [indirect cost] multipliers to estimate indirect manufacturing costs instead of RPE factors.'").

[23] 85 Fed. Reg. at 24,350. *See also id.* at 24,364 ("On balance, and considering the relative merits of both approaches for realistically estimating indirect costs, the agencies consider the RPE method to be a more reliable basis for estimating indirect costs."); *id.* at 24,366 (claiming that ICM values "have not been validated" and "conflict with the empirically derived RPE value").

[24] See FRIA at 374–75 & tbl. VI-32 (summarizing compliance costs depending on the method used for computing indirect costs); *see also* Preliminary Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021 – 2026 Passenger Cars and Light Trucks 1194–95 & tbl. 9-90 (2018).

[25] FRIA at 374.

[26] *Id*.

than under their main analysis.[27] And they conclude that the rule is net costly at this RPE no matter the discount rate: the SAFE Rule's CAFE program would result in net benefits of -$41.7 billion at a 3 percent discount rate, or -$5.1 billion using a 7 percent discount rate.[28]

The agencies' main argument against ICM is the presence of uncertainties associated with that methodology. But while some uncertainty exists with ICMs, those values were derived through a rigorous peer review[29] and mere imprecision in those estimates does not justify discarding them and returning to the RPE methodology that the agencies acknowledge to be flawed. Technologies to comply with fuel-efficiency and greenhouse gas emission standards are frequently of low complexity, such as rolling-resistance tires, and so it is intuitive that they may have lower indirect costs than technologies that, for instance, improve vehicle acceleration. At minimum, the agencies should have conducted further analysis of ICMs, or assessed the RPE and ICM methods in tandem as they did in 2016.[30] By reverting entirely to the RPE methodology that overstates the indirect costs of complying with this rule, according to available estimates, the agencies likely overstate the compliance costs of the baseline standards and attendant cost savings of the SAFE Rule, perhaps drastically so.

[27] *Id*. at 1790 tbl. VII-478 (projecting that the SAFE Rule's CAFE program would increase new vehicle sales by 2.1 million assuming an RPE of 1.24—a decline of 600,000 vehicles from the primary analysis applying an RPE of 1.5).

[28] *Id.* at 1804, 1806. The same is true of the greenhouse gas standards, with net benefits of -$42.3 billion at a 3 percent discount rate and -$9.3 billion at a 7 percent rate. *Id.* at 1808, 1810. The agencies' main analyses of both the CAFE and greenhouse gas standards (using an RPE of 1.5) indicate that the rollback is net costly under 3 percent discount rates but slightly net beneficial when 7 percent discount rates are used. *See supra* notes 3–4 and accompanying text.

[29] *See, e.g.*, Rogozhin et al. (2010), *supra* note 16.

[30] 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 at 5-239 (2016) ("For this Draft TAR analysis, recognizing there are uncertainties in the use of either ICM or RPE as indicators of indirect costs, … EPA chose to assess indirect costs using both the ICM and RPE approaches.").

II. The Agencies Further Overestimate Cost Savings by Irrationally Assuming that Manufacturers Pass 100% of Compliance Costs on to Purchasers

Summary of Pass-Through Considerations

- The agencies assume that all compliance costs (both direct and indirect, including profit margin) are fully passed on to consumers.
- This contrasts with literature, both theoretical and empirical, finding that while automakers may pass some compliance costs to their consumers, there is usually less than full pass-through. Faced with this countervailing evidence, the agencies do not provide a strong justification for assuming full pass-through.
- Discarding the assumption of full pass-through reveals that the SAFE Rule saves fewer compliance costs and is thus is far more costly to consumers than the agencies acknowledge.

Background

After determining how much automaker compliance costs allegedly increased under the baseline standards, the agencies need to make assumptions about how those cost increases translate into higher sticker prices for new vehicles. The degree to which manufacturers pass on the cost shocks (i.e. sudden additional costs) to consumers is referred to as "pass-through." In analyzing the SAFE Rule, the agencies assume that additional compliance costs (both direct and indirect) from the baseline standards would be fully passed on to consumers in the form of higher prices. Importantly, full pass-through combined with the RPE approach, discussed above, implies that strengthening the standards (as the agencies did in the baseline standards) substantially increases retail prices, due to increased costs incurred by the producers to directly comply with fuel-economy and greenhouse gas emission standards as well as increases in the markup for those additional costs.

The Agencies' Assumption of Full Pass-Through Is Not Reasonable

In contrast to the agencies' assumption in the SAFE Rule, however, the economic literature—both empirical and theoretical—finds that companies frequently do not fully pass through additional costs.[31]

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[31] The bulk of the evidence for incomplete pass-through stems from studies that measure the impact of changes in the exchange rate or reductions in tariffs. Recently, incomplete pass-through has also been documented in the domestic setting. One study, for instance, found incomplete pass-through of energy input price changes across industries of the U.S. manufacturing sector. Sharat Ganapati, Joseph Shapiro & Reed Walker, *Energy Cost Pass-Through in U.S. Manufacturing: Estimates and Implications for Carbon Taxes*, 12 Am. Econ. J.: Applied Econ. 303 (2020). The assumption of full pass-through was prevalent in the older trade literature as the workhorse model in international economics (which much of the literature relied on) assumes constant elasticity of substitution demand and monopolistic competition. Those assumptions together have been shown to imply constant markups and complete pass-through in equilibrium. *See* Costas Arkolakis, Arnaud Costinot & Andrés Rodríguez-Clare, *New Trade Models, Same Old Gains?*, 102 Am. Econ. Rev. 94 (2012). However, if vehicle manufacturers do not face constant elasticity of substitution demand then the marginal cost shocks do not directly translate into price changes, meaning prices are substantially less volatile than costs.

The empirically estimated pass-through rates vary vastly across markets and implemented policies, with some studies finding even negative pass-through rates.[32] There are numerous explanations for why cost increases are not passed one-for-one into the prices paid by consumers and why there is heterogeneity of pass-through rates.

For one, economic theory suggests that fixed costs should not determine price levels, and there is empirical evidence that firms indeed only partly account for fixed costs when setting their prices.[33] The literature also finds that competition is one of the significant determinants of the exact pass-through level: Generally, competitive markets yield higher pass-through rates, because in a competitive market the consumer price already represents the marginal cost of production and so a variable cost shock is necessarily passed onto consumers.[34] Moreover, the nature of the demand has also been shown to affect pass-through. In a competitive market, if demand is perfectly "elastic"—meaning that a higher retail price leads to a large drop in sales—producers will bear the full impact of a production-cost increase. Conversely, if consumers are not price-sensitive, they will bear the burden of the cost increase.[35] Finally, the empirical work documents that more-profitable producers absorb a greater proportion of a cost shock into their markups, meaning that their pass-through rate is lower than it is for less-profitable producers.[36]

Indeed, one study—Gron and Swenson (2000)—looking particularly at the U.S. automobile market, confirms that full pass-through does not occur in this market. Analyzing automotive data from 1984 to 1994, the authors firmly reject the hypothesis of full cost pass-through and constant markups, finding that automobile manufacturers do not fully pass along additional costs to their consumers.[37]

Yet the agencies reject this strong evidence and instead rely on the assumption of complete cost pass-through, citing two peer reviewers of the CAFE model and the competitive character of the automotive sector in support of their decision.[38] But neither of these two justifications holds up.

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[32] For an explanation of the mechanism behind the negative pass-through rate, see Francesco Gullì, *Pollution Under Environmental Regulation in Energy Markets* (2013).

[33] *See, e.g.*, Michael Lucas, *Pricing Decisions and the Neoclassical Theory of the Firm*, 14 Mgmt. Accounting Res. 201 (2003) (reviewing accounting and economic studies on how firms set prices with respect to fixed costs).

[34] The pass-through differences between various market structures depend mostly on convexity of demand curves, with competitive markets leading to higher pass-through rates unless demand is very convex. *See* E. Glen Weyl & Michal Fabinger, *Pass-Through as an Economic Tool: Principles of Incidence under Imperfect Competition,* 121 J. Political Econ. 528 (2013). *See* also Francesco Gullì & Liliya Chernyavs'ka, *Theory and Empirical Evidence for Carbon Cost Pass-Through to Energy Prices*, 5 Annual Rev. Resource Econ. 349 (2013).

[35] The relationship between demand and pass-through is more complex for imperfectly competitive markets than it is for competitive markets. For an explanation of how demand characteristics affect pass-through in markets depending on producers' market power, see RBB Economics, *Cost Pass-Through: Theory, Measurement, and Potential Policy Implications A Report Prepared for the Office of Fair Trading* 14-17 (2014), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/320912/Cost_Pass-Through_Report.pdf.

[36] *See* Nicolas Berman, Philippe Martin & Thierry Mayer, *How Do Different Exporters React to Exchange Rate Changes?*, 127 Quarterly J. Econ. 437 (2012) (for evidence based on French data); Mary Amiti, Oleg Itskhoki & Jozef Konings, *Importers, Exporters, and Exchange Rate Disconnect*, 104 Am. Econ. Rev. 1942 (2014) (for evidence based on Belgian data).

[37] Anne Gron & Deborah Swenson, *Cost Pass-Through in the U.S. Automobile Market*, 82 Rev. Econ. & Statistics 316 (2000).

[38] *See* 85 Fed. Reg. at 24,595.

First, using the peer reviews to support full pass-through is a stretch to say the least. Indeed, as the agencies themselves acknowledge, the peer reviewers questioned the assumption of full pass-through and flagged it as an issue for further examination.[39] For instance one reviewer, Ph.D. economist and university professor James Sallee—one of the experts whom the agencies rely on in the SAFE Rule to justify their assumption of full pass-through—in fact explained that the agencies' assumption of full pass-through "likely overstates the effects of technology deployment costs on new car sales," and that, in reality, "only true marginal costs of technology would be reflected in the price."[40] Sallee further explained that assuming full pass-through for fixed costs, as the agencies do in the SAFE Rule, "distort[s] the sales response model."[41]

Second, the agencies are wrong to justify their assumption of full pass-through on the alleged competitiveness of the domestic automotive market. In competitive markets, pricing is typically determined by marginal costs—that is, the cost added by producing an additional unit of a product. But a substantial share of the compliance costs with fuel-efficiency regulations is fixed, or, in other words, non-marginal. For instance, redesigning an assembly line to implement engine changes or launching a particular marketing campaign to explain to consumers the advantage of a new fuel-economy technology cost the same, no matter how many vehicles are sold. In a perfectly competitive market, those fixed costs would not affect the final price, because in competitive markets the consumer price reflects the manufacturer's marginal cost and not fixed cost. In other words, cost shocks that have a fixed cost component will have a pass-through rate lower than 1 in competitive markets.[42] Thus, the agencies' assumption that the automotive market is competitive does not justify their hypothesis of full pass-through of costs, and, when considered in proper context, in fact supports the opposite conclusion.[43]

Additionally, the assumption of full pass-through conflicts with the agencies' prior statements. As recently as 2016, the agencies acknowledged that automakers likely "absorb some of the increased technology costs" rather than pass them onto consumers.[44] While concluding at that time that they lacked "sufficient information to model the way in which manufacturers actually price their current and future fleets," the agencies acknowledged that simply adding technology costs onto existing vehicle prices was "not accurate" for projecting future sticker prices because manufacturers may absorb some of the technology costs or engage in other pricing strategies."[45] Just four years later, however, the agencies now reverse course, claiming without reasonable justification that automakers fully pass through increased cost.

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[39] CAFE Model Peer Review B-3 (revised July 2019).

[40] *Id.* at B-55.

[41] *Id.*

[42] This point was also made by James Sallee in his review. See *id.* at B-7.

[43] The agencies also contradict themselves in characterizing the market structure of the automotive sector. Some sections of the rule discuss "strategic" actions of manufacturers, in particular "strategic pricing" decisions. But this conflicts with the assumption of the sector being competitive since strategic pricing is a feature of imperfectly competitive markets. *See, e.g.*, 85 Fed. Reg. at 24,596 ("[M]anufacturers are better positioned to incorporate smaller price adjustments into their current strategic pricing models."); *id.* at 24,625 ("Manufacturers have strategic, complex pricing models that rely on extensive market research and reflect each company's strategic interests in each segment.").

[44] 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 at 13-93 (2016).

[45] *Id.* at 13-94, 13-95.

And this error is significant. Assuming full pass-through, especially when combined with the assumption of a high RPE value, results in the conclusion that the baseline standards produced substantial sales declines, and thus makes the SAFE Rule appear far less costly than it really is. Correcting the pass-through would make the results more realistic. While projecting the precise impact of this error is difficult because the agencies do not conduct sensitivity analyses for pass-through rates, we can approximate the effects of the agencies' pass-through assumption by looking at the sensitivity analyses around retail price multipliers. This is because pass-through and RPE are both constant factors scaling up costs of compliance when computing the vehicle price changes driven by regulation. Therefore, they both produce the same effects on sales, rebound, and scrappage analyses. For that reason, we can assess the impacts of decreasing pass-through by looking at the impacts of a proportional RPE decrease.

For instance, we can look at the sensitivity analysis with an RPE of 1.24, which tells us the effects of a pass-through value of 0.82 (meaning 82% of added costs are passed along to consumers). Such pass-through would imply that the SAFE Rule's CAFE standards would increase vehicle sales by over 500,000 fewer cars than the agencies project by assuming full pass-through.[46] For the greenhouse gas emissions program, that pass-through assumption results in a similar decline from the agencies' unrealistic projection.[47] Thus, because the agencies justify the SAFE Rule in part on the purported sales increase of reducing the standards and the used vehicle scrappage effects, the use of more realistic, lower pass-through rates undermines their justification for the SAFE Rule and reveals the rule to be far more socially harmful than the agencies admit.

[46] FRIA at 1790 tbl. VII-478.

[47] *Id.* at 1794 tbl. VII-479.

III. The Agencies Also Inflate the SAFE Rule's Cost Savings by Disregarding Automakers' Well-Documented Sales-Mixing Strategies

Summary of Sales-Mix Considerations

- The agencies assume in their analysis of the SAFE Rule that any price increase caused by fuel-economy requirements is the same for every vehicle.
- But this contrasts with both empirical literature and economic theory finding that manufacturers reduce compliance cost and maximize profit by tailoring price increases to individual products, which is known as "sales mixing."
- Accounting for sales mixing further reduces the compliance costs of the baseline standards and thereby reveals that the rollback does not save costs to the degree predicted by the agencies and, conversely, that the rollback is much more socially detrimental than estimated.
- The agencies fail to provide a reasonable justification for disregarding well-documented sales-mixing effects.

Background

After establishing how much costs from the baseline standards get passed through to consumers, the agencies need to make assumptions about how manufacturers split that total amount among individual vehicles—in other words, how much individual car prices increase when standards are strengthened. But manufacturers can act strategically in how the price increases are spread across their fleets. Strategically passing the cost increase to individual vehicles—called "sales mixing" or, in the context of regulatory compliance, "shadow pricing"—increases profits compared to simply increasing the prices of all vehicles by the same amount as the agencies assume in the SAFE Rule.

The obvious way that manufacturers can decrease compliance cost and thereby maximize profit when standards are strengthened is to increase the price of gas-guzzlers more than the price of fuel-efficient cars. (Conversely, when standards are weakened—as the SAFE Rule does—the price of gas-guzzlers may decline more than the price of efficient vehicles). Doing so encourages the purchase of fuel-efficient cars, which, in turn, means that manufacturers can achieve a lower average fuel-economy and lower greenhouse gas emissions and thereby satisfy federal standards in part by shifting consumer choices rather than making technological investments. Accordingly, this sales-mixing strategy decreases the compliance cost that automakers face compared to the naïve strategy of increasing all vehicle prices equally.[48]

Vehicle manufacturers pursue sales mixing to reduce the overall compliance cost of the standards, while also ensuring a profit-maximizing recovery of those costs. This involves sophisticated pricing strategies to account for flexibility of consumer demand for individual vehicle types. By

[48] The agencies do separately model the rule's impacts on the price of passenger cars versus light trucks, but assume no sales-mixing within those broad categories.

strategically spreading price increases across segments (or even vehicles) with different price elasticities, automakers limit their sales losses and recoup part of the compliance cost of the standards, thereby decreasing the overall cost of the regulatory regime.

The evidence for sales-mixing impacts is not just theoretical: In fact, there is a widespread agreement among economists that sales-mixing is used by vehicle manufacturers. Empirical studies supporting the use of sales mixing by automakers include Goldberg (1998),[49] Austin & Dinan (2005),[50] Anderson & Sallee (2011),[51] and others[52]—providing firm evidence that automakers use sales mixing to reduce and recoup the compliance cost of more stringent technical standards.

Given this widespread empirical and theoretical evidence of sales mixing, the agencies should have assessed the impacts of the SAFE Rule assuming that manufacturers rely on sales mixing. In their analysis, however, the agencies assume that vehicle manufacturers act very naïvely and increase the price of every vehicle by the same amount[53]—disregarding common strategies that automakers have adopted in the past to maximize profit. The agencies provide no sensitivity analyses around that assumption, failing to recognize even the possibility that automakers may employ sales mixing.

The Agencies Fail to Rationally Justify Their Assumption of No Sales Mixing

The agencies attempt to justify their decision to ignore sales mixing by pointing to uncertainty around how manufacturers would apply the practice. Specifically, they explain that while it is "likely that manufacturers employ pricing strategies that push regulatory costs … into the prices of models and segments with less elastic demand, the extent to which any [manufacturer] is able to succeed at this is unknown by the agencies," and so the agencies simply disregard this effect and assume uniform price increases.[54]

But this excuse makes no sense. Tellingly, for one, the agencies acknowledge that sales mixing occurs. While the precise extent of sales mixing may be somewhat uncertain, the agencies could and should have used the existing empirical literature to make educated projections about the extent of sales mixing. In contrast, assuming no sales mixing—while simultaneously acknowledging that some sales mixing occurs—is irrational. Indeed, the agencies do not allow similar lack of readily available information to keep them from making other assumptions in the SAFE Rule when doing so makes the

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[49] Pinelopi Goldberg, *The Effects of the Corporate Average Fuel Efficiency Standards in the US*, 46 J. Industrial Econ. 1 (1998).

[50] David Austin & Terry Dinan, *Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline Taxes*, 50 J. Envtl. Econ. & Mgmt. 562 (2005).

[51] Soren Anderson & James Sallee, *Using Loopholes to Reveal the Marginal Cost of Regulation: The Case of Fuel-Economy Standards*, 101 Am. Econ. Rev. 1375 (2011).

[52] *See, e.g.*, Anne C. Mulkern, *Economists see errors in government claims on pricing*, E&E NEWS (Aug. 6, 2018), https://www.eenews.net/climatewire/2018/08/06/stories/1060092785 (giving an overview of economic thinking on pricing and quoting economist Mark Jacobsen, associate professor of economics at the University of California, San Diego as saying that "'[a]utomakers don't always raise the price of cars relative to the costs of meeting fuel economy standards" but rather have "price points they're trying to meet for specific markets").

[53] The agencies estimate the sales difference between the baseline standards and the SAFE Rule by the average compliance cost and the sales elasticity (which in the model assumes to be -1), without any accounting for sales mixing.

[54] 85 Fed. Reg. at 24,595.

SAFE Rule look less harmful—such as with the scrappage model, for instance.[55] Since we know that sales mixing reduces compliance cost for the baseline standards and thereby makes this SAFE Rule less cost-saving, the assumption of no sales mixing unequivocally inflates the benefits of this rule. While the precise effect of sales mixing is likely subject to some uncertainty, we can be confident that it at least has some impact—not none, as the agencies falsely assume.

The further justification that the agencies provide underscores that they may not fully comprehend the use of sales mixing. For instance, while the agencies correctly acknowledge that "luxury vehicles . . . often have fuel economy levels below (or CO2 levels above) their targets on the curves"[56]—which implies that these vehicles have a high shadow cost as they force the regulated company to apply disproportionally high fuel-economy improvements to other models to stay compliant on the fleet level—they then fail to draw this statement to its logical conclusion. According to the logic of sales mixing, manufacturers should increase the price of luxury vehicles to comply with more stringent standards, thus causing some drop in the sales of those vehicles.[57] But rather than recognizing that the profit-maximizing strategy to comply with the baseline standards would be to sell fewer luxury vehicles at higher prices, the agencies suggest the possibility of *increasing* the sales of those cars, surmising "that selling more of [the luxury vehicles would] compensate for lost profit elsewhere."[58] Increasing the sales of the luxury cars would require lowering the price of those vehicles relative to other cars—thus making it more difficult and expensive for agencies to comply with the baseline standards—and would not comport with the observed practice of sales mixing.

Had the agencies properly accounted for sales mixing, they would have recognized that the SAFE Rule is even more harmful than they acknowledge. For one, sales mixing would partially mitigate any negative sales effect of the baseline standards claimed in the SAFE Rule. Appropriately accounting for sales mixing would have also shown that the SAFE Rule will increase the proportion of gas-guzzlers

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[55] *See id.* at 24,628 ("The agencies agree that there is uncertainty around the magnitude of the sales and scrappage response, but do not agree that sign of either effect is uncertain. Importantly, excluding modeling of the sales and scrappage effects would only make sense if there was a legitimate existential concern—the sales and scrappage effects are founded in very basic economic theory. … Furthermore, the agencies believe that assessing the magnitudes of the sales and scrappage effects is a tractable task for researchers and sufficient data exists to quantify these effects. Thus, excluding these effects would be a serious omission that limits accurate accounting of the costs and benefits of fuel economy standards. Other stakeholders commented that the NPRM analysis did not thoroughly consider the uncertainty around the magnitudes of the sales and scrappage responses. … The agencies believe it is better to consider a range of the scrappage and sales response to address concerns about uncertainty, and that excluding them would be inappropriate.").

[56] *Id.* at 24,595.

[57] An additional argument for increasing the price of luxury vehicles more than the price of vehicles in other segments is the demand for luxury vehicles is likely the least price elastic. Price elasticity of different car segments has been summarized in Consumer Vehicle Choice Model Documentation. Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency Prepared for EPA by Oak Ridge National Laboratory. EPA-420-B-12-052 (Aug. 2012) ("Based on these estimates, we assume that price elasticities at make/model level are around -4 for non-luxury cars (-4 is about the central value of the literature estimates) and around -2 for luxury and sport cars (-2 is about the central estimate).").

[58] 85 Fed. Reg. at 24,595. The agencies make a similar mistake when they likewise assert that "[w]hile manufacturers could conceivably push some small cost increases into the prices of their vehicle segments that have less elastic demand to cover accordingly small increases in stringency, larger stringency increases would exhaust the ability of such segments to absorb additional costs." *Id.* at 24,596. This comment ignores the fact that, even with extreme price increases, there might be limits to what can be achieved through sales mixing, and not accounting for sales mixing still overestimates the costs.

relative to the baseline standards because automakers will strategically decrease the price of those vehicles the most, meaning that the rollback leads to more fuel costs and environmental damages than currently reported. As a result, a proper analysis of the SAFE Rule that includes sales-mixing effects would indicate that the SAFE Rule will produce substantially higher social costs than the agencies project.

Conclusion

The agencies' unsupported and unreasonable assumptions about automobile sales—inflating the compliance costs of the baseline standards (and thus inflating the supposed savings of the SAFE Rule) by assuming high indirect costs, overstating how much such costs are passed through to the consumers, and disregarding the impacts of sales mixing—all serve to exaggerate the compliance costs of the baseline standards and understate the harms of the SAFE Rule. The agencies fail to justify any of these assumptions, while the economic literature shows that all three are likely incorrect.

A proper analysis of these three assumptions that corrects for the agencies' errors reveals two critical truths about the SAFE Rule. For one, it shows that the SAFE Rule is far more costly than the agencies acknowledge—meaning that the rule is not only net costly for society (which the agencies' existing analysis already reveals), but very substantially so. And second, such an analysis undermines a key justification that the agencies provide for the SAFE Rule itself—that compliance costs for the baseline standards were too high and thus the SAFE Rule saves significant compliance costs. In reality, the agencies inflate the SAFE Rule's cost savings by ignoring how the industry actually works.

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Shortchanged

How the Trump Administration's Rollback of the Clean Car Standards Deprives Consumers of Fuel Savings

Institute *for* Policy Integrity
NEW YORK UNIVERSITY SCHOOL OF LAW

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Executive Summary

On April 30, 2020, the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) published the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule,[1] drastically rolling back the 2012 rule known as the Clean Car Standards.[2]

The Clean Car Standards were designed to save consumers hundreds of billions of dollars at the pump and significantly reduce greenhouse gas emissions from passenger vehicles by imposing average annual emissions cuts and fuel efficiency improvements, at a rate expected to increase efficiency by nearly 5% each year until reaching a fleetwide average of around 50 miles per gallon by 2025.[3]

The SAFE Rule, by contrast, will cause significant increases in emissions and fuel costs relative to the Clean Car Standards. The agencies admit that—even according to the most favorable numbers they can muster—their own cost-benefit analysis shows that the rollback is costly for society, resulting in $13.1–$22 *billion in net costs* when calculated at a 3% discount rate.[4] While the agencies claim that, under an alternative 7% discount rate, their rollback would instead show a few billion in gains,[5] at best the agencies admit that the rule's main cost-benefit analysis barely "straddle[s] zero."[6] And that is before considering the host of analytical flaws and omissions that still plague the agencies' main analysis, such as the tens of billions of dollars in climate costs that the agencies arbitrarily omit.[7] According to the agencies' own analysis, under the SAFE Rule, consumers will spend an additional $1,110 to $1,461 on gasoline over the life of the vehicle, depending on the discount rate used.[8] And the agencies admit that rolling back the Clean Car Standards will result in nearly a billion additional metric tons of carbon dioxide released into the atmosphere.[9]

The agencies landed on this analysis after their 2018 proposal to flatline the standards was roundly criticized, by public comments,[10] NHTSA's own peer review of the models,[11] EPA's Science Advisory Board,[12] and public articles.[13] That proposal showed net benefits for the rollback,[14] but to do so it relied heavily on spurious claims that a rollback would reduce car prices and then somehow—against the principles of basic economics—reduce the number of total cars on the road, thus yielding the alleged safety benefit of having fewer total vehicle-miles traveled overall.[15] In light of the harsh and valid critiques, the agencies could no longer rely on those inaccurate safety benefits calculated in their proposal.

Now, in the face of a cost-benefit analysis that at best "straddle[s] zero," the agencies struggle to find a justification for the SAFE Rule. At several points in the final rule, the agencies embrace a new economic analysis that focuses on upfront costs to manufacturers and consumers and claims that the Clean Car Standards' upfront costs were "too high."[16] But agencies are required to assess regulatory impacts from the perspective of society and are not permitted to "put a thumb on the scale by undervaluing the benefits and overvaluing the costs of more stringent standards."[17] And from the societal perspective, the agencies' own analysis shows that the Clean Car Standards' upfront costs were not "too high" when compared against long-term net benefits to consumers and the environment.

Buried in the thousands of pages that the agencies have published to justify the SAFE Rule is a "sensitivity case" that assumes that increased fuel economy must come at the expense of other vehicle features that consumers value, such as horsepower, and that the supposed "opportunity cost" of these lost features can be approximated by arbitrarily subtracting away a substantial portion of the valuable fuel savings that the Clean Car Standards would have delivered.[18] Though they explicitly do not adopt that sensitivity case, the agencies connect these “opportunity costs” to the “upfront costs” they prefer to focus on and also claim that, for consumers, these opportunity costs must offset the fuel saving benefits they would receive from increased vehicle efficiency.[19]

Only by selectively focusing on these hypothesized "opportunity costs" and artificially undercounting the lost fuel savings does the rollback begin to appear net beneficial.[20] Yet using a theory of opportunity costs to devalue fuel savings would represent a severely flawed and completely unjustified departure from how EPA and NHTSA have historically calculated the benefits of regulations that save fuel—and from how other agencies, such as the Department of Energy (DOE) and the Department of Interior, have calculated the benefits of energy savings—over the last four decades under administrations of both political parties.

Agencies have consistently used the full net present value of lifetime fuel savings to calculate the benefits of vehicle regulations, because doing so follows economic best practices and guidance for agency cost-benefit analysis. Due to market failures, consumers’ vehicle purchasing decisions may not take into account the full economic value of the future fuel savings they will experience over time—a phenomenon that economists have termed the “energy efficiency gap.” But avoided fuel consumption represents real resource savings to the economy regardless of what consumers expected at the time of purchase. And, once those savings appear in their pocketbooks, consumers will fully value and use that money—a dollar is a dollar, whether or not consumers fully expected or valued it when they were deciding which car to buy. It is precisely because market failures create a divergence between consumers’ *ex ante* valuation of potential fuel savings and their *ex post* realization of actual fuel savings that well-designed regulations to increase fuel efficiency will provide benefits to consumers and increase net public welfare. Weakening the standards will force society and consumers to forgo the full amount of those benefits, not merely a fraction of the benefits.

In the final rule, the agencies ultimately decline to take a clear position on the “energy efficiency gap” and calculate the full fuel savings in their main cost-benefit analysis.[21] Yet they repeatedly use the theory of opportunity costs to cast doubt on market failures, and they try to support their rollback by undermining the full valuation of the fuel savings from the Clean Car Standards. The agencies assert that the economic welfare from saving money at the pump might be offset because they incorrectly allege that the Clean Car Standards prevent consumers from buying vehicles with other features that they also value—features like horsepower, acceleration, or towing capacity. But that reasoning has never before been used in an energy saving regulation issued by NHTSA, EPA, or DOE. And for good reason: it has no sound basis.

First, the agencies’ novel explanation for the energy efficiency gap—that it might largely reflect a tradeoff with other vehicle features, like horsepower or acceleration, that consumers value more than energy savings—assumes away the existence of the market failures that cause consumers to miss out on fuel savings. But the economics research is clear that market failures play a substantial role in consumers’ failure to purchase vehicles with optimal levels of fuel economy. This rollback will cause consumers to lose out on valuable fuel efficiency improvements that they would have benefited from but may not have purchased on their own. The only way to reasonably to assess the Final Rule is to fully account for those losses.

Second, the agencies have not justified an assumption that requiring fuel economy improvements will necessarily lead manufacturers to reduce vehicle features to the detriment of consumers. Consumers remain free to demand—and automakers remain free to provide—whatever vehicle features consumers value, and the cost of additional features like acceleration would be reflected in the vehicle prices. Further, the wide availability of vehicle financing means that the cost of fuel economy improvements can be "paid for" out of the savings consumers save at the pump, and therefore consumers can save money from fuel economy improvements from the moment they purchase a vehicle. Nothing about the standards changes this reality. In fact, recent research suggests that fuel economy improvements may result in technology development that will also either automatically or cheaply provide other features that consumers value.

Third, an assumption that the Clean Car Standards would force consumers to give up vehicle features is plainly inconsistent with the agencies' evaluation of the cost of complying with the Clean Car Standards. The agencies analyze the costs of the vehicle standards by comparing the price of vehicles under the standards against the cost of identical vehicles without the fuel economy or emission improvements. The cost estimates assume that key vehicle features other than fuel economy will be unaffected by the standards. The agencies cannot both rely on a cost analysis that assumes the vehicle fleet will be identical except for the change in fuel economy, while at the same time arguing that the vehicle fleet will be different and that the difference will cause consumers to experience a welfare loss. If the agencies want to assume that manufacturers will trade off other vehicle features to achieve fuel economy, then the agencies would have to significantly lower their estimates of compliance costs for the Clean Car Standards, as well as model how much manufacturers would charge to install those other vehicle features—all of which would ultimately show that their rollback will not achieve the cost savings they attribute to it.

Fourth, the literature that the agencies cite to support the theory of opportunity costs is sparse and does not provide sufficient justification for any radical departures from past regulatory approaches. The agencies have also ignored contrary evidence, including studies commissioned by EPA that have found that increased fuel economy is not associated with negative evaluations of vehicle performance or other attributes.

Finally, it is not even clear that consumers would benefit, on net, if other attributes like acceleration continued to increase indefinitely across the entire fleet, because consumers may value only their own vehicle's *relative* acceleration as compared to the rest of the fleet, and do not necessarily benefit from an absolute increase in fleetwide acceleration. In fact, increasing the overall level of acceleration among new vehicles likely would increase the seriousness of accidents—a cost that would have to be taken into account along with any alleged benefits of increasing vehicle features. As the agencies' discussion of opportunity costs does not address these issues, it is incomplete and misleading.

While this report focuses on how the agencies' theory of opportunity costs fails to accurately consider the value of the fuel that would have been saved with more efficient vehicles, it is important to recognize that this is only one of many analytical errors that the agencies have made. For example, the agencies have also drastically undercounted the climate change damages from weakening greenhouse gas emission requirements.[22] The agencies used flawed models that overestimate the cost of technology needed to improve fuel economy and have failed to properly account for flexibility mechanisms that reduce compliance costs.[23] And the agencies continue to claim the Clean Car Standards would impose safety costs that are not supported by credible modeling.[24]

Put together, these and other serious errors lead the agencies to the demonstrably wrong conclusion—that rolling back the Clean Car Standards can be justified by focusing on upfront vehicle price effects while ignoring longer term losses to fuel savings and the environment. Correcting these errors would show that the agencies have taken an action that will cause much more harm than good to the pocketbooks and health of American consumers and that, overall, will leave America seriously shortchanged.

I. Background on Regulation of Vehicle Emissions and Fuel Economy

Under the Clean Air Act, EPA sets limits on the air pollution—including greenhouse gases—emitted by new cars and light trucks ("light-duty vehicles") sold in the United States.[25] Under the Energy Policy and Conservation Act ("EPCA"), NHTSA establishes Corporate Average Fuel Economy ("CAFE") Standards for light-duty vehicles to regulate fuel consumption.[26] Since 2010, EPA and NHTSA have implemented a coordinated regulatory program that establishes harmonized greenhouse gas and fuel economy standards under the two statutes.[27]

A. Vehicle Emissions Standards and Fuel Economy Standards Deliver Important Consumer Savings and Other Benefits

Government regulation is most typically justified to correct a "market failure": an inefficient outcome in which the market, left to itself, fails to allocate goods in the way that will maximize net social welfare. A classic market failure is pollution. For example, drivers do not fully consider how their vehicle choices and driving decisions affect the rest of society by emitting pollution from the production and combustion of gasoline. Without regulation, drivers can "externalize" those pollution costs onto society and so choose vehicles that emit an inefficient amount of pollution. Regulations, like vehicle emissions standards and fuel economy standards, can correct this market failure by addressing the pollution externality and efficiently requiring consumers to "internalize" their pollution costs by purchasing vehicles with technologies to reduce the combustion of gasoline per mile. If the total benefits of the regulation (such as the health and environmental benefits of reducing pollution) outweigh the regulatory costs (such as an increase in vehicle prices), then the regulation is cost-benefit justified and efficient.

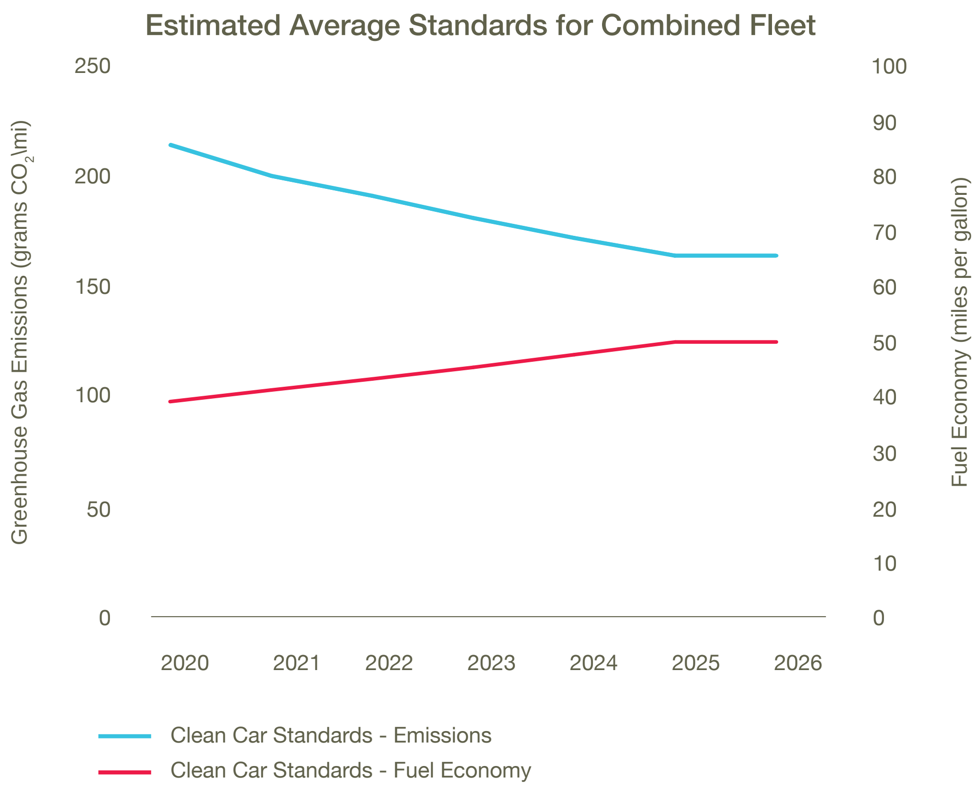
Besides the social benefits of decreasing pollution and improving energy security by reducing the consumption of gasoline,[28] vehicle emissions standards and fuel economy standards also deliver private benefits for consumers. Energy efficiency standards produce benefits by enabling consumers to receive a given level of services at lower operating costs. In the case of automobile fuel economy, consumers receive a given level of transportation services (vehicle-miles traveled) while spending less on fuel. Not only do more efficient vehicles require less gasoline per mile driven—meaning that consumers pay less for each mile they have to drive—but consumers also can drive farther on each gallon of gas and stop less often to refuel.[29]

While perfectly informed and fully rational consumers could, in theory, achieve these benefits for themselves under optimal market conditions simply by purchasing more efficient vehicles, as the economics literature has explored in detail, real-world consumers often make upfront vehicle purchasing decisions that fail to fully account for future fuel savings.[30] Fuel efficiency technologies save consumers and society money over the life of a vehicle, but those technologies also may increase the initial purchase price of a vehicle. Economic theory predicts that a rational consumer will choose to buy a vehicle with greater fuel efficiency as long as the marginal cost of the upfront purchase price is at least slightly less than the expected marginal benefit of fuel savings (that is, the net present value of the fuel saved).[31] However, in practice, consumers do not always behave consistently with standard economic theory.[32] Real consumers may not always be willing to pay $1 more when purchasing a vehicle today in exchange for an expected savings in future fuel costs that would be worth today just over $1. Instead consumers may demand much more than $1 in net present expected fuel savings before they are willing to pay $1 upfront to purchase a more efficient vehicle. Another way of expressing the same phenomenon is by measuring the implicit rate at which consumers discount future fuel savings when purchasing vehicles. In practice, consumers appear to use irrationally high discount rates—that is, they treat future fuel savings as worth very little today.[33] In the economics literature, this observed fact is termed the "energy paradox" or "energy efficiency gap."[34]

A suite of market failures collectively explains the energy efficiency gap: for example, consumers face informational costs to acquire and act on fuel-economy data; consumers experience "loss aversion" and so irrationally inflate the cost of an upfront expense over the benefits of long-term savings; manufacturers confront a first-mover disincentive that discourages being the first to experiment with new fuel-economy technologies; and so forth. Section IV below explores the details and empirical support for these market failures more thoroughly. But the general existence of these market failures explains why consumers are not, in fact, able to demand the optimal amount of fuel economy in the unregulated marketplace. Regulations that address these market failures, therefore, achieve not just social benefits but private benefits for consumers as well. Both EPA and NHTSA had long recognized and acted on such market failures (*see infra* Section V), and in 2012 they reaffirmed the need to address these market failures through efficient regulation.

B. In 2012, the Agencies Established Emissions and Fuel Economy Standards—and in 2016-2017, They Reaffirmed Those Standards

In 2012, EPA and NHTSA jointly issued the Clean Car Standards, harmonizing greenhouse gas emissions and fuel economy standards for light-duty vehicles in model years 2017 through 2021.[35] In the 2012 rulemaking, EPA also promulgated emission standards for model years 2022 through 2025. Due to limitations in NHTSA's statutory authority,[36] the fuel economy standards set in 2012 could not yet extend through model year 2025. Rather, NHTSA identified fuel economy standards for model years 2022 through 2025 that represented its best estimate of what the maximum feasible fuel economy standards would be for those model years.[37]



The Clean Car Standards were expected to result in an increase in fuel economy and a decrease in greenhouse gas emission rates of, on average, approximately 5 percent per year.[38] The standards were supported by extensive technical and economic analyses.[39] EPA and NHTSA conducted a rigorous cost-benefit analysis that showed the Clean Car Standards would result in over $450 billion in net benefits, with any increase in consumer costs significantly outweighed by fuel savings, greenhouse gas emission reductions, and other benefits.[40]

As part of the 2012 joint rulemaking, NHTSA made a commitment to evaluate the appropriateness of model year 2022–2025 standards by 2018 and to promulgate standards for those model year vehicles based on that evaluation.[41] In the same rulemaking, EPA also made a commitment to reassess the appropriateness of the standards for model years 2022–2025 by 2018.[42] As a result, from 2015 to 2017, the agencies conducted a "Midterm Evaluation" of the model year 2022–2025 standards, including extensive analysis undertaken in coordination with the California Air Resources Board (CARB). This analysis, as described in a 1200-page Draft Technical Assessment Report (TAR), confirmed that the Clean Car Standards would result in substantial net benefits.[43] In particular, the TAR, the Technical Support Document (TSD) for EPA's Proposed Determination to reaffirm the standards, and the exhaustive response to public comments received during the Midterm Evaluation all confirmed that consumers would experience substantial fuel savings from the standards, that those fuel savings should be fully counted as the private benefits of correcting ongoing market failures, and that there was no evidence that consumers would experience negative tradeoffs between fuel economy and vehicle performance under the standards.[44] The agencies' analyses drew heavily on a National Research Council report, which reached similar conclusions about technological feasibility and the costs and benefits of the Clean Car Standards.[45] In January 2017, EPA issued a Final Determination that the Clean Car Standards remained appropriate and would result in substantial improvements in economic welfare, based in part on the conclusion that improvements in technology would allow the standards to be reached at significantly lower cost than originally projected.[46] In fact, EPA's Administrator found that the record supported further increasing the stringency of the standards, but she declined to do so, citing the value of regulatory certainty.[47]

C. In 2018, EPA and NHTSA Proposed to Weaken the Clean Car Standards

Notwithstanding the extensive analyses from the National Research Council and the Midterm Evaluation, in April 2018, EPA withdrew its 2017 Final Determination and issued a new conclusion that the Clean Car Standards were "not appropriate."[48] EPA announced it would consider revising the greenhouse gas emission standards in coordination with NHTSA.[49]

In August 2018, EPA and NHTSA issued a proposal to freeze both fuel economy and greenhouse gas emission standards at their model year 2020 levels and apply those frozen standards at least through model year 2026.[50] The agencies made a number of unsupportable changes to the analytical approach they had taken when promulgating the Clean Car Standards and during their Midterm Evaluation of those standards. Based on these unsound changes to their analysis, the agencies found in 2018 that, contrary to all prior analyses, the Clean Car Standards would instead impose high consumer costs and safety costs while achieving only limited environmental benefits.

Most prominently, the agencies claimed that the Clean Car Standards would impose substantial safety costs because they would cause an increase in driving. Specifically, the agencies' deeply flawed economic modeling predicted that consumers would retain their used cars for longer than they otherwise would have, which would lead, in turn, to both a massive increase in the total number of cars on the road as well as an increase in total vehicle-miles traveled.[51] And because more cars and vehicle-miles traveled translates into more traffic accidents, the increase in vehicle-miles traveled meant that the agencies could claim that the Clean Car Standards would lead to a substantial increase in fatalities.

But while economic theory might support the idea that new vehicle price increases could change the *distribution* of new and used vehicles, economic theory provides no support for the idea that a shift from new to used vehicles will cause an increase in the *total number* of vehicles on the road.[52] In fact, if the Clean Car Standards were to increase the price of both new and used vehicles, and that increase exceeded consumers' valuation of future fuel savings, standard economic theory would predict a *reduction* in the number of vehicles. As the price of all vehicles goes up, consumers would be expected to reduce vehicle purchases, such as by forgoing buying a used car for their teen or shifting to alternative modes of transportation.

Nor does the academic literature or standard economic theory support the proposed rollback's assumption that with more vehicles on the road, total vehicle-miles traveled would increase irrespective of demand for driving. Again, if anything, an increase in the purchase price of both new and used vehicles would, all other things equal, likely cause aggregate vehicle-miles traveled to decrease.[53] This is because if vehicle purchasers faced higher vehicle purchase prices, they would have less money to spend on other things, including on fuel for driving.[54]

These conceptual errors, as well as myriad methodological problems with the specific models the agencies developed,[55] led the very experts whose work formed the basis of the agencies' proposed safety conclusions to roundly criticize those conclusions.[56] The press reported that the agencies had "flunked [their] math homework."[57]

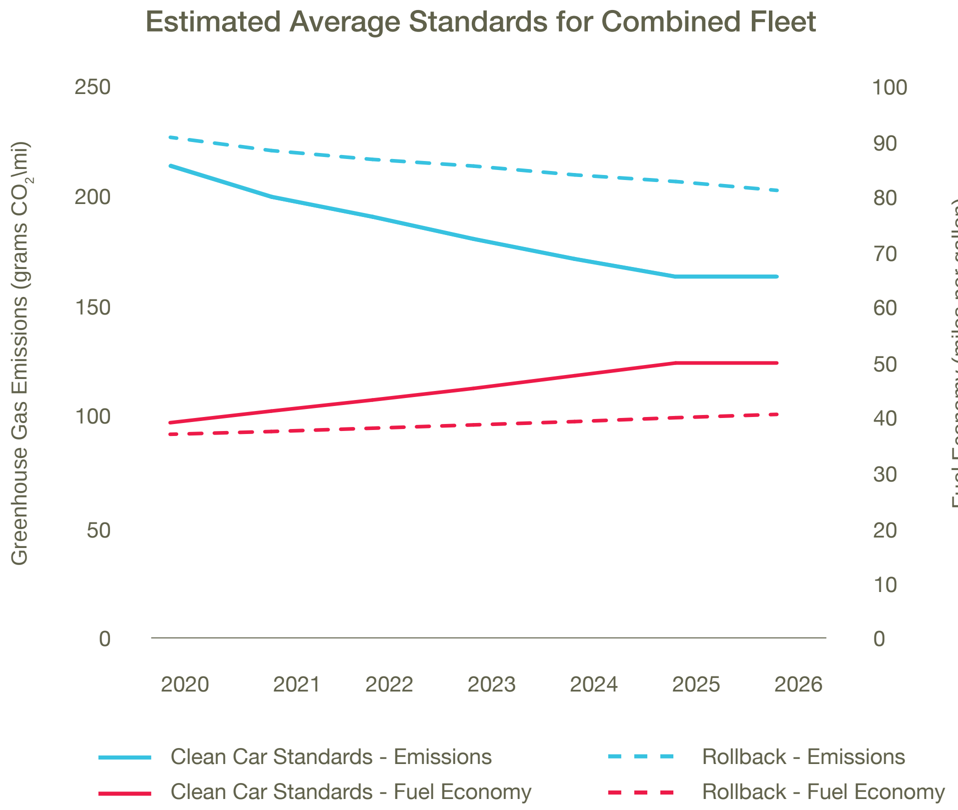
The proposal also contained a few additional flawed, underexplained, and unsupported hypotheticals, which would later reemerge in altered form during the final rollback. The proposed rollback's cost-benefit analysis appropriately counted all the lost fuel savings that consumers would miss out on without the more efficient vehicles produced under the Clean Car Standards.[58] But the agencies also very briefly described—buried fifteen hundred pages deep into the regulatory impact analysis—two "sensitivity cases" that instead imagined what the costs and benefits would be if consumers valued less than 100% of their total fuel savings and other benefits.[59] The agencies did not endorse these scenarios and gave no justification for why these notional scenarios should be considered or what the implications of considering them were.

Entirely separately, the agencies also speculated in the proposed rollback that perhaps the addition of fuel economy technologies would result in some losses of other vehicle attributes, like horsepower. Making no effort to respond to the Midterm Evaluation's firm rebuttal of that very same argument not even two years earlier, the proposal cited sparse and questionable evidence to produce what it called "illustrative" and "rough" estimates of the so-called "opportunity cost" of supposed forgone attributes of vehicle performance.[60] Specifically, the agencies attempted to estimate the alleged tradeoffs between fuel economy and either horsepower, torque, weight, or volume, and then value consumers' willingness to pay for those specific attributes. Both prongs of that analysis were seriously flawed however, as commenters explained.[61] For example, the Midterm Evaluation had announced that EPA would commission a study to investigate consumers' willingness to pay for specific attributes like horsepower as a measure of possible opportunity costs.[62] But that study found, in 2018, that there was "very little useful consensus" in the literature on such estimates and, as a result, the methodology of trying to assign specific dollar values to allegedly lost vehicle attributes was of "little use for informing policy decisions."[63]

The agencies admitted in the proposal that their estimates of opportunity costs "were not developed at the same level of detail or precision" as the rest of the analysis; consequently, the agencies never attempted to incorporate their proposed estimates even into a sensitivity case let alone into their main analysis.[64] In their final rollback, the agencies abandon that particular methodology of attempting to measure willingness to pay for specific allegedly lost attributes, which sent the agencies in search instead of related but novel economic tricks to try to support their rollback.

II. EPA and NHTSA's Final Rollback Invokes a Novel and Untenable Economic Analysis of Opportunity Costs

In April 2020, EPA and NHTSA issued a final rule that substantially weakens greenhouse gas emission and fuel economy standards as compared to the Clean Car Standards.[65] The Clean Car Standards would have required, on average, 5% annual reductions in greenhouse gas emissions and increases in fuel economy for model years 2021 through 2025; the SAFE Rule is dramatically weaker, requiring only 1.5% annual improvements.[66] Even under the agencies' own analysis, compared to the Clean Car Standards, the SAFE Rule will cost individual drivers up to $1500 more on gasoline over the life of their vehicles,[67] and vehicles will emit nearly a billion additional metric tons of carbon dioxide.[68] But these estimates of consumer losses and environmental losses from rolling back the Clean Car Standards may be grossly understated, as the agencies project—without any valid basis—that automakers will voluntarily over-comply with the SAFE Rule's standards.[69] That unjustifiable projection effectively erases from the agencies' analysis significant additional fuel-savings and greenhouse gas benefits that the Clean Car Standards would have achieved.[70]



In the Final Rule, the agencies have made some methodological changes that reduce the unexplained extra driving and therefore the safety costs that the proposed rollback had previously attributed to the Clean Car Standards. As a result of the agencies' new (though still flawed[71]) assumptions, the projected safety costs that they previously pointed to in order to support rolling back the Clean Car Standards have in large part disappeared.

The agencies now admit that—even according to the most favorable numbers they can muster—their own cost-benefit analysis shows that the rollback is costly for society, resulting in $13.1–$22 *billion in net costs* when calculated at a 3% discount rate.[72] While the agencies claim that, under an alternative 7% discount rate, their rollback would instead show $6.4–$16.1 billion in gains,[73] averaging together those two ranges of estimates from the different discount rates still strongly suggests that the rollback's cost-benefit analysis is likely underwater by billions of dollars in social losses.[74] At best, the agencies' analysis shows that the Final Rule's net benefits barely "straddle zero."[75] And that is before considering the host of analytical flaws and omissions that still plague the agencies' main analysis, such as the tens of billions of dollars in climate costs that the agencies arbitrarily omit.[76]

To justify this rollback when the benefits are "directionally uncertain,"[77] the agencies claim they can focus their regulatory choice on avoiding the Clean Car Standards' "upfront costs"—meaning both the price of purchasing a more efficient vehicle and the "opportunity cost" to consumers of supposedly having to forgo vehicle performance to achieve fuel economy.[78] The focus on upfront costs effectively ignores or devalues a sizeable chunk of the substantial longer-term lost fuel savings, as if consumers would not value having more money in their pockets in the future.[79] Indeed, such an emphasis on upfront costs is akin to selectively and inconsistently applying a very high discount rate just to future fuel savings, but not to future payments on vehicle loans, in contravention of guidelines for best analytical practices.[80]

To support their focus on upfront costs, the agencies hypothesize that consumers must experience opportunity costs from lost attributes, a theory that the agencies propound based on scant empirical evidence and with no effort to respond to the contrary evidence from the Midterm Evaluation and public comments that no such opportunity cost tradeoff exists.[81] The agencies even try to go so far as to claim that the possibility of opportunity costs—together with an unsubstantiated assertion that it may be perfectly rational for consumers to apply exceedingly high discount rates to future fuel savings—could explain away all private market failures and the existence of the energy efficiency gap.[82]

Then the agencies speculate that, if there are no market failures besides pollution and energy security, perhaps there may be no private cost savings for regulations to address, and the agencies may be able to ignore *all* the forgone consumer benefits of their rollback.[83] Though their main cost-benefit tables continue to fully value fuel savings,[84] the agencies muse at several points in the final rule about whether they could ignore all the rollback's "$26.1 billion in private losses to consumers," and focus instead only on the external gains they attribute to the rollback.[85] They also assert that fully valuing lifetime fuel savings actually "distorts the comparison," because they believe that "upfront" costs, like opportunity costs, are the "more important factor."[86] As a somewhat less extreme alternative to ignoring 100% of consumer losses, the agencies also propose as a sensitivity analysis that perhaps they can place a dollar figure on the alleged opportunity costs. But recognizing they have no way to accurately estimate such a cost directly, and so unwilling to repeat the flawed methodology from the proposed rollback, the agencies instead suggest subtracting 42 months' worth of fuel savings—a significant portion of total fuel savings, and an amount based on an unsound methodology—as a proxy estimate for the sensitivity analysis.[87] Only by ignoring the lost consumer benefits or significantly undercounting them as in the sensitivity case, could the agencies' rollback finally start to appear cost-benefit justified.[88] But the agencies did not adopt their sensitivity analysis into the main calculations of the Final Rule's costs and benefits, thus demonstrating that even they doubt the basis for such estimates of opportunity costs.

The remainder of this report details why the suggestion that a theory of opportunity costs might support a focus on upfront costs, while erasing a significant portion of consumer benefits, is flawed at every step of the analysis. As explained in Section III, there is no evidence that hidden opportunity costs[89] would have occurred under the Clean Car Standards: the agencies' analysis is theoretically and empirically weak, their own model already accounts for possible tradeoffs between fuel economy and other vehicle features, and the agencies also observe that many fuel economy-technologies actually improve other vehicle attributes. Instead of such allegedly hidden opportunity costs, Section IV recalls that it is market failures that explain the energy efficiency gap and so justify the use of efficient regulations to achieve private cost savings. Section V details how any undercounting of consumer benefits would fly in the face of past practice across agencies over the last four decades under Administrations of both political parties and, further, is inconsistent with best practices for agency economic analysis. Finally, as shown in Section VI, the agencies' attempt in the sensitivity analysis to monetize the opportunity costs related to consumers' valuation of other vehicle characteristics does not withstand scrutiny, especially as the agencies ignore the effect of those other vehicle characteristics on compliance costs and externalities like safety effects.

In short, the agencies wrongfully cast doubt on well-established market failures and wave their hands toward suspect estimates of opportunity costs to justify an otherwise costly rollback. Their attempts fail, and the agencies cannot escape the reality that their rollback shortchanges consumers by depriving them of valuable fuel savings.

III. The Agencies Do Not Prove That Any Hidden Opportunity Costs Exist

The agencies' entire argument for why they might be able to ignore a significant portion of consumer benefits hinges on the premise that "consumers have a scarcity of resources," that manufacturers and consumers must make tradeoffs between fuel economy and other vehicle features,[90] and therefore that consumers face an "up-front . . . opportunity cost of any other desirable features that consumers give up when they choose the more efficient [vehicle]."[91] For each element of that premise, the agencies fail to marshal adequate theoretical or empirical support, and they fail to square their assertions with contrary evidence from public comments, past agency evaluations, and even other portions of the agencies' own regulatory impact analysis. Many fuel economy technologies increase performance or are entirely compatible with other vehicle features. Even if manufacturers may occasionally reduce select vehicle features like weight to achieve an inexpensive boost to fuel economy, such compliance choices would significantly decrease regulatory costs in ways that the agencies have not accounted for, may lead to other benefits that the agencies have not accounted for, and are unlikely to ultimately decrease net consumer welfare (*see infra* Section VI). In short, the agencies' claims about potential widespread consumer welfare losses from opportunity costs under the Clean Car Standards are not supported by the evidence they present.

A. The Agencies Ignore That Consumers Can Access Financing to Purchase Fuel-Economy Technologies That Will Pay for Themselves

The agencies claim that consumers are forced by budget constraints to forgo other features in order to purchase vehicles that meet fuel economy requirements.[92] The agencies ultimately do not even have quite enough confidence in this claim to base their main cost-benefit analysis on it.[93] In any event, the agencies have not explained why consumers would be unable to purchase vehicles with improved fuel economy *and* any desired other features. In the absence of market failures, a rational consumer would continue to demand fuel economy improvements until the net present value of fuel savings[94] just meets the upfront cost of adding fuel efficiency technology.[95] This conclusion does not change even if certain specific attribute improvements were somehow inconsistent with certain specific fuel-economy technologies. There are many technological options for improving fuel economy, and there are many technological options for improving other features such as performance; some technologies even improve *both* fuel economy *and* performance or other attributes simultaneously, and there is no reason to assume the rest of the technological options are inherently incompatible.[96] If there were no market failures, manufacturers would be expected to provide the optimal level of fuel economy and the optimal level of other vehicle features. Technology that increases fuel savings would be included up to the level that the net present value of the fuel savings is equal to the cost of the technology, *and* other features would also be provided up to the level that consumers value those features. This is true even if, as would be expected, adding both fuel economy and other features further increases the upfront purchase price of a vehicle, so long as the additional features are valued by the consumer at least as much as they changed the cost of the vehicle, and so long as additional fuel efficiency technology would still save consumers money *on net*.

The agencies claim that consumers' fixed budgets constrain their ability to pay upfront for a car that has both fuel economy improvements and all of the additional features they want.[97] But especially given that 85% of new vehicle purchases are financed by loans,[98] the wide availability of vehicle financing means that a consumer's budget constraint should not force them to choose between fuel savings and other features. Fuel economy improvements save consumers money every time they drive. A rational consumer would be willing to pay for the additional cost of greater fuel economy through a higher monthly loan payment, which will be offset over time by the economic value of fuel saved—and, similarly, a rational bank or lender would be willing to offer such a loan affordably, knowing that the long-term fuel savings will help the consumer make the monthly loan payments. A consumer that wants and is willing to pay for a vehicle with an additional feature (such as greater horsepower) should still have the same ability to buy that feature under the Clean Car Standards: they simply also have to either pay upfront or adjust their loan to finance enough fuel economy technologies to meet the regulatory requirements—but the lifetime fuel savings will pay back the cost of those additional technologies.[99] The agencies never explain why they think consumers are rationally weighing upfront opportunity costs against longer term fuel savings but are simultaneously being irrational about accessing the credit market to finance fuel efficiency technologies that can pay for themselves.

With sufficient financing options, price should never make these vehicle features mutually exclusive. In fact, evidence in the rulemaking record suggests that there are plenty of loans that offer consumers *rate reductions* for fuel-efficient vehicles.[100] If consumers were systematically unable or unwilling to access an efficient credit market to finance cost-saving fuel economy technologies, that itself suggests the existence of a market failure, and such a market failure would justify regulation. The agencies never explain why an efficient credit market would not preclude their claims about opportunity costs.

B. The Agencies Offer No Consistent Theory of Unaccounted Technological Tradeoffs

Absent market failures, the only cases in which there would be a tradeoff between fuel economy and other features would be if there is a technical or engineering constraint that prevented manufacturers from adding those features *and* adding technology that improves fuel efficiency,[101] or if the technology for improving fuel economy necessarily increases the marginal cost of adding additional features (such as the cost of adding the next unit of performance). The agencies have not shown that these conditions occur frequently enough to support their claims that the standards "have a significant impact on vehicle utility and performance."[102]

To the contrary, the agencies admit that many technologies can provide both improved fuel economy and improved performance, undercutting their theory that all fuel economy improvements entail opportunity costs.[103] Examples listed in the final regulatory impact analysis include increasing the number of gear ratios in new transmissions to help the engine both run more efficiently and in the optimal "power band" for performance;[104] small mass reductions that improve both fuel economy and performance;[105] turbocharging;[106] certain hybridization technologies, which simultaneously and necessarily improve both fuel economy and performance;[107] and other options discussed by the agencies and commenters.[108] Previously, during the Midterm Evaluation, the agencies also listed numerous examples of how fuel-economy technologies could improve braking, handling, towing, hauling, steering responsiveness, torque vectoring, and multiple other non-performance attributes: for example, high-strength aluminum alloy bodies can provide better towing, better performance, *and also* improve fuel economy and reduce greenhouse gas emissions.[109]

In fact, "[i]n response to [public] comments," the agencies conducted an analysis of how different regulatory alternatives would affect fleetwide performance, and they initially calculated that the original Clean Car Standards might have *increased* vehicle acceleration times by 7.5%, versus only a 3.1% improvement to acceleration achieved under the agencies' own proposed rollback.[110] After making certain "refinements" to the sales data and changing other analytical assumptions, the agencies still find only a "negligible 0.1 percent difference" in acceleration between the Clean Car Standards and the proposed rollback.[111] Thus, regardless of which estimate is accurate, the agencies' own analysis shows it is at least possible that more stringent regulatory standards can improve performance and, even in the worst-case analysis, there is only a "negligible" difference in performance.

A negligible difference in vehicle performance between various regulatory alternatives would not be surprising because, assuming any tradeoffs even exist between fuel economy and other attributes, the agencies' model for estimating compliance costs already accounts for such tradeoffs by holding key attributes "constant"[112] to "maintain performance neutrality."[113] In other words, the model assumes that manufacturers will spend whatever additional costs are necessary to hold constant all the key non-fuel economy features of their vehicles.[114] If, for example, installing some specific fuel economy technology in a particular vehicle were to reduce that vehicle's acceleration times, the agencies' model adds in the extra costs of installing yet more improvements to bring those acceleration times back up to par.[115] According to the agencies' description of their model, this assumption *"eliminates the need to assess"* any possible opportunity costs,[116] because key performance characteristics are held constant across regulatory alternatives, and the agencies conclude that any other attribute changes not directly accounted for by their model would be "de minimis."[117] In fact, the agencies admit that if any attribute changes are not fully accounted for in their model already, there is no reason to think that the unaccounted for attribute changes are degradations rather than improvements in performance,[118] especially given the number of technological options that improve both fuel economy and other attributes simultaneously.[119]

The agencies' preliminary regulatory impact analysis for their proposed rollback offered yet one more admission that there should be no significant opportunity costs on net (though the relevant language was deleted from the final regulatory impact analysis, without explanation). The preliminary regulatory impact analysis explained that the agencies' baseline assumptions about what the vehicle fleet will look like without any further regulatory changes simplifies conditions by omitting the normal, gradual improvements in technology that would naturally lead to annual improvements of vehicle features.[120] In the preliminary regulatory impact analysis, the agencies explained how this simplifying assumption resulted in an overestimate of the actual compliance costs to achieve fuel economy improvements, and that overestimate would at least partly, if not entirely, offset any opportunity costs.[121]

In sum, the agencies' own analysis shows that fuel economy technologies will often improve vehicle performance, that vehicle performance under more stringent standards should be negligibly different or even improved compared to weaker standards, and that the costs to avoid consumer welfare impacts from any possible attribute-tradeoffs have already been accounted for in the model and compliance cost estimates. To repeat: manufacturers can combine technologies and attributes in multiple packages, many of which entail no performance tradeoff, and the agencies' compliance cost model assumes that manufacturers will add whatever extra costs may be necessary to hold vehicle performance constant. Of course, in the real world, it is possible that manufacturers are not offering vehicles that combine fuel economy with other features that consumers are willing to pay for. But such an occurrence would be symptomatic of a supply-side market failure (*see infra* Section IV), and the solution to such market failures would be efficient regulation.

C. The Agencies Offer Very Limited Empirical Evidence for Their Opportunity Cost Theory

The agencies' asserted "ample empirical evidence . . . from different authors" of a tradeoff between fuel economy and other vehicle attributes is based on just *two studies*—"Knittel" and "Klier and Linn"—neither of which looks at any attribute besides weight and horsepower/torque.[122] Moreover, the evidence available from those two studies does not support the agencies' specific claims. One of the studies (Klier & Linn 2016), for example, found "no evidence that the standards affected the direction" of technology adoption between fuel economy and other attributes for U.S. cars,[123] and even with respect to the rate of technological adoption for increasing other attributes, the study found rather mixed evidence for both U.S. cars and trucks.[124] For the other study (Knittel 2012), the agencies seem to actually be citing figures from an older, unpublished version of the analysis,[125] and they fail to disclaim that some of the numbers they cite in the final rule (like torque for cars) were not statistically significant.[126] In fact, the agencies seem to *invert all the data* from these studies. For example, the agencies claim that "Klier & Linn estimate reducing the average fuel economy of cars by one percent would enable producers to increase their average horsepower by 0.24 percent"[127]—but Klier & Linn actually reported the relationship in the opposite direction: that a one percent increase in horsepower (not in fuel economy) decreases fuel economy (not horsepower) by 0.24 percent.[128]

Perhaps tellingly, the agencies dropped a study they had cited in the preliminary regulatory impact analysis—a paper they listed as "Mackenzie."[129] Though it is not obvious which paper they meant, the reference is almost certainly to a 2015 paper by MacKenzie and Heywood. During the Midterm Evaluation, the agencies had discussed that paper at length specifically because it had raised significant "questions" about the methodology employed by the other two works.[130]

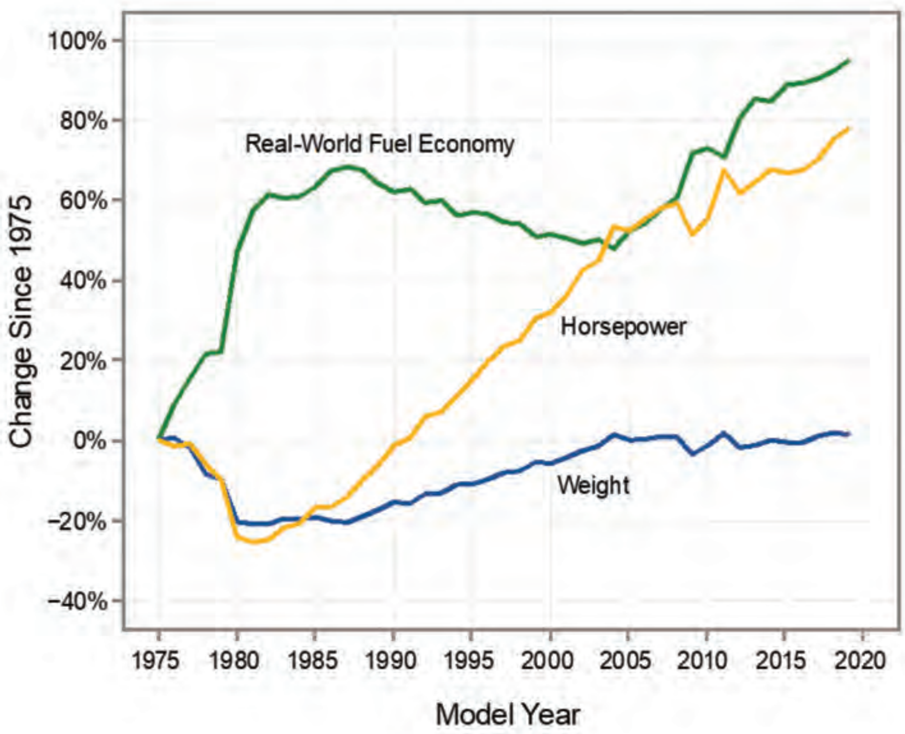
More broadly, the Midterm Evaluation heavily criticized the three works by Knittel, Klier & Linn, and MacKenzie & Heywood.[131] Among other problems highlighted by the agencies: the works largely assume no technological progress, and especially do not allow for innovations in the powertrain or technologies like strong, lightweight aluminum frames, thus overlooking the possibility for future technologies to improve both fuel economy and performance;[132] the works similarly do not allow for the possibility that regulatory standards could stimulate innovation;[133] they largely focus on changes in absolute horsepower, when consumers probably only care about relative acceleration or harder-to-quantify related attributes like handling and cornering;[134] and their data is skewed by the vehicles and technological combinations that historically have been made available by manufacturers for sale, which are affected by the very supply-side market failures that regulations can address.[135] The Midterm Evaluation reviewed both Knittel and Klier & Linn and found "statistical flaws that reduce their usefulness in projecting future trends."[136] In relying heavily on these two studies to support their entire claim that opportunity costs should now count against the Clean Car Standards' hundreds of billions of dollars in consumer fuel savings, the agencies fail to grapple with any of these past criticisms.

D. The Agencies Ignore Contrary Evidence

Public comments,[137] the agencies own prior evaluations,[138] research that the agencies themselves have commissioned,[139] and other evidence presented in the rulemaking record[140] all offer a contrary view: that there is no evidence of that negative performance is systematically associated with fuel economy technologies.[141] In fact, research has shown that the probability of a vehicle obtaining a negative evaluation of its operational characteristics is lower when that vehicle has fuel-saving technologies;[142] that any possible performance tradeoffs would likely decline over time;[143] and that "learning by doing" and knowledge spillovers should reduce manufacturers' compliance costs in ways that may obviate any need for tradeoffs.[144]

More generally, as the agencies have observed in prior evaluations, historical empirical evidence shows that automakers have been able to add fuel economy without creating a technical constraint on the amount of other features that can be added to vehicles.[145] As a recent figure from the 2019 EPA Automotive Trends Report (reproduced below) demonstrates,[146] since 2008, fuel economy began to rise (as a result of standards adopted by the agencies), yet features such as horsepower and weight continued on a similar upward path as they had prior to adoption of the standards. That graphical evidence certainly does not reveal any apparent tradeoff between increasing fuel economy and the continued increase in horsepower.

Relative Change in Fuel Economy, Weight, and Horsepower Over Time, from EPA's 2019 Automotive Trends Report



Furthermore, recent technological advancements have likely disrupted any historical tradeoffs between fuel economy and vehicle features that may have occurred before 2008 and that the agencies now try use to support their claims about future, ongoing tradeoffs.[147] As part of the Midterm Evaluation, EPA found that the recent simultaneous increase in fuel economy and vehicle features since 2008 reflects the fact that any historical tradeoff between performance and fuel economy is far less likely to hold for advanced technology engines.[148] EPA also pointed to literature that there may be technical limitations on increasing certain features such as acceleration that are independent of fuel economy improvements.[149] Recent studies using more sophisticated methodologies have confirmed this finding.[150] More recent literature also notes that learning by doing and knowledge spillovers should further reduce compliance costs, making any tradeoffs less necessary and potentially non-existent.[151] Studies suggest that this may be caused by a countervailing effect whereby the increased innovation spurred by the standards ultimately enables manufacturers to also provide other features at lower cost.[152] As the agencies discussed in the Midterm Evaluation, in the absence of a forcing mechanism like regulation, risk-averse manufacturers—which face first-mover disadvantages, switchover disruptions, and other barriers—are likely to apply only smaller, incremental innovations to fuel economy, instead of pursuing more major advances that may have greater potential to improve both fuel economy and performance simultaneously.[153] Consequently, regulation-induced innovation could be especially important to consider.

As a result of all of this uncertainty, in their economic analysis of the proposed rule, the agencies found that "sufficiently detailed information on the potential improvements in car and light truck attributes . . . is not currently available,"[154] and that "the specific improvements in attributes other than fuel economy that producers are likely to make to their individual car and light truck models when they face less demanding fuel economy standards cannot be estimated."[155] This conclusion was supported by the EPA's Science Advisory Board.[156] The agencies have not provided any reason to depart from these prior conclusions.

IV. Market Failures Cause the "Energy Efficiency Gap," and So Regulations Are Warranted to Deliver Both Private and Social Net Benefits

The agencies muse repeatedly through the final rule that, if only they could prove that no private market failures were responsible for consumers underinvesting in fuel economy, or if only the energy efficiency gap were not real, they might be able to ignore *all* the forgone consumer benefits of their rollback. Ultimately the agencies balked at taking that leap and instead continued to fully value fuel savings in their main cost-benefit tables.[157] Nonetheless, the agencies speculate at several points that "if no market failure exists to motivate the $26.1 billion in private losses to consumers," then the rollback would appear to be beneficial.[158] But there is no basis for that hypothesis.

The agencies put forward three ideas about why the energy efficiency gap either does not exist or is not caused by market failure.[159] One is their theory of opportunity costs, suggesting that consumers are unwilling to spend an additional $1 to purchase a vehicle that will save them more than $1 in fuel because there are hidden opportunity costs not being measured. The agencies attempt to deploy their concept of opportunity costs as a pretext to dismiss various market failures: for example, the agencies claim that consumers are not myopically undervaluing long-term savings or irrationally exhibiting loss aversion toward upfront purchase prices, but instead "simply value differences in vehicles' other attributes more highly than they do fuel economy, which would not reveal irrational or myopic behavior."[160]

Section III above showed the many flaws with the agencies' handling of opportunity costs. Additionally, the two papers that the agencies rely on for their theory of opportunity costs—Knittel (2012) and Klier & Linn (2016)—never make any connection between opportunity costs and the energy efficiency paradox.[161] Knittel (2012) and Klier & Linn (2016) use historical data to observe possible tradeoffs that manufacturers may have made in the past between installing fuel economy technologies versus increasing the horsepower or weight of vehicles. The energy efficiency paradox, by contrast, occurs when consumers enter the marketplace, see two cars with identical performance attributes but different fuel economies and different price tags, and are unwilling to pay the additional upfront price for fuel economy that will more than pay for itself over time. The possible existence of manufacturers' past technology tradeoffs is quite simply not an explanation for the energy efficiency paradox.

Besides opportunity costs, the agencies offer two other possible reasons for dismissing market failures. One of their alternative suggestions is that perhaps the increased purchase price for more efficient vehicles is simply being underestimated.[162] The agencies offer no evidence for this claim, nor do they respond to the numerous reasons presented by public comments why the agencies have, in fact, most likely *over*estimated compliance costs and vehicle price effects.[163]

Finally, the agencies offer the bald assertion that it is, perhaps, not irrational for consumers to discount future fuel savings at a rate as high as 24%[164]—a rate eight times higher than the 3% discount rate usually applied to assess how private consumers trade off their consumption over time.[165] The agencies offer no real theory or evidence for why it might be rational for consumers to apply very high discount rates specifically to fuel savings,[166] or how that would explain away all other market failures.[167] Moreover, the agencies do not explain the inconsistency between, on the one hand, assuming that consumers are rational even if they apply exceedingly high discount rates to future fuel savings while, on the other hand, recognizing that consumers accept only relatively modest interest rates to finance their vehicles. The agencies calculate that 85% of new vehicles are purchased through financing options, at an average interest rate of just 4.25%.[168] The interest rate on a loan reveals the rate at which consumers are willing to trade off future spending versus current consumption.[169] The agencies offer no explanation for why, absent some market failure, consumers would adopt vastly different attitudes toward spending money in the future simply depending on whether the money is to spent buying fuel or paying a loan.

Meanwhile, even as the agencies offer little to no support for their theories, they complain that public commenters did not "provide any empirical evidence" of the various market failures that have long been cited to support energy efficiency regulations.[170] In fact, both public commenters and the agencies' own prior analyses during the Midterm Evaluation explored the support from the economics literature on how private market failures explain the fuel efficiency gap.[171] The literature provides significant theoretical and empirical support for a number of relevant market failures that likely lead consumers to undervalue fuel economy and manufacturers to underprovide vehicles with fuel economy that consumers value. Some key market failures include:

- **Information Costs.**[172] The cost of obtaining detailed and actionable information regarding vehicle fuel economy may lead consumers to purchase vehicles with lower fuel economy than they would optimally prefer. This can also lead manufactures to underinvest in efficiency.

- **Consumer Myopia, Miscalculation, and Rules of Thumb.**[173] Consumers may use heuristics and rules of thumb that underemphasize or miscalculate the value of the fuel that they will save by purchasing more fuel-efficient vehicles, even if consumers would value those savings given a more focused, systematic, or accurate evaluation of the costs and benefits of a purchase decision. For example, consumers that do not intend to keep a vehicle for its full useful life may irrationally consider only the amount of fuel savings they expect to benefit from when driving the vehicle, while ignoring the increased resale value of a more fuel-efficient vehicle.

- **Consumer Loss Aversion.**[174] Consumers may irrationally emphasize the upfront "losses" of purchasing a more expensive, more fuel-efficient vehicle over the somewhat more uncertain gains of future fuel savings. As a result, consumers may not purchase more efficient vehicles, even if they (and society) would have saved more over time than the additional amount they pay upfront.

- **Manufacturer Technology Spillover Effects.**[175] Advancements that improve fuel economy are public goods due to the spillover of fuel economy-improving technologies and of information regarding consumer acceptance of those technologies. That is, manufacturers may underinvest in efficiency-enhancing technology because competitors will be able to learn from their R&D which technologies work the best in the real world and are most appealing to consumers. As a result, manufacturers do not see a private return that fully reflects the benefits of that investment. This limits the incentive that manufacturers have to be the "first mover" that invests in the development and deployment of new fuel saving technologies, even if consumers would prefer to purchase a vehicle with greater fuel economy. Since each manufacturer faces muted incentives, no manufacturer produces vehicles with the socially optimal level of fuel economy.

- **Manufacturer Market Power.**[176] Because of the limited competition in the vehicles market, manufacturers may be able to act strategically when pricing vehicles and when producing vehicles with combinations of different fuel economy and other vehicle features in order to push consumers towards purchases that lead to higher manufacturer profits at the expense of optimal fuel economy.

Market failures in the supply and demand for fuel economy are not merely theoretical. A number of studies find empirical evidence that the market failures outlined above exist and contribute to the energy efficiency gap.[177] EPA's own Scientific Advisory Board (SAB) urged the agencies not to rely solely on the handful of studies that the agencies claim support the conclusion that no energy efficiency gap exists.[178] The SAB presented additional evidence that consumer purchasing decisions do not fully reflect the value of fuel savings:[179]

- "When Hyundai and Kia were forced to downgrade their EPA mileage ratings on selected 2011-2013 models, the resulting changes in vehicle prices imply that consumers of these vehicles value savings in fuel expenditures at a much lower rate (approximately 15-38%) than full valuation."[180]

- "An especially sharp example of this phenomenon is the [hybrid electric] version of the popular Toyota RAV4, which has a short payback period for its modest $700 price premium, without any apparent compromise in performance, seating capacity, or other desired vehicle characteristics. Toyota reports that fewer than 25% of consumers are selecting the [hybrid electric] version of the RAV4."[181]

- More generally across all hybrid electric versions offered from 2004 to 2015, even when the hybrid version "is visually identical to a gasoline version of the same model and requires no significant compromises in performance, trunk space or other vehicle attributes," and when fuel savings would "more than pay for [the] price premiums," "fewer than 20% of consumers opt for the [hybrid electric vehicle] option."[182]

Not only did commenters and the SAB present empirical evidence of market failures, but the agencies themselves relied on market failures to justify the Clean Car Standards (see Text Box below) and reaffirmed the existence of those market failures during the midterm evaluation process. In any attempt to ignore those market failures, the burden would be on the agencies to justify such a dramatic change of course in their rollback.

Ultimately, the agencies could not even convince themselves entirely of their own theories. At one point, the agencies seem to "agree with [public] commenters that the market failures CAFE and CO_2 standards can help address *are likely to exist*."[183] Later, the agencies conclude that "despite our expressed reservations," their main analysis must assume that a "fuel efficiency gap persists."[184] They also acknowledge that, at a minimum, consumers may not fully anticipate how greater efficiency will increase a vehicle's trade-in value, thus seeming to recognize some irrational consumer myopia with respect to a significant portion of the vehicle's lifetime fuel savings.[185]

The presence of these market failures means that, absent government policy, the market does not by itself produce efficient amounts of fuel economy. Well-designed regulation has the potential to improve social welfare by correcting or compensating for the market failures discussed above.[186] With well-designed regulation, consumers will have more money to spend on other things, regardless of whether they would have paid for fuel saving technology upfront.[187] Similarly, well-designed regulation can compensate for these market failures and align consumer purchasing decisions with the optimal level of societal savings.[188]

Fuel economy standards create net consumer and societal benefits when the benefits of correcting market failures (especially the economic value of the additional fuel saved) exceed the costs (such as the cost of the technology required to improve fuel economy).[189] Yet, the agencies now cast doubt on well-established market failures in their repeated efforts to suggest—despite calculating the full value of lost fuel savings in their main cost-benefit analysis—that fully valuing fuel savings somehow "distorts" the analysis.[190] As the next section details, the agencies' attempts to dismiss market failures and so call into question fuel saving benefits fly in the face of best economic practices and forty years of regulatory history during which multiple federal agencies under multiple presidential administrations have consistently counted the full economic value of energy savings.

The Agencies' Current Attempt to Cast Doubt on Market Failures Contradicts Prior Agency Analysis

When issuing previous fuel economy and greenhouse gas emission regulations, the agencies concluded that market failures explain at least part of the energy efficiency gap and, as a result, provided a key justification for regulation. The existence of the energy efficiency gap was reaffirmed in a peer review of the modeling the agencies used to develop the proposed rule.[191] The agencies' attempt to undermine the full value of fuel savings by casting doubt on market failures arbitrarily breaks with this prior practice.

In their 2010 rulemaking establishing the first joint fuel economy and greenhouse gas emission standards, the agencies pointed to market failures as a reason why standards would produce fuel savings benefits.[192] For example, EPA pointed to the same consumer-side market failures outlined above:

- "Consumers might be myopic and hence undervalue the long-term.
- Consumers might lack information or a full appreciation of information even when it is presented.
- Consumers might be especially averse to the short-term losses associated with the higher prices of energy efficient products relative to the uncertain future fuel savings."[193]

EPA also pointed to comments identifying manufacturer-side market failures including "imperfect competition among auto manufacturers . . . ."[194]

In the 2012 rulemaking establishing the Clean Car Standards, the agencies found that the energy efficiency gap could be caused by consumers' lack of "information necessary to estimate the value of future fuel savings," from consumers' "not hav[ing] a full understanding of this information even when it is presented," from consumers' use of "simplified decision rules" in the face of a complicated choice, and from consumers' focus on "visible attributes that convey status."[195] The agencies also discussed supply-side market failures, explaining that imperfect competition in the vehicle market could "reduce[] producers' profit incentive to supply the level of fuel economy that buyers are willing to pay for,"[196] and that asymmetric information between manufacturers and consumers could also cause fuel economy to "remain persistently lower than that demanded by potential buyers."[197]

As part of the Midterm Evaluation, EPA once again recounted the potential for the market failures identified above to create a gap between consumer purchasing behavior and fuel savings that can be closed by the Clean Car Standards.[198] This included discussion of consumer-side market failures such as lack of information, myopia and rules of thumb, and loss aversion, among other explanations.[199] EPA also stated that "some of the gap in energy efficiency may be explained from the producer's side" and recounted evidence about strategic manufacturer behavior and technology spillovers.[200]

In the Final Rule, even as the main cost-benefit tables continue to report full fuel saving effects, the agencies have arbitrarily broken with prior practices by attempting to cast doubt both on the presence of market failures and on the full valuation of the fuel savings from the Clean Car Standards.

V. Counting Less Than the Full Fuel Savings Benefits of Regulation Is Inconsistent with Decades of Agency Practice and Regulatory Guidance

The agencies break from longstanding practices on the valuation of energy savings in several different ways. Though their main cost-benefit tables continue to fully value fuel savings,[201] the agencies use opportunity costs and other theories to cast doubt on the existence of market failures (*see supra* Section IV), and they then suggest that—if there were no market failures—they could ignore all the forgone consumer benefits of their rollback.[202] They also assert that fully valuing lifetime fuel savings actually "distorts the comparison" because they believe that "upfront" costs, like opportunity costs, are the "more important factor."[203] As a somewhat less extreme alternative to ignoring 100% of consumer losses, the agencies also propose as a sensitivity analysis that perhaps they can place a dollar figure on the alleged opportunity costs. But recognizing they have no way to accurately estimate such a cost directly, the agencies instead suggest subtracting 42 months' worth of fuel savings—a significant portion of total fuel savings—as a proxy estimate.[204] Only by significantly undercounting or entirely ignoring the benefits like fuel savings could the agencies' rollback finally start to appear cost-benefit justified.[205]

Counting anything less than the full value of fuel savings would diverge from the approach the agencies had consistently taken for over forty years, under administrations of both political parties. The longstanding approach has been simply to multiply the quantity of fuel that a regulation is expected to save consumers each year by the economic value—that is, the expected price—of all the fuel saved, discounting the savings that will accrue in the future back to their present-day value using a standard discount rate, and adding up all years of savings. This longstanding approach can be characterized as counting the net present economic value of fuel saved or the "full economic value of fuel savings."

Not only has that approach been used consistently by NHTSA and EPA over the last 40 years, it has also been consistently used by other federal agencies that promulgate rules with substantial energy saving benefits and is enshrined in guidance on regulatory impact analysis. In fact, we have identified no rulemaking where any agencies calculated the benefits of an energy-saving regulation based on consumers' perceived willingness to pay, as the agencies' "Implicit Opportunity Cost" sensitivity analysis would effectively do. Even during the Trump Administration, the Department of Energy has thus far continued to value energy savings using the full economic value based on expected prices.[206]

The following sections first review best practices for regulatory analysis, and then provide a series of examples demonstrating that both NHTSA and EPA have consistently used the full economic value of saved fuel when considering the costs and benefits of regulations that result in fuel savings. This is followed by examples from other agencies, demonstrating that the agencies' historic approach has been broadly consistent across the federal government.[207] The agencies' suggestion in the Final Rule that they can focus predominantly just on upfront costs—either to the complete exclusion of all longer-term consumer benefits or after erasing 42 months' worth of consumers' fuel savings—represents a sharp and unjustified departure from 40 years of sound economic analysis.

A. Regulatory Guidance Makes Clear That Fully Valuing Energy Savings Is the Best Practice for Cost-Benefit Analysis

Using the full economic value of fuel savings to calculate the consumer and societal benefits of regulations that save fuel is not only the longstanding practice of the agencies under administrations of both political parties—it is economically rational and consistent with best practices for agency cost-benefit analyses.

The agencies assert that consumers' observed unwillingness to pay for fuel economy is somehow evidence that there are no market failures.[208] In fact, in the presence of market failures, consumers' observed willingness to pay may not fully reflect the true welfare benefits they receive from purchasing vehicles with more fuel economy, and manufacturers may produce vehicles with less fuel economy than consumers are willing to pay for. This can be seen from both the consumer and the societal perspective. From the *consumer* perspective, the presence of market failures means that *ex ante* measures of consumers' willingness to pay for fuel economy will not reflect the *ex post* value consumers actually experience from fuel savings once they have purchased the vehicle. From a *societal* perspective, failures in the market for fuel economy mean that there is a divergence between consumer vehicle purchasing decisions and the value that society receives when consumers buy more fuel-efficient vehicles. When consumers operate more efficient vehicles, they consume fewer real economic resources (e.g., barrels of oil which must be extracted, refined, and transported) than they would have had they operated less efficient vehicles. These are real resource savings for society, the value of which is represented by the price of the fuel (i.e., gasoline or diesel) saved (not taking into account externalities such as air pollution and energy security). Government intervention—such as fuel economy standards that guarantee manufacturers produce vehicles with minimum levels of fuel economy—can lead to a more economically efficient level of fuel economy in vehicles by bridging the gap between consumers' willingness to pay for fuel saving and the economic value of the savings that accrue to consumers and society. The benefits produced by such regulation are the additional fuel savings that occur beyond what the distorted market would produce on its own.

The societal perspective on energy savings seems particularly crucial given the relevant statutory contexts. For example, NHTSA sets its CAFE Standards under the Energy Policy and Conservation Act (EPCA), which Congress specifically adopted for the purpose of conserving energy in response to a national energy crisis.[209] Failing to view energy savings from society's perspective would therefore seem inconsistent with EPCA's core purpose. Indeed, the agencies ultimately acknowledge that, whatever their assumptions about the private valuation of fuel savings, when accounting for social costs and benefits, the full lifetime fuel savings should be included.[210] Their simultaneous attempts to either ignore all lost consumer benefits or erase 42 months' worth of fuel savings in the sensitivity case are therefore inconsistent with sound economic principles and guidance.

The Office of Management and Budget's *Circular A-4*[211]—a guide for agencies on regulatory cost-benefit analysis issued under President George W. Bush and endorsed by the Trump Administration[212]—includes a specific discussion regarding how to evaluate fuel economy and other similar regulations where "cost savings . . . accrue to parties affected by a rule who also bear its costs."[213] For those regulations, agencies should monetize those "direct costs that are averted as a result of a regulatory action."[214] In the case of fuel economy, the "direct costs that are averted" are the fuel savings. In order to determine the appropriate price of fuel saved, *Circular A-4* explains that the best measure of the economic value of market goods affected by regulation is the market price of those resources.[215] Circular A-4 also cautions that willingness to pay is a good measure of benefits only "if" the underlying market is "well-functioning" and requires agencies to take "market imperfections" into account when valuing regulatory effects.[216] As a result of the market failures discussed above, when calculating benefits of the standards, the agencies should use the value of *fuel saved* (based on the market price of fuel) and not the value consumers appear to place on *fuel economy* (based on prices and purchase of vehicles).

EPA's *Guidelines for Economic Analysis* ("Guidelines") also support using the net present value of fuel saved to calculate the benefits of regulations that save fuel.[217] The Guidelines explain that consumers' willingness-to-pay is generally the appropriate measure of quantified social benefits.[218] However, in cases where consumer expectations are likely to be inaccurate, the Guidelines caution that consumer willingness to pay for a product may be an incomplete measure of social benefits.[219] Only in the case of "goods bought and sold in undistorted markets,"[220] should EPA use "market prices . . . to measure the value of market goods and services directly."[221] By implication, market data on consumers' valuation of *fuel economy* is not the appropriate measure of the benefits of fuel economy due to distortions in the market for fuel economy. However, because the market for fuel (as opposed to the market for fuel economy) does not suffer from these same market failures, the benefits of a regulation that saves fuel should be calculated using the market price of the *fuel*.[222] The Guidelines also explain that the purpose of the agency's cost-benefit analysis is to measure the "*social*" benefits (and costs) of regulation.[223] So where, as here, there is a divergence between the private willingness to pay for fuel economy (as expressed in market prices for vehicles) and the social valuation of actual fuel resources saved (expressed in the market price of fuel), the appropriate measure of the benefits of a regulation that saves fuel is the market price of fuel saved.

The Guidelines' discussion of the appropriate discount rate to use when evaluating regulation also supports using the net present value of fuel saved as a measure of the fuel savings benefits of the Final Rule. As explained above, the observed energy efficiency gap could perhaps be characterized as reflecting consumers' use of very high discount rates when evaluating vehicles with increased fuel efficiency—rates multiple times higher than normally assumed for rational consumer behavior.[224] However, because the purpose of regulation is to maximize *societal* (and not private) net benefits, the Guidelines direct EPA to calculate the present value of future savings using the rate that *society* (not a private individual) discounts future costs and benefits (that is, to use a social discount rate).[225] Even when agencies have elected to use private discount rates, they have used discount rates reflecting the actual opportunity cost of capital for buying the more efficient product, rather than the very high discount rate implied by consumers' upfront purchasing decisions (which are the product of market failures).[226] By assuming that consumers have very high discount rates, and by using those rates as an excuse to offset either 42 months of fuel savings or all the private and social benefits from fuel savings, the agencies' analysis fails to follow the approach outlined in EPA's Guidelines. It also fails to follow economic best practice of using a consistent discount rate when estimating costs and benefits.[227] Indeed, the agencies' focus on "upfront costs" is akin to selectively and inconsistently applying a very high discount rate just to future fuel savings, but not to future payments on vehicle loans.

A failure to fully value fuel saving is also inconsistent with the Department of Transportation's guidance documents on cost-benefit analysis. In its *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, the Department of Transportation explains that the benefits for programs that avoid vehicle use should be calculated based on vehicle operating costs including avoided fuel costs, discounted using a 7 percent discount rate.[228] In its *Operations Benefit/Cost-Analysis Desk Reference*, the Federal Highway Administration explains:

> Vehicle operating costs is usually relatively easy to estimate and is often based on simple valuations applied directly to vehicle miles of travel (VMT). For simple analysis, a static rate of average fuel use (gallons per VMT) is applied to any net change in VMT to estimate the net change in fuel use. A benefit value (cost per gallon of fuel exclusive of fuel taxes) is then applied to the change in the number of gallons of fuel consumed.[229]

The Final Rule will substantially reduce the amount of fuel saved over the life of vehicles that would otherwise have been subject to the Clean Car Standards. Given the fact that an unregulated market will not result in the economically efficient level of fuel savings—due to both consumer-side and producer-side market failures—consumers' willingness to pay for vehicles with greater fuel economy is not the appropriate measure of the economic benefits of those fuel savings. Rather, the agencies must use and fully acknowledge the net present value of fuel saved by society (i.e., using a social discount rate) over the lifetime of vehicles to assess the benefits of the Clean Car Standards and the costs of forgoing those fuel savings imposed by the Final Rule. By casting doubt on the net present value approach in favor of a predominant focus on upfront costs, the agencies analysis is inconsistent with economic theory. Such an approach also breaks with longstanding agency practices, as explored further below.

B. NHTSA Has Consistently Calculated the Benefits of Fuel Economy Regulations Using the Full Economic Value of Fuel Savings

For over forty years, under administrations of both political parties, NHTSA has used the same approach for calculating the fuel saving benefits of fuel economy regulations: the net present value of fuel saved.

Carter Administration. In its very first fuel economy regulation in 1977, NHTSA evaluated "the economic impact of [fuel economy] standards" for model year 1981-1984 passenger vehicles.[230] In conducting this evaluation, NHTSA compared the upfront increase in vehicle costs to consumer lifetime gasoline costs, and determined that "total consumer costs (that is, retail prices, maintenance costs, and gasoline costs) are anticipated to decrease by about $450 per car or $20 billion nationally."[231] In making this calculation, NHTSA explicitly rejected an approach that would have considered only the benefits of fuel savings that consumers were willing to pay for, stating that "since lifetime [fuel savings] benefits do actually accrue to the initial and subsequent owners, they are included in the analysis, regardless of their perception by individuals."[232] As a result, NHTSA included the full economic value of those savings, calculated as the expected quantity of fuel saved times the expected price of fuel.[233]

Reagan Administration. In a regulation that reduced the model year 1985 fuel economy standard for light-duty trucks and established standards for model year 1986 trucks, NHTSA considered the expected economic impacts of its regulation using a similar approach.[234] NHTSA projected that vehicle price increases of $35 "would be offset by operating cost savings of $176 for the average 1986 light truck, due to reduced lifetime gasoline consumption."[235] Just as the agency had during the Carter Administration, the Reagan Administration's NHTSA also considered the full economic value of fuel savings rather than consumers' willingness to pay for fuel economy in its economic analysis.[236]

George H.W. Bush Administration. NHTSA finalized two fuel economy standards during the George H.W. Bush Administration.[237] However, the preambles for these regulations do not include any discussion of consumer fuel savings, and NHTSA no longer has copies of Regulatory Impact Analysis documents for those rulemakings. Nonetheless, it is likely that NHTSA counted the full value of the fuel savings, as there is no evidence that NHTSA took a different approach when analyzing these rules. And as detailed below, EPA under George H.W. Bush used the full economic value of fuel savings to calculate the benefits of its regulations.

Clinton Administration. In 1993, NHTSA finalized a rule to establish fuel economy standards for model year 1995-1997 light trucks.[238] The Final Regulatory Impact Analysis for that rule makes clear that NHTSA considered the full economic value of fuel savings, not consumers' willingness to pay.[239] In 1994, NHTSA issued a regulation establishing fuel economy standards for model year 1996-1997 light trucks.[240] In the economic analysis supporting that rulemaking, NHTSA evaluated the operating costs of trucks under different levels of fuel economy standards. NHTSA explained that "[o]perating cost expenditures are defined as the present discounted value of dollar expenditures for gasoline that the vehicle owner would have to make over the life of a vehicle."[241] That is, for each fuel economy level analyzed, NHTSA calculated the benefit of saving fuel using the full economic value of fuel savings, not consumers' willingness to pay for that level of fuel economy.

George W. Bush Administration. In 2006, NHTSA again used the full economic value of saved fuel when evaluating the costs and benefits of fuel economy standards for model year 2008-2010 light trucks.[242] NHTSA again considered and rejected an approach that would have limited the benefits of fuel savings to the value that individual consumers ascribe to a given level of fuel economy when purchasing a vehicle.[243] NHTSA explained that it was appropriate to use the full economic value of fuel savings both because it was considering the "broader societal effect" of the standards and because that was the actual value from the consumer perspective:

> The agency believes that CAFE standards should reflect the true economic value of resources that are saved when less fuel is produced and consumed . . . . Consumer's perceptions of these values may differ from their actual impacts, but they will nonetheless experience the full value of actual fuel savings just as they will pay the full increased cost when the vehicle is purchased.[244]

Obama Administration. In 2010, NHTSA and EPA issued harmonized fuel economy and greenhouse gas emission standards for model year 2012-2016 vehicles.[245] In that rulemaking, NHTSA explained that "[t]he main source of economic benefits from raising CAFE standards is the value of the resulting fuel savings over the lifetime of vehicles that are required to achieve higher fuel economy."[246] NHTSA calculated these benefits as the net present value of fuel saved, and not consumers' willingness to pay for savings.[247] In 2012, NHTSA adopted the same approach when it issued regulations establishing the Clean Car Standards jointly with EPA. Together, the agencies calculated the benefits of the standards using the full economic value of fuel savings.[248] The agencies explained that fuel prices multiplied by quantity of fuel saved "determine[s] the value of fuel savings both to new vehicle buyers and to society."[249] From a consumer perspective, NHTSA stated that "the retail price of fuel is the proper measure for valuing fuel savings."[250] From the societal perspective, NHTSA specifically explained that the proper scope of analysis when calculating the fuel savings benefits in the context of a cost-benefit analysis is not consumers' willingness to pay for fuel economy,[251] but "the economic value of fuel savings to *the U.S. economy*."[252] As NHTSA explained:

> When estimating the aggregate value to the U.S. economy of fuel savings resulting from alternative increases in CAFE standards—or the "social" value of fuel savings—the agency includes fuel savings over the *entire* expected lifetimes of vehicles that would be subject to higher standards, rather than over the shorter periods we assume manufacturers employ to represent the preferences of vehicle buyers, or that buyers are assumed to employ when assessing changes in the net price of purchasing and owning new vehicles. Valuing fuel savings over vehicles' entire lifetimes recognizes the savings in fuel costs that subsequent owners of vehicles will experience from higher fuel economy, even if their initial purchasers do not expect to recover the remaining value of fuel savings when they re-sell those vehicles, or for other reasons do not value fuel savings beyond the assumed five-year time horizon.[253]

C. EPA Has Consistently Evaluated the Benefits of Fuel Saving Using the Full Economic Value of Those Savings

Just as with NHTSA, over the past six presidential administrations, EPA has consistently used the net present value of the fuel saved, and not consumers' *ex ante* willingness to pay for fuel economy, to calculate the fuel savings benefits that are produced when its emission standards for mobile sources are met through fuel economy improvements.

Carter Administration. In 1980, EPA proposed a regulation to establish evaporative emission regulations for gasoline-fueled heavy-duty vehicles.[254] EPA projected that this regulation would cause heavy-duty gasoline-fueled vehicles to install closed-loop fuel metering systems that would have the ancillary benefit of improving vehicle fuel economy.[255] When calculating the costs and benefits of the standards, including the fuel economy improvements, EPA used the full economic value of saved gasoline and not a measure of consumers' willingness to pay for fuel economy.[256]

Reagan Administration. In 1987, EPA issued a proposed regulation to comprehensively control evaporative emissions from motor vehicles.[257] As part of that regulation, EPA considered fuel volatility regulations that, if adopted, would have improved the fuel economy of engines.[258] EPA evaluated the economic benefit of this change based on the expected volume of fuel saved multiplied by the expected price of fuel.[259] That is, EPA considered the full economic value of fuel savings and not consumers' willingness to pay for fuel economy.

George H.W. Bush Administration. In 1990, EPA proposed regulations to establish cold temperature carbon monoxide exhaust emission standards for light-duty vehicles.[260] EPA determined that compliance with the proposed standards would involve technology changes that also improved fuel economy.[261] When calculating the net cost for vehicles to comply with the standards, EPA offset the upfront technology costs with the full economic value of the expected fuel savings over the life of each vehicle.[262] EPA did not measure the benefits of fuel savings using a more limited measure such as consumer willingness-to-pay.[263]

Clinton Administration. In 2000, EPA promulgated regulations establishing "Tier 2" motor vehicle emission standards for both exhaust and evaporative emissions.[264] EPA analysis predicted that requirements of this rulemaking regarding On-board Refueling Vapor Recovery would lead to the adoption of technology that improves fuel economy.[265] When calculating the net cost of the standards, EPA used "the net present value of fuel savings over the life of the vehicle."[266] This reflected the full economic value of fuel saved rather than consumers' willingness to pay for fuel economy improvements.

George W. Bush Administration. In a 2004 regulation establishing evaporative emissions from motorcycles, EPA considered a technology that would reduce fuel leaks and, therefore, save fuel.[267] When evaluating the benefits of these fuel savings, EPA used the full economic value of the savings rather than a measure of consumers' willingness to pay for fuel savings.[268]

Obama Administration. In its 2010 rule establishing joint fuel economy and greenhouse gas emissions standards for model year 2012-2016 passenger vehicles, EPA explicitly considered whether the full economic value of fuel savings or consumers' observed willingness to pay for fuel savings is "the appropriate measure of consumer benefit[.]"[269] EPA concluded that full valuation is the better measure because of market failures that prevent consumers from actualizing their fuel economy preferences.[270] EPA also considered the full economic value of fuel savings when calculating the benefits of the Clean Car Standards.[271] EPA specifically rejected using a measure of consumers' willingness to pay for fuel economy, explaining that "[r]egardless how consumers make their decisions on how much fuel economy to purchase, EPA expects that, in the aggregate, they will gain these fuel savings, which will provide actual money in consumers' pockets."[272]

D. The Department of Energy Has Used the Full Economic Value of Energy Savings When Calculating the Benefits of Appliance Efficiency Standards

The Department of Energy (DOE) has consistently used a similar approach for almost 40 years when promulgating regulations that set minimum energy efficiency standards for appliances and commercial and industrial equipment. Pursuant to EPCA (the same law that directs NHTSA to establish fuel economy standards), DOE sets minimum standards for the energy efficiency of consumer appliances and commercial and industrial equipment.[273] Under EPCA, DOE is directed to establish standards that are "designed to achieve the maximum improvement in energy efficiency . . . which [DOE] determines is technologically feasible and economically justified."[274] In evaluating whether standards are economically justified, DOE is directed to weigh the benefits of more efficient appliances, including energy savings, against the costs of the standards, including higher up-front purchase prices.[275]

In 1980, the Carter Administration's DOE issued the first proposed energy conservation standard for a variety of consumer appliances, including refrigerators, freezers, clothes dryers, water heaters, room air conditioners, home heating equipment, kitchen ranges, central air conditioners, and furnaces.[276] This proposed rule established the key analytical considerations that DOE has used to set energy conservation standards ever since. A critical component of this analysis involves calculating the benefits of the fuel—in the case of appliances, electricity, oil, or natural gas—that is saved due to the standards. DOE presented these benefits as part of two different calculations: (1) the benefits to consumers as represented by the difference in life-cycle cost (LCC)—that is, the sum of the purchase price and the operating expenses discounted over the lifetime of the appliance—between appliances subject to a standard and the baseline; and (2) the benefits to society, including, primarily, the net present value (NPV) of energy savings over the lifetime of the appliance.[277] These calculations were made using the full economic value of energy savings (and of up-front appliance costs), not a measure based on consumers' willingness to pay for standard-compliant appliances or equipment.[278]

Under every administration since, DOE has finalized regulations regarding energy conservation standards that rely on a similar analytical framework to evaluate the economic justification for the standards. That is, when calculating the benefits of the standards, DOE considers the full economic value of energy saved by both the consumer and the nation, rather than a measure of consumers' willingness to pay for the more efficient appliance or equipment. To list just a few examples:

- In 1982, the Reagan DOE issued a rule declining to set energy conservation standards for clothes dryers and kitchen ranges on the grounds that they would "not result in a significant conservation of energy and would not be economically justified."[279] In reaching that conclusion, DOE conducted LCC and NPV analyses using the discounted value of energy saved multiplied by the expected price of electricity, oil, or natural gas (as appropriate for the specific appliance).[280]

- In 1989, the George H.W. Bush DOE finalized a regulation to establish energy conservation standards for refrigerators and freezers and for small gas furnaces.[281] DOE used the same net present value methodology established during the Carter Administration for calculating the costs and benefits of the standards and comparing them to alternatives.[282] In doing so, DOE considered and rejected comments suggesting it calculate NPV and LCC using very high "implied" discount rates that reflect consumers' upfront purchasing decisions rather than standard market discount rates based on the economic value of fuel savings.[283] In 1991, the George H.W. Bush DOE issued a regulation establishing energy conservation standards for clothes washers, clothes dryers, and dishwashers.[284] DOE used the net present value of energy savings to consumers and society in its calculation of the costs and benefits of the standards.[285]

- In 1996, under President Clinton, DOE issued a new "Process Rule" that was intended to improve the process by which DOE develops and analyzes appliance efficiency standards.[286] The Process Rule reaffirmed the importance of evaluating consumer impacts through the use of the LCC analysis and of evaluating national economic impacts using the NPV analysis.[287] In 1997, DOE issued its first energy conservation standards under the new Process Rule: standards for refrigerators and freezers.[288] These standards were set at the level with the lowest life-cycle cost and highest net present value.[289] Both LCC and NPV were calculated based on multiplying the quantity of energy saved by estimated electricity prices and discounting future savings to present value.[290] The Clinton Administration used a similar methodology for six additional standards.[291]

- In 2002, DOE under President George W. Bush issued new more stringent energy conservation standards for central air conditioners and heat pumps.[292] DOE analyzed the economic effect of these standards based on the standards' LCC and NPV, both of which included the benefits of energy savings calculated using the full economic value of those savings.[293] The Bush Administration promulgated four additional energy conservation standards, calculating the costs and benefits using the same approach.[294]

- The DOE under President Obama promulgated 40 energy conservation standards for consumer, commercial, and industrial appliances. These regulations all included similar analyses that calculated the benefits of energy savings by multiplying the quantity of energy saved by the price of energy and discounting future savings to present value—that is, the full economic value of those savings.[295]

- The Trump Administration DOE has continued to use an identical methodology when considering the economic justification for consumer appliance and commercial and industrial equipment standards.[296]

E. Other Agencies Use the Full Economic Value of Energy Savings When Calculating Benefits of Regulations that Save Energy

A number of other rulemakings have evaluated the economic benefits of energy savings using the full economic value of energy saved rather than a measure of *ex ante* willingness to pay for savings.

- Under the Obama Administration, EPA issued regulations establishing new source performance standards to limit methane leaks from the oil and gas sector.[297] When calculating the benefits of these standards, EPA included the full revenue from recovered natural gas.[298] This was the case even though EPA acknowledged that industry could have chosen to recapture the gas on its own but for various reasons had not—in other words, the economic value of natural gas savings exceeded the industry's willingness to pay for natural gas recovery. The Trump Administration EPA has taken a similar approach to valuing reduced natural gas leaks in its proposal to amend the standards, claiming that "from a social perspective . . . the increased financial returns from natural gas recovery accrues to entities somewhere along the natural gas supply chain and should be accounted for in the national impacts analysis."[299]

- Under the Obama Administration, the Bureau of Land Management took an approach that was similar to EPA when setting standards to limit methane leaks from the oil and gas sector on federal land.[300] The Bureau included as benefits the full economic value of any natural gas that would be recovered and sold due to the regulation.[301] The Trump Administration has taken the same approach when calculating the costs and benefits of rescinding that rule.[302]

- In regulations establishing energy efficiency standards for new construction of certain government-assisted housing, the Obama Administration Department of Housing and Urban Development and Department of Agriculture calculated the benefits of more stringent standards using the full economic value of energy saved.[303] The agencies justified these standards as a regulatory solution to the market failures embodied by the energy efficiency gap.[304]

For forty years, agencies across the federal government and under administrations of both political parties have used the full economic value of energy savings when calculating the benefits of regulations that save energy. The Department of Energy has even continued thus far to do so during the Trump Administration. On numerous past occasions, NHTSA and EPA explicitly considered and rejected alternative approaches, including using consumer willingness to pay for energy savings. There is no cause now to abandon that longstanding best-practice.

VI. The Agencies' Valuation of Opportunity Costs in the Sensitivity Case Is Flawed and Overlooks Substantial Countervailing Effects

After failing to convince themselves that no market failures exist and that, for the first time in forty years, it would be acceptable to ignore all energy savings,[305] the agencies turn to their alternative sensitivity analysis. In their sensitivity analysis,[306] the agencies hypothesize a proxy value for the alleged opportunity cost of forgone vehicle attributes that they assume must exist (despite all the reasons no such hidden opportunity costs will exist, *see supra* Section III). Having tried and failed in the preliminary regulatory impact analysis to estimate such opportunity costs directly[307]—and acknowledging there is no existing way to estimate the attributes allegedly lost from more efficient vehicles[308]—the agencies now try a proxy estimation in the final rule. Specifically, the agencies claim that since consumers could purchase additional fuel savings on their own in the marketplace but choose not to (ignoring the many market failures that prevent consumers from doing so), it must be because the opportunity cost of allegedly lost attributes is greater than the value of fuel savings.[309] The agencies admit that consumers do value and are willing to pay for the first 30 months' worth of fuel savings.[310] The agencies also exclude the value of fuel savings after 72 months from their proxy calculation, calling the selection of 72 months a "conservative" choice, though the agencies do not sufficiently explain the logic behind their selected timespan, and the cited data would seem to support a lower number.[311] But for the 42 months in between, the agencies' sensitivity case assumes that consumers recognize the fuel savings but are unwilling to pay for those savings on their own because they value something else instead—namely, according to the agencies, the opportunity cost of other attributes.[312] Therefore, the agencies subtract out 42 months' worth of fuel savings as a proxy for the opportunity costs.

For all the reasons explained above, this approach is completely untenable. There is no empirical support for hidden opportunity costs. Opportunity costs, to the extent they exist, would not explain away all the market failures that create the energy efficiency gap (*see supra* Section IV). In forty years, no federal agency has ever counted less than the full value of energy savings (*see supra* Section V). Even more specifically, no agency has ever before used alleged consumer costs associated with reducing other features to justify undercounting other consumer benefits of fuel economy or greenhouse gas emission standards.[313] Nor have other agencies that issue regulations on the basis of energy savings undercounted energy savings benefits by claiming that consumers' undervaluation of energy savings is explained by a rational desire to avoid changes in other features or performance. For example, the Department of Energy's appliance efficiency standards are constructed to apply only to appliances with identical features,[314] and the department finds that such appliance standards save consumers money on net by increasing energy savings beyond what consumers would have purchased without the standards.[315] EPA and NHTSA have not explained in the Final Rule why it would be appropriate to break from those past practices.

If the agencies had actually wanted to measure lost consumer surplus from supposedly forgone attributes, they would have needed first to model actual tradeoffs chosen by manufacturers, which would likely have revealed that the Clean Car Standards had much lower compliance costs (*see infra* Section VI.A). Then the agencies would have needed to estimate consumers' willingness to pay for such attributes. But there is a reason that the agencies abandoned that very approach from their preliminary regulatory impact analysis: the agencies recognized that "sufficiently detailed information on the potential improvements in car and light truck attributes . . . is not currently available,"[316] and that "the specific improvements in attributes other than fuel economy that producers are likely to make to their individual car and light truck models when they face less demanding fuel economy standards cannot be estimated."[317]

The literature also has not estimated consumer valuation of vehicle features with enough consistency to be useable for policymaking.[318] During the Midterm Evaluation, the agencies announced an EPA-commissioned study "to determine whether there are robust [willingness-to-pay] values that could be used for monetizing at least some of the opportunity costs and ancillary benefits" of fuel economy standards (to the extent they exist).[319] That study concluded "we have found very little useful consensus" regarding "estimates of the values of various vehicle attributes,"[320] and that the willingness-to-pay estimates "encompass[ ] such a wide range of values that [they are] of little use for informing policy decisions."[321] In a follow-up paper, the author of EPA's commissioned study, David Greene, found "striking[ly]" high variation in willingness-to-pay estimates across the literature.[322] As such, Greene et al. (2018) concluded that focusing on any specific willingness-to-pay estimate is methodologically suspect.[323]

Additionally, the literature largely estimates consumers' *historical* willingness to pay for small changes in vehicle features. But these marginal willingness-to-pay estimates are not good measures of the changes that the agencies assert might happen absent the Clean Car Standards. As vehicles become more featured (e.g., have higher horsepower), consumers may not continue to value additional features (e.g., endlessly increasing acceleration rates) at the same rate. The agencies should not rely on historical estimates of consumers' valuation of marginal vehicle feature improvements to estimate how much they would value additional future changes in vehicle features.[324]

Moreover, the agencies' proxy estimation of opportunity costs fails to consider substantial countervailing effects, as the rest of this Section details. In particular, if there were tradeoffs between fuel economy and other vehicle attributes, it would significantly lower the agencies' estimate of the compliance costs for the Clean Car Standards. In fact, the agencies' current methodology for estimating compliance costs adopts assumptions that would almost certainly entail simultaneous improvements in vehicle performance features like acceleration, none of which have been valued by the agencies or weighed against the hypothetical opportunity costs. Furthermore, the other attributes consumers might desire are associated with various externalities, and the agencies have not valued the external costs or benefits of any such attributes. Finally, even if the Clean Car Standards would result in consumers purchasing vehicles with fewer other features, it does not follow that consumers would lose welfare. Consumers would not be relatively worse off if *everyone's* vehicles, and not just their own, had fewer features that consumers primarily value in relation to their neighbors.

A. Assuming Lost Welfare from Forgone Vehicle Features Is Inconsistent with the Agencies' Compliance Costs Calculations

The idea that consumers would lose net welfare from forgone attributes cannot be reconciled with the agencies' current analysis of the costs of the standards. The agencies calculate the costs of the Clean Car Standards by assuming key vehicle performance attributes are held constant between the baseline scenario with the Clean Car Standards and the scenario with the rollback.[325] The agencies conclude that any vehicle attribute not held perfectly constant by this assumption would be a "de minimis" change, and the agencies admit the change could likely be that regulatory standards *improve* vehicle performance and other attributes.[326] This is the same approach that NHTSA and EPA have used historically to evaluate the cost of complying with fuel economy and emission standards.[327] Yet the agencies now, for the first time, also claim that consumers may lose welfare because they are forgoing features that they would have had without the standards.[328] It cannot both be true that, (1) for the purpose of calculating vehicle prices, non-efficiency features are the same as they would have been without the standards and that, (2) for the purpose of calculating forgone benefits of the rollback, non-efficiency features would have been different.

At the same time as the agencies' sensitivity analysis seeks to count as benefits of the rollback the additional features consumers will allegedly now be able to purchase instead of fuel economy (by using such alleged benefits as a reason to offset 42 months' worth of fuel savings), the agencies fail to count how those additional features also require technology that will raise the price of the vehicle (compared to a vehicle without the performance features). Instead, the agencies make the conclusory assumption that their estimate of opportunity costs is "net of the [technology] cost of these attributes" and so can be added on top of the "technology cost/savings estimated in the primary analysis."[329] But if the agencies are correct that, once free of fuel economy standards, manufacturers will redeploy their technology advancements toward improving other vehicle features such as performance while staying within consumers' assumed "budget constraint," the agencies may have incorrectly attributed some cost savings to their rollback. At the very least, the agencies have not sufficiently explained why they do not need to account for the cost of such additional features in the price of new vehicles. And if vehicle prices will not actually drop when fuel economy standards are repealed (because the technology that would have been used to improve fuel economy will instead be used to improve other features), then the agencies' conclusions about the effect of the rollback on new vehicle prices and sales, used vehicle scrappage, and the corresponding benefits from those effects are overstated.

If the agencies want to assume that the Clean Car Standards would have forced some manufacturers to sacrifice features like horsepower for the sake of fuel economy, then the agencies would need to actually model what vehicle features manufacturers would have provided (and what those features would have cost). This would involve a substantial change to the agencies' methodology for calculating compliance costs.[330] Specifically, the agencies would need to relax the assumption that non-efficiency features will be held constant.[331] Relaxing the assumption that vehicle attributes are held constant would show that compliance with the Clean Car Standards likely will produce vehicles that are *less expensive* than the agencies' prior modeling found—and therefore, that rolling back the standards will produce even fewer cost savings than the agencies now estimate.[332] That is because relaxing the constant-features assumption for each vehicle would allow the agencies to model what manufacturers may do in the real world: produce vehicles with a different mix of features and costs that better meets consumer demand. The literature consistently shows that if manufacturers are allowed to use attribute-tradeoffs to comply with regulatory standards, compliance costs could be "significantly lower" than what the agencies estimate. Instead, manufacturers will produce different vehicles with mixes of fuel economy and other attributes, allowing those consumers who are willing to pay for extra attributes on top of fuel economy to do so, while those consumers who do not value extra attributes like acceleration as much can purchase cheaper but more efficient vehicles.[333]

Finally, the agencies fail to consider or value the indirect improvements to performance and other features associated with the Clean Car Standards under the agencies' existing compliance cost estimates and the constant-performance assumption. As the agencies admit, not only is it possible that holding attributes constant will lead to other performance improvements, but it is "unavoidable" and "expected."[334] For example, if installing certain fuel economy technologies in a certain vehicle would decrease that car's 0-60 mph initial acceleration, the agencies' model assumes that manufacturers will install additional technologies to bring that acceleration back up to par; but such additional technologies are likely to improve not just 0-60 mph initial acceleration, but other attributes that consumers value, like 50-80 mph passing acceleration or the vehicle's ability to maintain speed on an incline.[335] Indeed, various commenters noted that the agencies' constant-performance assumption *overcorrected* in multiple ways that would increase overall vehicle performance, precisely along the lines of that example above.[336] Yet when the agencies' model assumes that manufacturers will install technologies—at extra cost—to ensure there is no loss of 0-60 mph acceleration, the agencies do not value the consumer welfare gains that may come from any incidental increases in performance to, for example, 50-80 mph acceleration or other attributes.

Furthermore, as the agencies acknowledge, many fuel economy technologies actually improve various performance attributes.[337] During the Midterm Evaluation, the agencies listed numerous examples of how fuel-economy technologies could improve braking, handling, towing, hauling, steering responsiveness, torque vectoring, and a host of other attributes.[338] The agencies never monetize the value of any of these attributes associated with the Clean Car Standards.

B. The Agencies Fail to Consider How Ancillary Effects Could Swamp Much If Not All of Their Estimated Opportunity Costs

The agencies' identification of lost welfare from consumers purportedly purchasing vehicles with fewer other features ignores the important countervailing benefit of avoiding significant negative externalities that such features impose on society.

Economic research has long recognized the various implicit subsidies and externalities imposed on society by vehicles. These include: accidents, road congestion, road and parking construction and maintenance costs, the space used for parking, and pollution.[339] Drivers with higher horsepower vehicles are much more likely to speed—by 10 miles per hour or more—increasing the risk of accidents, damages, and fatalities.[340] Vehicles with features that allow faster acceleration also cause a greater number of and more consequential accidents.[341] Vehicles with internal combustion engines are more dangerous than those with electric engines due to the latter's additional crumple space.[342] Heavier vehicles also increase the cost of road maintenance and repair.[343] Vehicles with greater acceleration also may be driven in ways that consume more fuel and so emit more pollution.[344] And as discussed below (Section VI.C), certain status features like horsepower impose negative positional externalities on other drivers. According to academic literature, the total cost of these all these externalities is sizable.[345]

Ignoring such externalities is inconsistent with the position the agencies have now taken with respect to the indirect risks from "rebound" driving. "Rebound" miles are the additional miles that consumers can afford to and choose to drive once greater fuel economy lowers their fuel costs per mile driven. Such additional driving does carry some risks, such as slightly increased risks of accidents. The agencies claim it would be inconsistent to assume that drivers are rational and informed enough to internalize the risks of additional driving from the rebound effect, but not sufficiently rational and informed to weigh the fuel savings versus opportunity costs of purchasing vehicles with fuel economy versus other attributes.[346] However, the agencies in fact do *not* assume that drivers fully internalize all the risks of rebound driving, and they instead assume that consumers at least partly externalize the safety risks of their additional driving onto the other drivers and passengers with whom they share the road.[347] It therefore is inconsistent to count supposed opportunity costs from consumers not having the bigger, faster cars they supposedly want without also counting the externalities of those bigger, faster cars.[348]

Looking only at the benefits of allegedly forgone features without also accounting for the other side of the ledger, as the agencies have done, inappropriately puts a thumb on the scale in rolling back the Clean Car Standards.[349]

C. Forgone Vehicle Features Do Not Necessarily Result in Lost Consumer Welfare

Even if the Clean Car Standards would have caused a reduction in other vehicle features compared to what would occur without the standards, and even if the agencies had reasonably estimated the amount consumers have historically been willing to pay for vehicles with those features, the agencies have not shown that a society-wide reduction in features will result in welfare losses that can be calculated by summing the average consumers' willingness to pay for those features. In fact, there are strong reasons to believe that society will not lose welfare when everyone forgoes some features. This is because the features that the agencies identify—such as horsepower and weight—are what the economics literature calls "positional goods."[350] And a fleetwide reduction of positional goods need not cause any aggregate loss of consumer welfare.[351]

Positional goods are goods for which the value to one individual depends on how it compares with similar goods possessed by others.[352] In other words, the good is valued according to how much status a good imparts in relation to the amount of the good *others* have, rather than according to innate characteristics of the good itself.[353] A growing body of research indicates that cars are positional goods;[354] namely, many consumers do not necessarily want the biggest and fastest vehicle, so long as their vehicle is bigger and faster than their friends' and neighbors' vehicles.[355] According to a recent U.S. survey on the visibility of 31 expenditure categories (from food to mobile phones), new or used motor vehicle purchases were the second most visible expenditure; related expenditures on gasoline/diesel, vehicle maintenance, and insurance were all substantially less visible.[356]

The trouble with positional goods is they impose externalities. If Joan buys a fast, flashy sportscar to move up the status hierarchy, John's fast, flashy sportscar is no longer as rare. John feels relatively worse off and so will have to invest in an even faster, flashier car just to restore his previous status position. Joan's purchase made John feel worse off (a positional externality), and then John's subsequent purchase made Joan feel worse off (another positional externality), and at the end they wind up with the same relative status that they started with. As a result, both consumers spend resources without actually improving their relative status.[357]

Because vehicle purchase decisions are made non-cooperatively but in fact alter the spending behavior of others, consumers get stuck on a "positional treadmill" that does not increase welfare.[358] Yet if any individual unilaterally tries to opt out of this "expenditure arms race," it would only move that consumer backwards on the status hierarchy.[359] If consumers could maintain their *relative* position with respect to positional vehicle features, they might not suffer any welfare loss.[360]

Therefore, even if the Clean Car Standards were to reduce the availability of some features due to a tradeoff with fuel economy, they would do so in a way that serves as a cooperative solution that allows consumers to achieve what they could not in the non-cooperative open market: an increase in fuel economy and decrease in other features (compared to what would have existed without the standards) without losing position in the status hierarchy.[361]

Because of the positional nature of many vehicle features, the agencies cannot assume that rolling back the Clean Car Standards will improve welfare by allowing consumers to select a vehicle with more of those features and less fuel efficiency.[362] That consumers are individually willing to pay for positional features does not establish that a regulation that (purportedly) collectively reduces the provision of those features will cause consumers to lose aggregate welfare. As a result, the agencies have not supported any assumption that, even if there were a tradeoff between fuel efficiency and other features, such a tradeoff includes a corresponding welfare loss that justifies undercounting the economic value of fuel saved when calculating fuel savings benefits.

Conclusion

By rolling back the Clean Car Standards, the agencies have adopted a regulation that will result in significant additional fuel usage and greenhouse gas emissions. Reversing course, as the agencies have done, requires a nonarbitrary, well-reasoned analytical basis.[363] But even the agencies' own flawed modeling and analysis show that the net benefits of their rollback at best "straddle zero."[364] A proper and balanced analysis consistent with economic best practices and the agencies' historical regulatory practices would demonstrate that the benefits of the Clean Car Standards exceeded their costs by an even greater magnitude than the agencies admit.

To justify this rollback when the benefits are "directionally uncertain,"[365] the agencies claim they can focus their regulatory choice on avoiding the Clean Car Standards' "upfront costs"—meaning both the price of purchasing a more efficient vehicle and the unproven "opportunity cost" to consumers of supposedly having to forgo vehicle performance to achieve fuel economy.[366] The focus on upfront costs effectively ignores or devalues a sizeable chunk of the substantial longer-term lost fuel savings, as if consumers would not value having more money in their pockets in the future.[367] The agencies even nearly go so far as to claim that the possibility of opportunity costs—together with an unsubstantiated assertion that it may be perfectly rational for consumers to apply exceedingly high discount rates to future fuel savings—could explain away all private market failures and perhaps allow the agencies to ignore *all* the forgone consumer benefits of their rollback. The agencies muse at several points in the SAFE Rule about whether they could ignore all the rollback's "$26.1 billion in private losses to consumers," and focus instead only on the external gains they attribute to the rollback.[368] As a somewhat less extreme alternative, the agencies also propose as a sensitivity analysis that perhaps they can estimate opportunity costs by proxy, by arbitrarily subtracting away 42 months' worth of fuel savings—a significant portion of total fuel savings.[369] Only by significantly undercounting or entirely ignoring key benefits like fuel savings could the agencies' rollback finally start to appear cost-benefit justified.[370]

But even the agencies ultimately back away from completely dismissing market failures,[371] and their main cost-benefit tables fully value fuel savings.[372] And in any event, the agencies' suggestion that a theory of opportunity costs might support a focus on upfront costs while erasing a significant portion of consumer benefits is flawed at every step of the analysis. There is no evidence that hidden opportunity costs will occur: the agencies' analysis is theoretically and empirically flawed, and their own model already accounts for possible tradeoffs between fuel economy and other vehicle features and finds many fuel economy-technologies actually improve other vehicle attributes. Instead of such allegedly hidden opportunity costs, the economics literature shows that market failures explain the energy efficiency gap and so justify the use of efficient regulations to achieve private cost savings. Any undercounting of consumer benefits from fuel savings flies in the face of past practice across agencies over the last four decades under Administrations of both political parties and, further, is inconsistent with best practices for agency economic analysis. Finally, the agencies' attempt in their sensitivity analysis to quantify opportunity costs related to consumers' valuation of other vehicle characteristics does not withstand scrutiny, especially as the agencies ignore the effect of those other vehicle characteristics on compliance costs and externalities like safety effects.

In short, the agencies wrongfully cast doubt on well-established market failures and wave their hands toward arbitrary estimates of opportunity costs to justify an otherwise costly rollback. Their attempts fail, and the agencies cannot escape the reality that their rollback shortchanges consumers by depriving them of valuable fuel savings.

Endnotes

[1] The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 85 Fed. Reg. 24,174 (Apr. 30, 2020) [hereinafter Final Rule].

[2] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 15, 2012) [hereinafter Clean Car Standards].

[3] *See* NHTSA, *Fact Sheet* 1, 4 (2012), https://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2017-25_Fact_Sheet.pdf (reporting that NHTSA's standards would reach a combined fleet-wide average of 48.7-49.7 mpg, while EPA's—if achieved all through fuel economy improvements and not air conditioning improvements—would hit 54.5 mpg by 2025, with an overall rate of improvement of about 4.7-4.9%). NHTSA also estimated that the Clean Car Standards "would lead to fuel savings totaling about 170 billion gallons throughout the lives of light duty vehicles sold in MYs 2017–2025" (worth up to $488 billion in savings), and "corresponding reductions in CO_2 emissions totaling 1.8 billion metric tons" (which would achieve $49 billion in economic benefits). 77 Fed. Reg. at 62,629.

[4] Final Rule, *supra* note 1, 85 Fed Reg. at 24,176.

[5] *Id.*

[6] *Id.* at 24,176.

[7] *See, e.g.,* Institute for Policy Integrity, Key Economic Errors in the Clean Car Standards Rollback 2 (2020), https://policyintegrity.org/files/media/Vehicles_Emissions_Rollback_-_Key_Economic_Errors.pdf [hereinafter "Key Errors"]; *see also* Institute for Policy Integrity et al., Comments on Quantifying and Monetizing Greenhouse Gas Emissions in the Safer Affordable Fuel-Efficient Vehicles Proposed Rule and Preliminary Regulatory Impact Analysis at 1-4 (Oct. 26, 2018), https://policyintegrity.org/documents/Emissions_Standards_PRIA_SCC_Comments_Oct2018.pdf [hereinafter "Joint SCC Comments"] (more fully explaining the underestimation of the social cost of carbon that persists in the Final Rule).

[8] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,180-81, tables I-5 & I-6 (showing a low estimate of consumers' net present fuel costs of $1,110 under the CAFE standards at a 7% discount rate, and a high estimate of $1,461 under the CO_2 standards at a 3% discount rate; in all cases, consumers lose money per vehicle even after comparing fuel costs against more modest purchase price savings).

[9] *Id.* at 25,054-55, tables VII-116 & VII-118 (reporting an increase of 867.2 million metric tons of carbon dioxide under the CO_2 standard and 922.5 million metric tons under the CAFE standard, as well as significant increases in methane and nitrous oxide). *But see* NHTSA, SAFE Rule Final Environmental Impact Statement 5-35 (2020) (reporting that the final standard, labeled "Alternative 3," will increase carbon dioxide emissions by 7,800 million metric tons over the next eighty years); *and see* Joint SCC Comments, *supra* note 7, at 1-4 (explaining that the agencies inaccurately and incompletely quantified emissions, especially upstream methane emissions).

[10] *See, e.g.,* Institute for Policy Integrity, Comments on The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars & Light Trucks at 13-98 (Oct. 26, 2018), NHTSA-2018-0067-12213 and EPA-HQ-OAR-2018-0283-5083, *available at* https://policyintegrity.org/documents/Emissions_Standards_EPA_NHTSA_Comments_Oct2018.pdf [hereinafter Policy Integrity Oct. 2018 Comments]; Cal. Air Res. Bd., Analysis in Support of Comments on the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model years 2021-2026 Passenger Cars & Light Trucks at 188-282 (Oct. 26, 2018), https://www.regulations.gov/contentStreamer?documentId=NHTSA-2018-0067-11873&attachmentNumber=2&contentType=pdf; Mark Jacobsen & Arthur van Benthem, Comment on fleet turnover modeling in the Notice of Proposed Rulemaking for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars & Light Trucks (Oct. 8, 2018), https://www.regulations.gov/document?D=NHTSA-2018-0067-7788;. Antonio Bento, Comments on Notice of Proposed Rulemaking for the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars & Light Trucks (Oct. 22, 2018), https://www.regulations.gov/document?D=NHTSA-2018-0067-11598; *see also* Cal. Air Res. Bd., *Expert Reports on Specific Subjects (Vehicle Technology, VMT, Scrappage, Consumer Behavior, Traffic Safety etc.)*, https://ww2.arb.ca.gov/expert-reports-specific-subjects-vehicle-technology-vmt-scrappage-consumer-behavior-traffic-safety (last visited May 26, 2020) (collecting 12 reports authored by multiple experts, including Dr. Kenneth Gillingham, Dr. David Greene, and Dr. David Bunch).

[11] *See generally* NHTSA, CAFE Model Peer Review Revised (Jul. 2019), https://www.regulations.gov/contentStreamer?documentId=NHTSA-2018-0067-0055&attachmentNumber=2&contentType=pdf [hereinafter CAFE Peer Review].

[12] EPA Science Advisory Board, Consideration of the Scientific and Technical Basis for the EPA's Proposed Rule Titled *The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light*

Trucks at 21 (Feb. 27, 2020), https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebReportsLastMonthBOARD/1FACEE5C03725F268525851F006319BB/$File/EPA-SAB-20-003+.pdf [hereinafter SAFE Rule SAB Review]

13 *See, e.g.,* Robinson Meyer, *The Trump Administration Flunked Its Math Homework*, Atlantic (Oct. 31, 2018), https://www.theatlantic.com/science/archive/2018/10/trumps-clean-car-rollback-is-riddled-with-math-errors-clouding-its-legal-future/574249/; Antonio Bento, Kenneth Gillingham, Mark. R. Jacobsen, Christopher R. Knittel, Benjamin Leard, Joshua Linn, Virginia McConnell, David Rapson, James M. Sallee, Arthur A. van Benthem, & Kate S. Whitefoot, *Flawed Analyses of U.S. Auto Fuel Economy Standards*, 362 Sci. 1119 (Dec. 7, 2018), https://doi.org/10.1126/science.aav1458.

14 *See* The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, Proposed Rule, 83 Fed. Reg. 42,986, 42,998 (Aug. 24, 2018) [hereinafter "Proposed Rule"].

15 Policy Integrity Oct. 2018 Comments, *supra* note 10, at 13-98.

16 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,176; *see also id.* at 25,119, 25,172 (admitting that the final rule does not maximize net social benefits, and explaining that instead the final rule was chosen to limit upfront costs).

17 *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1198 (9th Cir. 2008).

18 *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,177, n.10, 24,701.

19 *See, e.g., id.* at 24,701-02, 25,110-11, 25,171.

20 *Id.* at 24,177 n.10 (claiming that if the agencies account for opportunity costs, then "the Final Rule would generate benefits . . . at 3% and 7% discount rates"). The agencies have performed other sensitivity analyses that show that the harms of the rule could actually be even worse than they appear in the main analysis. For example, if the Interagency Working Group's social cost of carbon estimates (central estimate at a 3% discount rate) are used instead of the agencies' dramatic underestimate of the costs of climate change, the rule is no longer net beneficial at the 7% discount rate, but instead causes $19-$27 billion in net costs. NHTSA & EPA, SAFE Rule Final Regulatory Impact Analysis at 1805, table VII-483, 1809, table VII-485 (Mar. 2020) https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/final_safe_fria_web_version_200330.pdf [hereinafter "FRIA"].

21 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,612-13 ("the agencies do not take a position in this rule on whether a fuel efficiency gap exists or constitutes a failure of private markets").

22 *See* Policy Integrity, Key Errors, *supra* note 7, at 2.

23 *Id.* at 1.

24 *See, e.g., id.* at 2 (explaining how the agencies are still overestimating accidents associated with the rebound effect).

25 Clean Air Act, § 202(a), 42 U.S.C. § 7521(a) (2020).

26 Energy Policy and Conservation Act, 49 U.S.C. § 32902(f) (2020); *see also* Proposed Rule, *supra* note 14, at 42,995, 43,015, 43,205 (explaining that EPCA requires NHTSA to set standards to conserve energy).

27 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 Fed. Reg. 25,324 (May 7, 2010) [hereinafter Model Year 2012-2016 Joint Standards].

28 Besides pollution, consumers also do not fully consider how their consumption of gasoline affects national importation of oil and the associated national security implications. Energy security is another externality that energy efficiency regulations can address.

29 Time saved refueling and the welfare benefits of additional driving through the "rebound effect" are important consumer benefits. For example, the rebound effect means that a consumer can drive a more efficient vehicle a few miles farther than a less efficient car on the same $20 of gasoline—and may choose to drive more as a result. This extra driving produces consumer benefits but may come with some costs such as fuel usage and externalities. The agencies have continued to make analytical errors in estimating the rebound effects, the refueling time effect, and associated costs and benefits. *See, e.g.,* Policy Integrity, Key Errors, *supra* note 7, at 2. However, for simplicity, this report will focus on fuel savings as the most important consumer benefit. Note also that, even if fuel savings were not considered a private consumer benefit, they would still represent real resources saved and so also create a benefit from the perspective of society. *See infra* Section V.E.

30 *See* David Greene, Anushah Hossain, Julia Hofmann, Gloria Helfand & Robert Beach, *Consumer Willingness to Pay for Vehicle Attributes: What Do We Know?*, 118 Transp. Res. Part A: Pol'y & Prac. 258 (2018), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6260949/ (meta-analysis of the academic literature regarding consumers' willingness to pay for fuel economy and other attributes).

31 Gloria Helfand & Ann Wolverton, *Evaluating the Consumer Response to Fuel Economy: A Review of Literature*, 5 Int'l Rev. Envtl. & Res. Econ. 103, 128-30 (2011), https://www.nowpublishers.com/article/Details/IRERE-0040 ("One would expect from economic theory that consumers would continue to demand fuel economy improvements until the benefits of a marginal improvement just meets the cost."). Fuel efficiency improvements also save consumers time by reducing the need to refuel the vehicle and can save consumers in maintenance costs. A rational consumer would also take these time and maintenance cost savings into account when making a vehicle purchase decision.

32 Greene et al., *supra* note 30, at 270-71.

33 Nat'l Res. Council, Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles 317 (2015), http://nap.edu/21744.

34 Helfand & Wolverton, *supra* note 31, at 126 ("Th[e] disconnect between net present value estimates of energy-conserving cost savings and what consumers actually spend on energy conservation is often referred to as the Energy Paradox."); Nat'l Res. Council, *supra* note 33, at 312. There is an extensive academic literature on the causes of the energy efficiency gap and what precisely is meant by "the energy efficiency gap." *See* Adam B. Jaffe & Robert N. Stavins, *The Energy-Efficiency Gap: What Does it Mean?*, 22 Energy Pol'y 804 (1994). For clarity, this report uses the term to mean the difference between the net present value of energy savings from efficiency improvements and the amount consumers are willing to pay *ex ante* for those efficiency improvements.

35 Clean Car Standards, *supra* note 2.

36 49 U.S.C. § 32902(b)(3)(B) (prohibiting NHTSA from issuing standards for more than 5 model years at a time).

37 NHTSA's MY 2022-2025 standards are sometimes referred to as "augural standards." *See* Clean Car Standards, *supra* note 2, 77 Fed. Reg. at 62,629-30 n.8.

38 NHTSA, Fact Sheet, *supra* note 3, at 4; EPA, Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards at 10-4, Table 10-4 (2012). The particular standards vary by automaker and depend on the mix of vehicles sold each year. Each automaker must meet an emissions standard based on the emissions from the fleet of vehicles that they sell. Each vehicle in the fleet has an emissions "target" based on the size of the vehicle and whether the vehicle is a car or a light truck. Larger vehicles and light trucks have more lenient targets. If an automaker cannot meet its standard, it can buy credits from other automakers that have more than met their standard in previous years.

39 EPA, Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards (2012); NHTSA, Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY 2025 Passenger Cars and Light Trucks (2012); EPA & NHTSA, Joint Technical Support Document: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards (2012).

40 Clean Car Standards, *supra* note 2, 77 Fed. Reg. at 62,629 (reporting that EPA's CO2 standards would achieve $451 billion in lifetime net benefits at a 3% discount rate, or $326 billion at a 7% discount rate).

41 *Id.* at 62,652.

42 *Id.*

43 EPA, NHTSA & CARB, 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 at 12-74, 13-102 (2016), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF [hereinafter Draft TAR].

44 *Id.* at 4-26 to 4-36; EPA, Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Standards under the Midterm Evaluation: Technical Support Document at 4-1 to 4-55 (2016), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3L4.pdf [hereinafter Midterm TSD]; *see also* EPA, Proposed Determination at 26, A-43 to A-61 (2016), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3DO.pdf [hereinafter Proposed Determination]; EPA, Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation: Response to Comments at 127, 130-31 (2017), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100QQ9Y.pdf [hereinafter Response to Comments].

45 *See* Draft TAR, *supra* note 43, at 2-8 (citing the NRC report as a key source); *See generally* Nat'l Res. Council, *supra* note 33.

46 *See* EPA, Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation at 29 (2017), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100QQ91.pdf [hereinafter 2017 Final Determination]. EPA's Final Determination relied on substantial additional technical and economic analysis that built upon the analysis in the TAR, as well as public comments on the TAR and the Proposed Determination. EPA, Proposed Determination, *supra* note 44; EPA, Midterm TSD, *supra* note 44; EPA, Response to Comments, *supra* note 44.

47 EPA, 2017 Final Determination, *supra* note 46, at 30.

48 Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022-2025 Light-Duty Vehicles, 83 Fed. Reg. 16,077, 16,078 (Apr. 13, 2018) [hereinafter Revised Final Determination]. The conclusion that the Clean Car Standards were "not appropriate" was not supported by the evidence. *See* Bethany Davis Noll, Peter Howard & Jeffrey Shrader, Institute for Policy Integrity, Analyzing EPA's Vehicle-Emissions Decisions: Why Withdrawing the 2022-2025 Standards Is Economically Flawed (2018), https://policyintegrity.org/files/publications/Analyzing_EPAs_Fuel-Efficiency_Decisions_Policy_Brief.pdf. In litigation over this decision, the U.S. Court of Appeals for the D.C. Circuit made clear that EPA must consider the evidence developed for the Midterm Evaluation in any final rule changing the Clean Car Standards. *California v.*

Environmental Protection Agency, 940 F.3d 1342, 1351 (D.C. Cir. 2019) (holding that the withdrawal of the 2017 Final Determination was not a final agency action subject to judicial review, but reminding EPA that any final regulatory changes will require a reasoned explanation for disregarding the facts underlying the record developed during the midterm valuation process).

49 Revised Final Determination, *supra* note 48, 83 Fed. Reg. at 16,087.

50 Proposed Rule, *supra* note 14, 83 Fed. Reg. at 42,986.

51 NHTSA & EPA, Preliminary Regulatory Impact Analysis: The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Year 2021-2026 Passenger Cars and Light Trucks 1004 (Aug. 23, 2018) [hereinafter PRIA]; Proposed Rule, *supra* note 14, 83 Fed. Reg. at 43,095.

52 Policy Integrity Oct. 2018 Comments, *supra* note 10, at 62-79.

53 Vehicle miles traveled may nonetheless increase for the separate reason that more efficient vehicles have lower operating costs, which allows consumers to drive more for the same cost. This "rebound effect" was included separately in the agencies' analysis. While conceptually correct, the agencies' proposed and final rules are also flawed because they substantially overestimate the level of the rebound effect. *See id.* at 99-125; Policy Integrity, Key Errors, *supra* note 7, at 2.

54 Sarah E. West, *Distributional Effects of Alternative Vehicle Pollution Control Policies*, 88 J. Pub. Econ. 735, 739-40 (2004); Lucas W. Davis, *Durable Goods and Residential Demand for Energy and Water: Evidence from a Field Trial*, 39 RAND J. Econ. 530, 532-33 (2008).

55 *See* Policy Integrity Oct. 2018 Comments, *supra* note 10, at 59-98.

56 *See, e.g.,* Cal. Air Res. Bd., Expert Reports, *supra* note 10 (collecting 12 reports authored by multiple experts). NHTSA's own peer review of the new modeling "raises fundamental issues regarding the model's specification and implementation." NHTSA, CAFE Peer Review, *supra* note 11, at B-3.

57 Robinson Meyer, *supra* note 13; *see also* Bento et al., *supra* note 13.

58 *See* PRIA, *supra* note 51, at 12 (indicating that the reference case counts 100% of consumer benefits).

59 *Id.* at 1531; *see also id.* at 12; Proposed Rule, *supra* note 14, 83 Fed. Reg. at 43,353 (briefly mentioning but not explaining the rationale for the sensitivity cases).

60 PRIA, *supra* note 51, at 943, 1091, 1097.

61 One of the authors the agencies rely on for their analysis, "Whitefoot," *see id.* at 1096, also submitted public comments, which said that the agencies' assumptions were not supported by the literature. *See* Comments from Jeremy J. Michalek & Kate S. Whitefoot, Comment on the Notice of Proposed Rulemaking for the Safer Affordable Fuel-Efficient Vehicle Rule for Model Years 20121-2026 Passenger Cars and Light Trucks at 9-10 (Oct. 26, 2018), https://www.regulations.gov/document?D=NHTSA-2018-0067-11903 ("[T]he agencies include an assumed loss of value to consumers associated with undesirable attributes of fuel-saving technologies, but a number of fuel saving technologies actually increase performance, and publications in peer-reviewed scientific journals have found that (1) the evidence of hidden costs to vehicle operation characteristics from fuel saving technologies is limited' and (2) taking advantage of fuel economy / performance tradeoffs while accounting for pricing and consumer demand allows automakers to comply at lower costs than agencies estimate, not higher costs.").

62 Draft TAR, *supra* note 43, at 4-36.

63 EPA, Consumer Willingness to Pay for Vehicle Attributes: What is the Current State of Knowledge? 7-1 (2018), https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=OTAQ&dirEntryId=339388.

64 PRIA, *supra* note 51, at 1097; *see also id.* at 1531-34 (not listing an opportunity cost sensitivity analysis).

65 Final Rule, *supra* note 1.

66 Compare NHTSA, Fact Sheet, *supra* note 3, with Final Rule, *supra* note 1, 85 Fed. Reg. at 24,175.

67 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,180-81, tables I-5 & I-6 (showing a low estimate of consumers' net present fuel costs of $1,110 under the CAFE standards at a 7% discount rate, and a high estimate of $1,461 under the CO2 standards at a 3% discount rate; in all cases, consumers lose money per vehicle even after comparing fuel costs against more modest purchase price savings).

68 *Id.* at 25,054-55, tables VII-116 & VII-118 (reporting an increase of 867.2 million metric tons of carbon dioxide under the CO2 standard and 922.5 million metric tons under the CAFE standard, as well as significant increases in methane and nitrous oxide). *But see supra* note 9 for important caveats about why emissions may be underestimated.

69 Final Rule, *supra* note 1, 85 Fed. Reg. at 25,107-08 (discussing over-compliance under various alternatives).

70 *See id.* at 24,232 (summarizing EDF's criticism of the over-compliance assumption).

71 *See, e.g.,* Policy Integrity, Key Errors, *supra* note 7, at 2 (noting the continued errors in estimating rebound-related safety effects, among other errors).

72 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,176.

73 *Id.*

74 The average across the two discount rates for each regulatory program would suggest negative $7.8 billion for the CO_2 program versus positive $1.5 billion for the CAFE program.

And there are, in fact, many reasons to favor the calculations at the 3% discount rate. *See, e.g.,* EPA, Guidelines for Preparing Economic Analyses 6-18, 19 (Dec. 17, 2010), https://www.epa.gov/sites/production/files/2017-08/documents/ee-0568-50.pdf [hereinafter EPA Guidelines] (explaining that for policies with long time horizons, when benefits stretch out over fifty years or more, a 3% consumption rate of interest should be the primary choice of discount rate, as well as other approach like a declining discount rate schedule).

75 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,176.

76 *See, e.g.,* Policy Integrity, Key Errors, *supra* note 7, at 2; *see also* Joint SCC Comments, *supra* note 7 (more fully explaining the underestimation of the social cost of carbon that persists in the Final Rule).

77 Final Rule, *supra* note 1, 85 Fed. Reg. at 25,099.

78 *See, e.g., id.* at 24,604 (defining "up-front costs" to include the "opportunity cost of any other desirable feature"); *id.* at 25,171 (same); *id.* at 25,111, n.2479 (discussing EPA's focus on upfront costs and then citing to the sensitivity case's analysis of opportunity costs); *id.* at 25,109 (explaining that EPA considers any "significant impact on vehicle utility and performance" when considering consumer costs); *id.* at 25,120 (basing EPA's regulatory decision on hard-to-quantify costs); *id.* at 24,214 (weighing "consumer demand for . . . other vehicle attributes" as part of NHTSA's statutory factors); *id.* at 25,141 (referencing "upfront . . . tradeoffs" in balancing NHTSA's statutory factors).

79 *See, e.g., id.* at 25,171 (comparing NHTSA's focus on upfront costs, including opportunity costs, to its skepticism that fuel savings exist that consumers could not purchase on their own); *id.* at 25,110-11, n.2479 (claiming that valuing lifetime fuel saving on equal footing with upfront costs "distorts the comparison," and then citing to the sensitivity case's analysis of opportunity costs). A focus on upfront costs, while devaluing longer term costs, is analytically equivalent to using an extremely high (and unjustified) discount rate.

80 *See, e.g.,* Office of Mgmt. & Budget, Circular A-4: Regulatory Analysis at 9 (2003) ("In undertaking these analyses, it is important to keep in mind the larger objective of analytical consistency."); *id.* at 33 (recommending a 3% discount rate for regulations that "primarily and directly affect[ ] private consumption (e.g., through higher consumer prices for goods and services").

81 *See infra* Section III.

82 *See infra* Section IV.

83 *See infra* note 85.

84 *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,201-08 (counting "retail fuel savings" as a forgone social benefit of the rollback).

85 *Id.* at 24,612 ("If either case is true—that the analysis is incomplete regarding consumer valuation of other vehicle attributes or discount rates used in regulatory analysis inaccurately represent consumers' time preferences—no market failure would exist to support the hypothesis of a fuel efficiency gap. In either case, the agencies' central analysis would overstate both the net private and social benefits from adopting more stringent fuel economy and CO_2 emissions standards. . . . Because government action cannot improve net social benefits in the absence of a market failure, if no market failure exists to motivate the $26.1 billion in private losses to consumers, the net benefits of these final standards would be $42.2 billion."); *see also id.* at 24,701 (same); FRIA, *supra* note 20, at 1011 (same); *id.* at 116 (touting that, as opposed to consideration of private costs and benefits, "external net benefits—those incremental reductions and increases in the harms associated with market failure upon which there is little disagreement or doubt—are higher for less stringent alternatives").

86 Final Rule, *supra* note 1, 85 Fed. Reg. at 25,110-1, n.2479 (citing to the sensitivity case's implicit opportunity cost analysis).

87 *Id.* at 24,701-02 (explaining that the proxy estimate is based on "fuel savings over the first seventy-two months (less the first thirty months").

88 *See id.* at 24,177 n.10.

89 By hidden opportunity costs, we refer to attribute tradeoffs that allegedly are not already accounted for in the agencies' model, which already assumes additional technology costs sufficient to hold vehicle performance and features constant without trading off attributes against fuel economy.

90 The agencies talk about not just the value of forgone attributes but also about getting consumers back "savings" that they could spend on entirely different, non-vehicle goods. *Id.* at 24,702. The agencies never explain what "savings" they are possibly referring to or how any "savings" could occur other than what is already reflected in the technology cost savings estimate in the primary analysis.

91 *Id.* at 24,604.

92 *Id.* at 24,612.

93 *Id.* at 24,612-13 (refusing to fully adopt the position that no market failures exist and the energy efficiency gap is due solely to constrained optimization).

94 Rational consumers would also consider the fact that such technology saves time at the pump and the value of additional miles traveled. However, the presence of these additional consumer benefits does not change the analysis and so, for simplicity, we refer only to the fuel savings

[95] Gloria Helfand & Reid Dorsey-Palmateer, *The Energy Efficiency Gap in EPA's Benefit-Cost Analysis of Vehicle Greenhouse Gas Regulations: A Case Study*, 6 J. Benefit Cost Analysis 432, 438 (2015) ("If vehicle buyers minimize costs of ownership, as in standard economic models, then all else equal, they should be willing to purchase additional fuel-saving technology as long as the additional cost of this technology to them is less than the expected discounted fuel savings."); Helfand & Wolverton, *supra* note 31, at 129-130 ("[T]he relative preference for performance over fuel economy still does not explain the seeming paradox that fuel savings appears to exceed the cost of adding additional fuel economy to the vehicle. One would expect from economic theory that consumers would continue to demand fuel economy improvements until the benefits of a marginal improvement just meets the cost. Only if there are limits on the total amount of efficiency that can go in a vehicle does economic theory predict that the marginal benefit of fuel economy should not equal its marginal cost.").

[96] *See, e.g.,* Draft TAR, *supra* note 43, at 4-35 to 4-36 (citing numerous examples of fuel economy technologies that also improve other features); EPA, Proposed Determination, *supra* note 44, at A-49 ("First, it is possible for automakers to continue to improve some other vehicle attributes, such as infotainment systems, in the absence of the standards. Second, EPA believes that the standards are contributing to innovation and adoption that would not have happened in the absence of the standards. In some cases, that innovation has contributed both to reduced GHG emissions and to improvements in other vehicle characteristics. For instance, Ford points out that the MY2015 F-150, with high-strength steel frame and high-strength, aluminum alloy body, provides better towing and hauling in addition to reduced GHG emissions."); Helfand & Dorsey-Palmateer, *supra* note 95, at 442 ("Power is also considered a substitute for fuel economy (e.g., Klier & Linn, 2012), though it is possible to increase both power and fuel economy, at a cost.").

[97] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,612 (also explaining that the "central analysis" in the Final Rule "does not account for the possibility that imposing stricter standards may require manufacturers to make sacrifices in other vehicle features that compete with fuel economy, and that some buyers may value more highly").

[98] *Id.* at 24,706.

[99] If a consumer anticipates selling the car before the end of its life, the value of the remaining fuel savings would be reflected in the car's resale value, and so should still accrue to the vehicle's initial purchaser.

[100] Comments from University of California, Berkeley's Environmental Law Clinic at 16-17 (Sept. 5, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0879 (citing a November 2016 memorandum commissioned by EPA, identifying over 60 financial institutions that offer loan rate reductions to consumers that purchase fuel-efficient vehicles); Memorandum from Hsing-Hsiang Huang & Gloria Helfand to EPA, Lending Institutions That Provide Discounts for More Fuel-Efficient Vehicles (Nov. 2016), *available at* https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0827-5832 ("EPA believes this information is valuable in illustrating the current practice of lenders providing green auto loans that factor in the consumer fuel savings from more efficient vehicles into the lending terms.").

[101] Helfand & Wolverton, *supra* note 31, at 130 ("Only if there are limits on the total amount of efficiency that can go in a vehicle does economic theory predict that the marginal benefit of fuel economy should not equal its marginal cost.").

[102] *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 25,109; accord. *id.* at 25,115; *see also id.* at 24,612 ("As such, it is not necessary that purchasers do not value lifetime fuel savings—and, in all likelihood, purchasers would prefer vehicles with better fuel efficiency and all of their preferred attributes—but rather consumers are forced to choose between fuel economy and other vehicle attributes while weighing how much each attribute contributes to the total cost of the vehicle.").

Note, for example, that in the FRIA, *supra* note 20, at 314, table VI-23 lists attributes that "could be impacted," but the table does not present evidence of such tradeoffs (i.e., it says "could be," not "are impacted"), nor do the agencies adequately explain why there would be such real-world engineering constraints.

[103] *See* FRIA, *supra* note 20, at 326 (explaining that multiple options exist for "technology [to] provide both improved fuel economy and performance").

[104] *Id.* ("[I]f a new transmission is applied to a vehicle, the greater number of gear ratios helps the engine run in its most efficient range which improves fuel economy, but also helps the engine to run in the optimal 'power band' which improves performance.").

[105] *Id.* ("Another example is applying a small amount of mass reduction that improves both fuel economy and performance by a small amount.").

[106] *Id.* at 239 (relaying comments from industry that "manufacturers may apply turbocharging to improve not just fuel economy, but also to improve vehicle performance"); *see also id.* at 317.

[107] *Id.* at 320 ("[A] PHEV50 may have an electric motor and battery appropriately sized to operate in all electric mode through the repeated accelerations and high speeds in the US06 driving cycle, but the resulting motor and battery size enables the PHEV50 slightly to over-perform in 0-60 acceleration."); *see also id.* at 324 (concluding it is "an appropriate outcome" that certain electrification or hybridization options lead to a "small increase in passing performance").

[108] *See* Comment by the International Council on Clean Transportation (ICCT) at II-11 to II-16, NHTSA-2018-0067-11741 and EPA-HQ-OAR-2018-0283-5456 (Oct. 25, 2018), *available at* https://www.regulations.gov/contentStreamer?documentId=NHTSA-2018-0067-11741&attachmentNumber=3&contentType=pdf (discussing how technologies such as 10-speed engines, variable valve and direction injection, turbocharging, lightweighting, and high-volt hybridization simultaneously and necessarily improve both fuel economy and features such as performance); *see also* FRIA, *supra* note 20, at 322-27 (discussing comments from CARB, ICCT, and others on how the CAFE model's constant-performance assumption overcorrected in ways that would increase performance, particularly with respect to electric vehicles' acceleration).

For yet other technologies, the agencies offer no plausible theory for how any possible performance tradeoffs would occur: how would more efficient LED lighting, for example, ever be associated with changes to handling or acceleration? *See* EPA, Proposed Determination, *supra* note 44, at A-55.

[109] *See* Draft TAR, *supra* note 43, at 4-35 to 4-36; EPA, Proposed Determination, *supra* note 44, at A-49 (citing evidence presented from Ford about the F-150).

[110] FRIA, *supra* note 20, at 329.

[111] *Id.* The agencies do not seem to provide data on how the final rule, as opposed to the proposed rollback, fares with respect to acceleration.

[112] *Id.* at 303 ("[C]ertain attributes were held at constant levels within each technology class to maintain vehicle functionality, performance and utility including noise, vibration, and harshness (NVH), safety, performance and other utilities important for customer satisfaction. For example, in addition to the vehicle performance constraints discussed in Section VI.B.3.a)(6), the analysis does not allow the frontal area of the vehicle to change, in order to maintain utility like ground clearance, head-room space, and cargo space, and a cold-start penalty is used to account for fuel economy degradation for heater performance and emissions system catalyst light-off.").

[113] *Id.* at 318 (explaining that low-speed acceleration, high-speed acceleration, gradeability, and towing capacity are held constant).

[114] Note that the constant-performance assumption is applied to estimate technology costs under both the baseline and the regulatory alternatives. If the agencies wanted to try to model actual opportunity costs, they would first have to model an alternative baseline that would allow for cost-reducing tradeoffs as well as technological advancement.

[115] *Id.* at 318-19. The agencies have long used this constant-performance cost assumption in their model, and the approach has been endorsed by manufacturers as reasonable. *Id.* at 320. For their part, environmental organizations have complained that the assumption results in an overestimate of costs and, in fact, overcorrects and improves vehicle performance. *Id.* at 322-27.

[116] *Id.* at 317 (emphasis added).

[117] *Id.* at 316 ("The agencies believe that any minimal remaining differences, which may directionally either improve or degrade vehicle attributes, utility and performance are small enough to have de minimis impact on the analysis.").

[118] *Id.* ("any minimal remaining differences, *which may directionally either improve or degrade vehicle attributes*") (emphasis added).

[119] *See supra* notes 103-108 and accompanying text.

[120] PRIA, *supra* note 51, at 943 ("[B]y using a reference fleet from a previous model year (2016), the analysis does not incorporate the normal gradual improvements in vehicle technology that enable slow but steady increases in fuel economy and other features that buyers value.").

[121] *Id.* (first explaining that "the estimates of the cost to improve the fuel economy of the reference fleet to meet higher CAFE standards during future model years may overstate the incremental cost of the additional technology that would be required," then mentioning possible opportunity costs, and concluding "it is difficult to anticipate the net effect of these over- and under-estimates," suggesting that the over-estimated technological costs could almost—or perhaps even completely—offset any possible underestimated opportunity costs).

[122] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,702.

[123] Thomas Klier & Joshua Linn, *The Effect of Vehicle Fuel Economy Standards on Technology Adoption*, 133 J. Pub. Econ. 41, 49 (2016). The study did find statistically significant effects for European cars, but the magnitude of the effects was "relatively small." *Id.* at 51.

[124] *Id.* at 50 (reporting an effect for cars in just one of three time periods analyzed, and an effect for trucks that decreased almost to statistical insignificance over time; the overall effect for cars is smaller than for trucks).

[125] *Compare* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,703, table VI-185 (citing results from "Knittel" as 0.26% for cars-HP, 0.08% for cars-torque, 0.39% for cars-weight, 0.06% of trucks-HP, 0.31% for trucks-torque, and 0.36% for trucks-weight) *with* Christopher Knittel, *Automobiles on Steroids: Product Attribute Trade-Offs and Technological Progress in the Automobile Sector*, 101 Am. Econ. Rev. 3368, 3379 (2012) (explaining that "I focus on [results from] Model 3"); *id.* at 3381 (reporting Model 3 results for cars as 0.262 for HP but 0.045 for torque (not 0.08) and 0.419 for weight (not 0.39), and listing no set of results that matches the agencies' data); *id.* at 3383 (similarly reporting slightly different results for trucks). *But see* Christopher Knittel, *Automobiles on Steroids* (Ctr. for the Study of Energy Mkts., Working Paper No. 187, 2009), http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.362.4558&rep=rep1&type=pdf at 30

(reporting results for cars that, in Model 2, do match the agencies' data); *id.* at 32 (reporting results for trucks that, in Model 2, do match the agencies' data).

126 *See* Knittel (2012), *supra* note 125, at 3381 (showing that the results for cars' torque were not statistically significant; *id.* at 3383 (showing that the results for trucks' horsepower were only statistically significant at the 10% level); *see also* Knittel (2009) *supra* note 125, at 32 (reporting that the results for trucks' horsepower were not statistically significant even at the 10% level).

127 FRIA, *supra* note 20, at 1015.

128 Klier & Linn, *supra* note 123, at 46 ("[A] 1% increase in horsepower increases the log fuel consumption rate by about 0.24.").

129 *Compare* PRIA, *supra* note 51, at 1091, table 8-31 *with* FRIA, *supra* note 20, at 1015, table VI-220.

130 Draft TAR, *supra* note 43, at 4-30.

131 *Id.* at 4-29 to 4-32; *see also* EPA, Midterm TSD, *supra* note 44, at 4-4 to 4-7. The Midterm Evaluation's critiques of MacKenzie and Heywood include that even their acceleration data does not reflect consumers' actual experience of performance, which is more about handling, cornering, and so forth; that tradeoffs based on historic data may not apply to newer technologies; and their failure to consider how the standards themselves can affect the rate of technological innovation.

132 Draft TAR, *supra* note 43, at 4-30 ("In these studies, a large vehicle with significant mass reduction and improved fuel economy would show up in the data to have the same attributes as a small efficient car, though consumers would view them very differently."). Assumptions about holding constant other attributes, like manual transmission and turbocharging, might also have skewed some of the results in these works.

133 *Id.* at 4-30, 4-31 to 4-32; *see also* Proposed Determination, *supra* note 44, at A-50 (explaining that studies of attribute tradeoffs have not been "capable of distinguishing between innovation and adoption).

134 Draft TAR, *supra* note 43, at 4-30 (also explaining that, with respect to weight, "In these studies, a large vehicle with significant mass reduction and improved fuel economy would show up in the data to have the same attributes as a smaller efficient car, though consumers would view them very differently."). *See also* Gloria Helfand et al., EPA, Power and Fuel Economy Tradeoffs, and Implications for Benefits and Costs of Vehicle Greenhouse Gas Regulations at 7 (Powerpoint Presentation, 2018), https://www.regulations.gov/contentStreamer?documentId=EPA-HQ-OAR-2018-0283-6963&attachmentNumber=17&contentType=pdf, also *available at* https://www.epa.gov/sites/production/files/2018-10/documents/sbca-benefit-cost-ghg-regs-helfand-2018-03.pdf [hereinafter Helfand et al. Powerpoint] (questioning whether people really care about horsepower, or just acceleration); Kate S. Whitefoot, Meredith L. Fowlie & Steven J. Skerlos, *Compliance by Design: Influence of Acceleration Trade-Offs on CO_2 Emissions and Costs of Fuel Economy and Greenhouse Gas Regulations*, 51 Envtl. Sci. & Tech. 10,307, 10,308 (2018), *available at* https://www.regulations.gov/contentStreamer?documentId=NHTSA-2018-0067-11903&attachmentNumber=1&contentType=pdf ("A[nother] concern [with Klier and Linn 2016] is that correlations between attributes of interest (e.g., energy efficiency) and attributes that are difficult to quantify or otherwise unobservable in historical data (e.g., vehicle shape) can make it difficult to identify attribute tradeoffs econometrically."). Even MacKenzie & Heywood focus on acceleration and not handling, Draft TAR, *supra* note 43, at 4-31.

135 Draft TAR, *supra* note 43, at 4-31 ("Manufacturers do not produce vehicles with all possible combinations of horsepower, fuel economy, and weight; instead, the vehicles they produce include a mix of those characteristics that the companies believe consumers prefer. . . . As a result, the tradeoff estimates may not represent strictly technological tradeoffs, but also manufacturer choices that potentially bias tradeoff estimates"). *See also* Helfand et al. Powerpoint, *supra* note 134, at 7 ("The data are not a random sample of all possible combination of power & fuel economy: Only vehicles produced."); Whitefoot, Fowlie & Skerlos, *supra* note 134, at 10,308 ("One limitation of this approach [by Klier and Linn 2016] is that many combinations of product attributes are not observed in the marketplace, but are technologically feasible and potentially optimal under future policy scenarios.").

136 Proposed Determination, *supra* note 44, at A-49.

137 Comments from Environmental Defense Fund at 86-89 (Oct. 26, 2018), https://www.regulations.gov/contentStreamer?documentId=NHTSA-2018-0067 12108&attachmentNumber=3&contentType=pdf; Policy Integrity Oct. 2018 Comments, *supra* note 10, at 50. Comments from Michalek & Whitefoot, *supra* note 61, at 9-10.

138 Draft TAR, *supra* note 43, at 4-26 to 4-36; Proposed Determination, *supra* note 44, at A-48 to A-51.

139 Hsing-Hsiang Huang et al., *Re-Searching for Hidden Costs: Evidence from the Adoption of Fuel-Saving Technologies in Light-Duty Vehicles*, 65 Transp. Res. 194 (2018); Gloria Helfand et al., *Searching for Hidden Costs: A Technology-Based Approach to the Energy Efficiency Gap in Light-Duty Vehicles*, 98 Energy Pol'y 590 (2016).

140 Helfand et al Powerpoint, *supra* note 134; Hsing-Hsiang Huang, Gloria Helfand & Kevin Bolon, EPA, Consumer Satisfaction with New Vehicles Subject to Greenhouse Gas and Fuel Economy Standards (Powerpoint Presentation, 2018), https://www.regulations.gov/contentStreamer?documentId=EPA-HQ-OAR-2018-0283-6963&attachmentNumber=1&contentType=pdf; Hsing-Hsiang Huang et al., Re-Searching for Hid-

den Costs with Producer Heterogeneity (Powerpoint Presentation, 2017), https://www.regulations.gov/contentStreamer?documentId=NHTSA-2018-0067-11768&attachmentNumber=2&contentType=pdf.

141 *See supra* notes 137-140.

142 Helfand et al. (2016), *supra* note 139, at 605 ("Though we are unable to demonstrate causality or robustness, we find that technologies are more likely to be associated with reducing negative reviews of operational characteristics than with increasing them.").

143 Helfand et al. Powerpoint, *supra* note 134, at 17 ("The tradeoff between power & fuel economy has dropped over time.").

144 Antonio M. Bento, Kenneth Gillingham, Mark. R. Jacobsen, Christopher R. Knittel, Benjamin Leard, Joshua Linn, Virginia McConnell, David Rapson, James M. Sallee, Arthur A. van Benthem, & Kate S. Whitefoot, *Flawed Analysis of U.S. Auto Fuel Economy Standards*, 362 Sci. 1119, 1119 (2018), https://doi.org/10.1126/science.aav1458.

145 Draft TAR, *supra* note 43 & Midterm TSD, *supra* note 44, at 4-20, discussing, e.g., Hsing-Hsiang Huang, Gloria Helfand, Kevin Bolon, Robert Beach, Mandy Sha, & Amanda Smith, *Re-Searching for Hidden Costs: Evidence from the Adoption of Fuel-Saving Technologies in Light-Duty Vehicles*, 65 Transp. Res. 194, 194 (2018) (finding that "automakers have typically been able to implement fuel-saving technologies without harm to vehicle operational characteristics" like "acceleration, handling, ride comfort, noise, braking feel, and vibration").

146 EPA, 2019 Automotive Trends Report 30 (2020), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YVFS.pdf. *See also* Policy Integrity Oct. 2018 Comments, *supra* note 10 at 46 (showing data from 1994-2017 and including acceleration as well as horsepower and weight).

147 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,703-05 (attempting to use historical differences in the rates of technological increases as evidence of future tradeoffs between fuel economy and other attributes).

148 *See* Midterm TSD, *supra* note 44, at 2-247 to 2-249, 4-6 ("[T]he assumption in the previous research that the tradeoffs among acceleration, fuel economy, and weight are constant does not appear to accurately represent the new technologies, and in fact may substantially overestimate the magnitude of the performance-fuel economy tradeoff."); *see also* EPA, Response to Comments, *supra* note 44, at 127 ("[F]uel economy and other vehicle attributes are not mutually exclusive, so there is no necessary tradeoff between fuel economy and other vehicle attributes.").

149 *See* Midterm TSD, *supra* note 44, at 4-7 (citing Don McKenzie & John Heywood, *Quantifying Efficiency Technology Improvements in U.S. Cars from 1975-2009*, 157 Applied Energy 918 (2015)).

150 *See* Helfand et al. Powerpoint, *supra* note 134, at 13.

151 Bento et al., *supra* note 144, at 1119; Erik Hille & Patrick Möbius, *Environmental Policy, Innovation, and Productivity Growth: Controlling the Effects of Regulation and Endogeneity*, 73 Envtl. & Res. Econ. 1315, 1316, 1328 (2019).

152 Draft TAR, *supra* note 43, at 4-32 to 4-34.

153 *Id.* at 4-32 (citing GDI as an example of major technological diffusion stimulated by regulatory standards, as well as scientific research and popular press on how vehicle standards have driven innovation).

154 PRIA, *supra* note 51, at 1091.

155 *Id.* at 1097.

156 SAFE Rule SAB Review, *supra* note 12, at 22 ("We concur with the agencies that it is not yet feasible to quantify the impact on new vehicle sales of additional vehicle characteristics (beyond fuel economy) that are desired by consumers but restrained by federal standards.").

157 *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,201-08 (counting "retail fuel savings" as a forgone social benefit of the rollback). *But see id.* at 24,613 (expressing "reservations" about market failures and suggesting the energy efficiency gap is "of smaller magnitude than the agencies found in previous analyses").

158 *Id.* at 24,612 ("If either case is true—that the analysis is incomplete regarding consumer valuation of other vehicle attributes or discount rates used in regulatory analysis inaccurately represent consumers' time preferences—no market failure would exist to support the hypothesis of a fuel efficiency gap. In either case, the agencies' central analysis would overstate both the net private and social benefits from adopting more stringent fuel economy and CO2 emissions standards. . . . Because government action cannot improve net social benefits in the absence of a market failure, if no market failure exists to motivate the $26.1 billion in private losses to consumers, the net benefits of these final standards would be $42.2 billion."); *see also id.* at 24,701 (same); FRIA, *supra* note 20, at 1011 (same); *id.* at 116 (touting that, as opposed to consideration of private costs and benefits, "external net benefits—those incremental reductions and increases in the harms associated with market failure upon which there is little disagreement or doubt—are higher for less stringent alternatives").

159 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,608, 24,610-12 (using opportunity costs and high discount rates as theories to explain away market failures like loss aversion, positional externalities, myopia, and satisficing, and also claiming that purchase prices are underestimated by engineering studies).

160 *Id.* at 24,611.

161 *See* Knittel (2012), *supra* note 125 (not mentioning the energy efficiency paradox); Klier & Linn, *supra* note 123 (same); *see also* Don McKenzie & John Heywood, *Quantifying Efficiency Technology Improvements in U.S. Cars from 1975-2009*, 157 Applied Energy 918 (2015) (same).

[162] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,610 ("Most obviously, it does not acknowledge the possibility that engineering studies systematically underestimate costs to produce vehicles with higher fuel economy.").

[163] For example, the failure to fully model flexible compliance options and incomplete pass-through of costs to consumers. *See* Policy Integrity, Key Errors, *supra* note 7, at 1; Policy Integrity Oct. 2018 Comments, *supra* note 10, at 13-31.

[164] *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,605 (reporting that, in one of the agencies' three preferred studies (Allcott & Wozney), consumers are only fully valuing future fuel savings if consumers were applying "discount rates of 24 percent or higher.").

[165] *See* Office of Mgmt. & Budget, Circular A-4, *supra* note 80, at 33.

[166] The best the agencies offer is to summarize three studies and find that, if consumers use a discount rate of 5-6%, they "value at least half—and perhaps all—of the savings in future fuel costs." Final Rule, *supra* note 1, 85 Fed Reg. at 24,606. Public comments extensively critiqued the agencies' exclusive reliance on those three studies. *See, e.g.,* Policy Integrity Oct. 2018 Comments, *supra* note 10, at 33-50. *See also* SAFE Rule SAB Review, *supra* note 12, at 20 ("A more recent working paper by Leard et al. (2017) with a somewhat similar research design produces a much lower estimate of consumer valuation of fuel economy than reported by the three original published studies.") (citing Benjamin Leard, Joshua Linn & Yichen Zhou, *How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adoption* (Res. for Future Report, June 2017), https://media.rff.org/documents/RFF-Rpt-WTP_FuelEconomy26Performance.pdf); Antonio M. Bento et al., *Estimating the Costs and Benefits of Fuel-Economy Standards,* in Environmental and Energy Policy and the Economy, vol. 1 (Matthew J. Kotchen et al., eds., 2020) ("The empirical literature that provides estimates for [consumer valuation of fuel savings] continues to evolve, with some studies . . . suggesting substantial amounts of undervaluation.").

[167] *See, e.g.,* Klier & Linn, *supra* note 123, at 52-53 & n.15 (conducting a "back-of-the-envelope" comparison which showed that even if U.S. fuel economy standards had been significantly more stringent and even if U.S. consumers only valued future fuel savings at a 10% discount rate, willingness to pay for allegedly lost horsepower would only offset around half of fuel savings). In other words, this study, which the agencies rely heavily on for evidence, suggests that even opportunity costs and high discount rates together cannot fully explain the energy efficiency gap. *See also id.* at 52-53 (reporting that for European cars, the opportunity cost of lost attributes is less than 15% of the value of fuel savings). Thus, Klier & Linn (2016) does not support the agencies' assertions that there is no energy efficiency gap.

[168] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,706-07.

[169] *See* Office of Mgmt. & Budget, Circular A-4, *supra* note 80, at 11 (connecting interest rates and discount rates); EPA Guidelines, *supra* note 74, at 6-7 (same).

[170] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,609-10.

[171] *See* Draft TAR, *supra* note 43, at 6-5 to 6-9; EPA, Proposed Determination, *supra* note 44, at A-27 to A-34; Helfand & Wolverton, *supra* note 31, at 124-40 (reviewing the literature regarding justifications for the energy paradox); Todd D. Gerarden et al., *Assessing the Energy-Efficiency Gap*, 55 J. Econ. Literature. 1486, 1487-88 (2017) (listing traditional and behavioral market failures); *see also*, e.g., Policy Integrity Oct. 2018 Comments, *supra* note 10, at 38-40 (explaining reasons for the energy efficiency gap).

[172] James Sallee, *Rational Inattention and Energy Efficiency*, 57 J. Law & Econ. 781, 782-85 (2014).

[173] Helfand & Dorsey-Palmateer, *supra* note 95, at 439.

[174] David L. Greene, *Consumers' Willingness to Pay for Fuel Economy and Implications for Sales of New Vehicles and Scrappage of Used Vehicles,* Environmental Defense Fund 5 (Oct. 21, 2018), https://www.edf.org/sites/default/files/CARB_Report_Greene_UTenn_Consumer_Behavior_Modeling.pdf (describing behavioral economic explanations for the fuel efficiency paradox, including loss aversion).

[175] Nat'l Research Council, *supra* note 33, at 319 (2015) (explaining that manufacturers may face a first-mover disadvantage for developing new fuel-efficiency technologies, and regulation can help overcome that perceived disadvantage as well as bring down costs through economies of scale and learning, and thus may "lead to a more optimal provision of fuel economy in the marketplace").

[176] Carolyn Fischer, *Imperfect Competition, Consumer Behavior, and the Provision of Fuel Efficiency in Light-Duty Vehicles* (Resources for the Future, Discussion Paper DP 10-60, 2010), https://www.rff.org/documents/1472/RFF-DP-10-60.pdf.

[177] Gerarden et al., *supra* note 171, at 1489-90, 1503 (reviewing the academic literature assessing the fuel efficiency gap and concluding that empirical evidence supports the importance of information costs, consumer inattention and myopia, and manufacturer market power); Kenneth Gillingham, Sebastian Houde, & Arthur van Bentham, *Consumer Myopia in Vehicle Purchases: Evidence from a Natural Experiment* (Nat'l Bureau of Econ. Research, Working Paper No. 25845, 2019), https://www.nber.org/papers/w25845 (finding significant empirical evidence of consumer myopia); Antonio Bento et al., *Estimating the Costs and Benefits of Fuel-Economy Standards* (Nat'l Bureau of Econ. Research, Working Paper No. 26309, 2019), https://www.nber.org/chapters/c14288; Greene, *supra* note 174 (finding substantial empirical evidence in the literature for consumer loss aversion in the energy efficiency context); Helfand & Wolverton, *supra* note 31, at 133 (finding empirical evidence in the literature

for consumer myopia, loss aversion, and use of rules of thumb when making vehicle purchase decisions due to the difficulty of calculating fuel savings); Sebastian Houde & C. Anna Spurlock, *Minimum Energy Efficiency Standards for Appliances: Old and New Economic Rationales*, 5 Econ. Energy & Envtl. Policy 65 (2016) (finding evidence of manufacturer technology spillovers).

178 SAFE Rule SAB Review, *supra* note 12, at 21 ("The SAB finds that caution is warranted in the interpretation of the three recent econometric studies of consumer valuation. They evaluate how consumers respond to changes in fuel prices, not changes in the technologies offered on new vehicles. In a rational-choice framework, changes in fuel price and changes in technology can have an equivalent impact on the present value of fuel expenditures. From a behavioral perspective, however, seemingly equivalent changes in fuel price and technology may be perceived quite differently by consumers" (citing Greene and Welch 2016); *see also* Hunt Allcott, *Paternalism and Energy Efficiency: An Overview,* 8 Ann. Rev. Econ. 145 (2016) (identifying shortcomings in studies that find no fuel efficiency gap, including failure to fully address the endogeneity of attention and the costly acquisition of information, and reliance on assumptions about fuel costs, price forecasts, and discount rates (which may also be heterogenous instead of homogenous as assumed in these papers)).

179 SAFE Rule SAB Review, *supra* note 12, at 20 ("A more recent working paper by Leard et al. (2017) with a somewhat similar research design produces a much lower estimate of consumer valuation of fuel economy than reported by the three original published studies.") (citing Benjamin Leard, Joshua Linn & Yichen Zhou, *How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adoption* (Res. for Future Report, June 2017), https://media.rff.org/documents/RFF-Rpt-WTP_FuelEconomy26Performance.pdf); *see also* Antonio M. Bento et al., *Estimating the Costs and Benefits of Fuel-Economy Standards*, in Environmental and Energy Policy and the Economy, vol. 1 (Matthew J. Kotchen et al., eds., 2020) ("The empirical literature that provides estimates for [consumer valuation of fuel savings] continues to evolve, with some studies . . . suggesting substantial amounts of undervaluation.").

180 SAFE Rule SAB Review, *supra* note 12, at 21 (citing Kenneth Gillingham et al., *Consumer Myopia in Vehicle Purchases: Evidence from a Natural Experiment* (NBER Working Paper No. 25845, 2019), *available at* https://environment.yale.edu/gillingham/GillinghamHoudevanBenthem_ConsumerMyopia.pdf).

181 *Id.* (citing D. Neil, *Toyota RAV4 Hybrid: Great Performance, Even Better Fuel Economy*, Wall St. J., Apr. 19, 2019).

182 *Id.* (citing D. Duncan et al., Most Consumers Don't Buy Hybrids: Is Rational Choice a Sufficient Explanation? 10 J. Benefit-Cost Analysis 1 (2019)).

183 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,608. *But see id.* (claiming that CAFE and CO_2 standards cannot "resolve, or even mitigate, most of the various phenomena [that commenters] describe as market failures").

184 *Id.* at 24,613 (though arguing the energy efficiency gap is "of smaller magnitude than the agencies found in previous analyses").

185 *See id.* at 25,110 n.2476. Even if a consumer is not planning to keep a car for its full lifespan and so may not directly benefit from lifetime fuel savings, a rational consumer would be willing to pay upfront for the fact that "improved fuel economy can improve resale value of a vehicle." *Id.*

186 *See* David L. Greene, Consumers' Willingness to Pay for Fuel Economy and Implication for Sales of New Vehicles and Scrappage of Used Vehicles at 20 (2018), https://ww2.arb.ca.gov/sites/default/files/2018-10/10-21-2018_Greene_UTenn-Consumer_Behavior_Modeling.pdf; Nat'l Research Council, *supra* note 33, at 314, 319 (explaining that fuel economy standards can be an economically efficient solution given market failures). In fact, some recent literature has found that efficiency standards can outperform taxes as a tool for addressing both misperception of energy savings and externalities associated with energy use. Sébastien Houde & Erica Myers, *Heterogeneous (Mis-) Perceptions of Energy Costs: Implications for Measurement and Policy Design* 2-3 (Nat'l Bureau of Econ. Research, Working Paper No. 25722, 2019), http://www.nber.org/papers/w25722.

187 Draft TAR, *supra* note 43, at 6-9 ("If the gap exists, then the standards are providing net benefits to vehicle buyers, even if it is unclear why this is happening").

188 Nat'l Research Council, *supra* note 33, at 360 (describing social benefits of the Clean Car Standards including "[t]he private benefit of the fuel savings . . . though it may not be considered by car buyers at the time of purchase").

189 Fuel economy standards also create net social benefits by reducing externalities such as pollution and by addressing fuel security concerns. Those benefits would be on top of the benefits to consumers and society from directly saving fuel.

190 Final Rule, *supra* note 1, 85 Fed. Reg. at 25,110-11 ("[C]onsider[ing] fuel savings, spread over the lifetime of the vehicle . . . compared to the upfront vehicle costs . . . distorts the comparison. Instead, EPA concludes that the upfront vehicle technology costs (and associated financing costs) are a more important factor."); *see also supra* note 158 (collecting cites from the final rule where the agencies speculate that, if no market failures exist, then they need not count any private losses).

191 CAFE Peer Review, *supra* note 11, at 211, B-34.

[192] Model Year 2012-2016 Joint Standards, 75 Fed. Reg. at 25,510 ("The existence of large private net benefits from this rule, then, suggests" the market for vehicles is not one with "full information, perfect foresight, perfect competition, and financially rational consumers and producers").

[193] *Id.* at 25,511. NHTSA also identified these market failures as explanations for the energy efficiency gap in its Regulatory Impact Analysis. NHTSA, Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks 421 (2010).

[194] Model Year 2012-2016 Joint Standards, 75 Fed. Reg. at 25,512.

[195] Clean Car Standards, *supra* note 2, 77 Fed. Reg. at 62,914.

[196] NHTSA, Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY2025 Passenger Cars and Light Trucks 987-88 (2012).

[197] *Id.*

[198] Proposed Determination, *supra* note 44, at A-29 to A-30.

[199] *Id.* at A-29.

[200] *Id.* at A-31 to A-33.

[201] *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,201-08 (counting "retail fuel savings" as a forgone social benefit of the rollback).

[202] *See supra* note 158 (collecting references).

[203] Final Rule, *supra* note 1, 85 Fed. Reg. at 25,110-11 & n.2479 (citing to the implicit opportunity cost analysis).

[204] *Id.* at 24,701-02 (42 months equals "the fuel savings over the first seventy-two months (less the first thirty months").

[205] *See id.* at 24,177 n.10.

[206] *See, e.g.,* Energy Conservation Program: Energy Conservation Standards for Walk-In Cooler and Freezer Refrigeration Systems, 82 Fed. Reg. 31,808, 31,843, 31,811 (July 10, 2017); *see also infra* Section V.D.

[207] Though this section discusses examples across agencies and parties it is not an exhaustive list of all regulations that improve energy efficiency.

[208] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,611 (arguing that consumer's "tendency to underinvest in fuel economy" because of "differing attitudes about the importance of future costs relative to more immediate ones" should not be "dismissed" as irrational, but instead can help "readily explain" the energy efficiency gap).

[209] *See, e.g.,* Proposed Rule, *supra* note 14, 83 Fed. Reg. at 42,995, 43,015, 43,205 (explaining that EPCA requires NHTSA to set standards to conserve energy); Final Rule, *supra* note 1, 85 Fed. Reg. at 24,214 (explaining the "need of the United States to conserve energy" factor).

[210] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,606 n.1590.

[211] Circular A-4, *supra* note 80.

[212] *See* Office of Mgmt. & Budget, *Guidance Implementing Executive Order 13771* at 9 (Apr. 5, 2017), https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2017/M-17-21-OMB.pdf.

[213] Circular A-4, *supra* note 80, at 37-38.

[214] *Id.*

[215] *Id.* at 19 ("Market prices provide rich data for estimating benefits and costs based on willingness-to-pay if the goods and services affected by the regulation are traded in well-functioning competitive markets"); *id.* at 21 ("Economists ordinarily consider market prices as the most accurate measure of the marginal value of goods and services to society").

[216] *Id.* at 19, 21 (cautioning that willingness to pay is a good measure of benefits only "if" the underlying market is "well-functioning" and requiring agencies to take "market imperfections" into account when valuing regulatory effects); EPA Guidelines, *supra* note 74, at 7-21 (market prices are appropriate only "[f]or goods bought and sold in undistorted markets"); *see also id.* at 7-15 (directing use of healthcare costs not otherwise accounted for in individual consumers' willingness-to-pay to avoid morbidity because "these costs represent diversions from other uses in the economy, [and so] represent real costs to society [that] should be accounted for").

[217] *See generally* EPA Guidelines, *supra* note 74.

[218] *Id.* at 7-6.

[219] *Id.* at 7-15 (directing use of healthcare costs not otherwise accounted for in individual consumers' willingness-to-pay to avoid morbidity because "these costs represent diversions from other uses in the economy, [and so] represent real costs to society [that] should be accounted for"); *see also* Helfand & Dorsey-Palmateer, *supra* note 95, at 446 (discussing Guidelines' recommendation to use professional estimates of mortality risk when calculating benefits of reduced mortality rather than inaccurate consumer expectations of that risk).

[220] EPA Guidelines, *supra* note 74, at 7-21.

[221] *Id.* at 7-7.

[222] Of course, the production and use of vehicle fuel suffers from other market failures such as air pollution and market power. These failures, however, have been separately calculated in the agencies' cost-benefit analysis. *See, e.g.,* FRIA, *supra* note 20, at 116 (agreeing that climate change and energy security externalities are "paramount" and "there is little disagreement or doubt" about such market failures).

[223] EPA Guidelines, *supra* note 74, at 7-6; *id.* at 8-1 ("In conducting a [cost-benefit analysis], the correct measure to use is the social cost").

[224] Nat'l Research Council, *supra* note 33, at 315 ("Short payback periods imply high discount rates for fuel economy, which may indicate undervaluation of fuel economy"); *id.*

at 317 (discussing studies that compared implicit consumer discount rates of 13%-42% with rational discount rate of 6%). *See also supra* notes 164-169 and accompanying text.

225 EPA Guidelines, *supra* note 74, at 6-1.

226 *See* Energy Conservation Program for Consumer Products: Energy Conservation Standards for Two Types of Consumer Products, 54 Fed. Reg. 47,916, 47,921-22 (Nov. 17, 1989) (rejecting use of discount rates implied from historical consumer purchasing decisions rather than average cost of capital for financing purchases of more efficient appliances). EPA Guidelines, *supra* note 74, at 6-1.

227 *See* Kenneth Arrow et al., Determining Benefits and Costs for Future Generations, 341 Sci. 349 (2013).

228 U.S. Dep't of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs 9, 13, 30 (2018), https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/14091/benefit-cost-analysis-guidance-2018.pdf.

229 Federal Highway Administration, Operations Benefit/Cost-Analysis Desk Reference 40 (2012), https://ops.fhwa.dot.gov/publications/fhwahop12028/fhwahop12028.pdf.

230 Passenger Automobile Average Fuel Economy Standards, 42 Fed. Reg. 33,534, 33,550 (June 30, 1977).

231 *Id.* at 33,550-551.

232 NHTSA, Final Impact Assessment of the Automotive Fuel Economy Standards for Model Year 1981-84 Passenger Cars at I-24 (June 30, 1977) ("An important issue which is often raised is that the new car buyer would be impacted more by costs than benefits as that person more readily perceives initial costs than benefits accruing over the life . . . of the vehicle. In our view all costs (and benefits of owning and operating a vehicle) incurred over the economic vehicle life . . . must be accounted for in the analysis, and not only those faced by any one owner, such as the new car buyer").

233 *Id.*

234 Light Truck Average Fuel Economy Standards Model Years 1985–86, 49 Fed. Reg. 41,250, 41,252 (Oct. 22, 1984).

235 *Id.*

236 NHTSA, Final Regulatory Impact Analysis for Model Years 1985-86 Light Truck Fuel Economy Standards at IV-22 (Sept. 1984) ("Operating cost savings are defined as the present value of dollar savings in gasoline that the vehicle owner would realize over the life of the 1986 vehicles").

237 Light Truck Average Fuel Economy Standards; Model Year 1992, 55 Fed. Reg. 12,487 (Apr. 4, 1990); Light Truck Average Fuel Economy Standards; Model Years 1993-1994, 56 Fed. Reg. 13,773 (Apr. 4, 1991).

238 Light Truck Average Fuel Economy Standards Model Year 1995, 58 Fed. Reg. 18,019 (Apr. 7, 1993).

239 NHTSA, Final Regulatory Impact Analysis: Average Fuel Economy Standards for Model Year 1995 Light Trucks at VI-10, VI-14 (Mar. 1993).

240 Light Truck Average Fuel Economy Standards; Model Years 1996-1997, 59 Fed. Reg. 16,312 (Apr. 6, 1994).

241 NHTSA, Final Regulatory Evaluation: Average Fuel Economy Standards for Model Years 1996-1997 Light Trucks at VI-11 (Dec. 1993).

242 *See* Average Fuel Economy Standards for Light Trucks Model Years 2008–2011, 71 Fed. Reg. 17,566, 17,631 (Apr. 6, 2006) [hereinafter MY 2008-2011 Light Truck Standards]; *see also* NHTSA, Final Regulatory Impact Analysis: Corporate Average Fuel Economy and CAFE Reform for MY 2008-2011 Light Trucks at VIII-21 (Mar. 2006), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/2006_fri-apublic.pdf [hereinafter MY 2008-2011 Light Truck FRIA] (explaining the methodology for calculating the benefits of fuel savings).

243 MY 2008-2011 Light Truck Standards, *supra* note 242, 71 Fed. Reg. at 17,631; MY 2008-2011 Light Truck FRIA at VII-20.

244 MY 2008-2011 Light Truck Standards, *supra* note 242 , 71 Fed. Reg. at 17,631; *see also* MY 2008-2011 Light Truck FRIA at VII-20 to VII-21.

245 Model Year 2012-2016 Joint Standards, 75 Fed. Reg. at 25,324.

246 NHTSA, Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks at 371 (Mar. 2010).

247 *Id.* at 380. NHTSA discussed but ultimately rejected alternative approaches to calculating the value of fuel savings, including offsetting fuel savings with estimates of the value of forgone performance features. *Id.* at 432-33.

248 Clean Car Standards, *supra* note 2, 77 Fed. Reg. at 62,715.

249 EPA & NHTSA, Joint Technical Support Document: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards at 4-7 (Aug. 2012).

250 NHTSA MY 2017-2025 FRIA, *supra* note 196, at 863.

251 Clean Car Standards Rule, 77 Fed. Reg. at 62,992.

252 NHTSA MY 2017-2025 FRIA at 863 (emphasis in original).

253 Clean Car Standards Rule, 77 Fed. Reg. at 62,992.

254 Evaporative Emission Regulation and Test Procedure for Gasoline-Fueled Heavy-Duty Vehicles, 45 Fed. Reg. 28,922 (proposed Apr. 30, 1980).

255 *Id.* at 28,924.

256 *Id.*

257 Regulation of Fuels and Fuel Additives: Volatility Regulations for Gasoline and Alcohol Blends Sold in 1989 and Later Calendar Years, 52 Fed. Reg. 31,274 (proposed Aug. 19, 1987).

258 EPA, Draft Regulatory Impact Analysis: Control of Gasoline Volatility and Evaporative Hydrocarbon Emissions from New Motor Vehicles at 5-24 (July 1987), https://bit.ly/2Br7pkx.

259 *Id.* at 5-60 to 5-61.

260 Interim Regulations for Cold Temperature Carbon Monoxide Emissions from Light-Duty Vehicles and Light-Duty Trucks, 55 Fed. Reg. 38,250 (Sept. 17, 1990).

261 *Id.* at 38,264.

262 *Id.*

263 *Id.*

264 Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements, 65 Fed. Reg. 6698 (Feb. 10, 2000).

265 Regulatory Impact Analysis - Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements at V-27 (Dec. 1999), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100F1UV.PDF?Dockey=P100F1UV.PDF.

266 *Id.* at V-31 n.9.

267 Control of Emissions from Highway Motorcycles, 69 Fed. Reg. 2398, 2429 (Jan. 15, 2004).

268 *Id. See also* Final Regulatory Support Document: Control of Emissions from Highway Motorcycles at 5-5 (Dec. 2003), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100231W.PDF?Dockey=P100231W.PDF.

269 Model Year 2012-2016 Joint Standards, *supra* note 27, 75 Fed. Reg. at 25,512.

270 *Id.*

271 Clean Car Standards, *supra* note 2, 77 Fed. Reg. at 62,715.

272 *Id.* at 62,924.

273 42 U.S.C. § 6295.

274 *Id.* at § 6295(o)(2)(A).

275 *See id.* at § 6295(o)(2)(B)(i) (enumerating factors for DOE to consider).

276 Energy Conservation Program for Consumer Products, 45 Fed. Reg. 43,976 (proposed June 30, 1980).

277 *Id.* at 44,005-07.

278 *Id.* at 44,005 n.1.

279 Energy Conservation Program for Consumer Products; Final Rule for Clothes Dryers and Kitchens Ranges and Ovens, 47 Fed. Reg. 57,198, 57,198 (Dec. 22, 1982).

280 *Id.* at 57,202, 57,211, 57,212.

281 Energy Conservation Program for Consumer Products: Energy Conservation Standards for Two Types of Consumer Products, 54 Fed. Reg. 47,916 (Nov. 17, 1989).

282 *Id.* at 47,942.

283 *Id.* at 47,921-923.

284 Energy Conservation Program for Consumer Products: Final Rule Regarding Energy Conservation Standards for Three Types of Consumer Products, 56 Fed. Reg. 22,250 (May 14, 1991).

285 *Id.* at 22,254.

286 Energy Conservation Program for Consumer Products: Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products, 61 Fed. Reg. 36,974 (July 15, 1996).

287 *Id.* at 36,983.

288 Energy Conservation Program for Consumer Products: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers and Freezers, 62 Fed. Reg. 23,102 (Apr. 28, 1997).

289 *Id.* at 23,109, 23,112.

290 *Id.*

291 *See* Energy Conservation Program for Consumer Products: Final Rule Regarding Energy Conservation Standards for: Room Air Conditioners, 62 Fed. Reg. 50,122, 50,139 (Sept. 24, 1997); Energy Conservation Program for Consumer Products; Energy Conservation Standards for: Electric Cooking Products (Electric Cooktops, Electric Self-Cleaning-Ovens, and Microwave Ovens), 63 Fed. Reg. 48,038, 48,050 (Sept. 8, 1998); Energy Conservation Program for Consumer Products: Fluorescent Lamp Ballasts Energy Conservation Standards, 65 Fed. Reg. 56,740, 56,745 (Sept. 19, 2000); Energy Conservation Program for Consumer Products: Clothes Washer Energy Conservation Standards, 66 Fed. Reg. 3314 (Jan. 12, 2001); Energy Conservation Program for Consumer Products: Energy Conservation Standards for: Water Heaters, 66 Fed. Reg. 4474, 4483-94 (Jan. 17, 2001); Energy Conservation Program for Consumer Products: Central Air Conditioners and Heat Pumps Energy Conservation Standards, 66 Fed. Reg. 7170 (Jan. 22, 2001).

292 Energy Conservation Program for Consumer Products; Central Air Conditioners and Heat Pumps Energy Conservation Standards, 67 Fed. Reg. 36,368 (May 23, 2002).

293 *Id.* at 36,400, 36,401-02.

294 *See* Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule, 72 Fed. Reg. 58,190 (Oct. 12, 2007); Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnaces and Boilers, 72 Fed. Reg. 65,136 (Nov. 19, 2007); Energy Conservation Program for Commercial and Industrial

Equipment: Packaged Terminal Air Conditioner and Packaged Terminal Heat Pump Energy Conservation Standards, 73 Fed. Reg. 58,772 (Oct. 7, 2008); Energy Conservation Program for Commercial and Industrial Equipment: Energy Conservation Standards for Commercial Ice-Cream Freezers; Self-Contained Commercial Refrigerators, Commercial Freezers, and Commercial Refrigerator-Freezers Without Doors; and Remote Condensing Commercial Refrigerators, Commercial Freezers, and Commercial Refrigerator-Freezers, 74 Fed. Reg. 1092 (Jan. 9, 2009).

[295] *See, e.g.,* Energy Conservation Program: Energy Conservation Standards and Test Procedures for General Service Fluorescent Lamps and Incandescent Reflector Lamps, 74 Fed. Reg. 34,080, 34,098 (July 14, 2009) ("DOE calculated the sum of the purchase price and the operating expense—discounted over the lifetime of the equipment—to estimate the range in LCC benefits that consumers would expect to achieve due to standards . . . . Another tool calculates national energy savings and national NPV that would result from the adoption of energy conservation standards."); Energy Conservation Program: Energy Conservation Standards for Ceiling Fans, 82 Fed. Reg. 6826, 6828 (Jan. 19, 2017) ("The cumulative net present value (NPV) of total consumer costs and savings of the standards for ceiling fans ranges from $4.488 billion (at a 7-percent discount rate) to $12.123 billion (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for ceiling fans purchased in 2020-2049."); *see also* U.S. Dep't. Of Energy, Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Ceiling Fans at 8-14 (2016), https://www.regulations.gov/document?D=EERE-2012-BT-STD-0045-0149 (detailing the calculation of LCC operating cost to be the net present value of seasonal energy consumption times seasonal electricity prices over the lifetime of the ceiling fan); *id.* at 10-8 (explaining that for the calculation of NPV, "DOE calculated annual [total operating cost] for ceiling fans by summing over the operating costs of all product classes and sectors in the affected stock").

[296] *See e.g.,* Energy Conservation Program: Energy Conservation Standards for Walk-In Cooler and Freezer Refrigeration Systems, 82 Fed. Reg. 31,808, 31,843, 31,811 (July 10, 2017). DOE recently finalized revisions to its Process Rule. *See* Energy Conservation Program for Appliance Standards: Proposed Procedures for Use in New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Commercial/Industrial Equipment, 85 Fed. Reg. 8626 (Feb. 14, 2020). Notably, the revised Process Rule preserves that private impacts to consumers should be estimated based on "national average energy prices and energy usage," likely indicating an intent to continue fully valuing energy savings. *Id.* at 8706 (while also noting that sensitivity analyses will employ both high and low discount rates from both the private and social perspective). However, DOE also announced its intentions to undertake a peer review of its analytical methodologies, including its approach to "welfare analysis," *id.* at 8686, and possibly also a reconsideration of "consumer discount rates," *id.* at 8687. In a new supplemental proposal issued together with the final revisions to the Process Rule, DOE also suggested it could start factoring into its analysis "potential consumer welfare impacts," including whether consumers suffer from lost performance, as with the alleged inconvenience of longer cycle times on more efficient appliances—a subject that would be examined during the forthcoming peer review. Energy Conservation Program for Appliance Standards: Procedures for Evaluating Statutory Factors for Use in New or Revised Energy Conservation Standards, 85 Fed. Reg. 8483, 8486-87 (Feb. 14, 2020). Whether DOE will attempt to change its approach to valuing energy savings following this peer review remains to be seen.

[297] Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources, 81 Fed. Reg. 35,824 (June 3, 2016).

[298] EPA, Regulatory Impact Analysis of the Final Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources at 3-14–15 (2016), https://perma.cc/HPT9-8CFN.

[299] EPA, Regulatory Impact Analysis for the Proposed Reconsideration of the Oil and Natural Gas Sector Emission Standards for New, Reconstructed, and Modified Sources at 2-13 (2018), https://perma.cc/UDB2-KEM5.

[300] Waste Prevention, Production Subject to Royalties, and Resource Conservation, 81 Fed. Reg. 83,008, 83,069 (Nov. 18, 2016).

[301] Bureau of Land Mgmt., Regulatory Impact Analysis for: Revisions to 43 CFR 3100 (Onshore Oil and Gas Leasing) and 43 CFR 3600 (Onshore Oil and Gas Operations at 107 (Nov. 10, 2016), https://www.regulations.gov/document?D=BLM-2016-0001-9127.

[302] Bureau of Land Mgmt., Regulatory Impact Analysis for the Final Rule to Rescind or Revise Certain Requirements of the 2016 Waste Prevention Rule at 47 (Aug. 31, 2018), https://www.regulations.gov/document?D=BLM-2018-0001-223607.

[303] Final Affordability Determination—Energy Efficiency Standards, 80 Fed. Reg. 25,901, 25,921 (May 6, 2015).

[304] *Id.* at 25,910-911.

[305] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,612-13 ("In sum, the agencies do not take a position in this rule on whether a fuel efficiency gap exists or constitutes a failure of private markets . . . despite our expressed reservations.").

[306] Despite being just one of many sensitivity analyses, and despite many other sensitivity analyses showing the rollback will be even more costly than the agencies admit, this

particular sensitivity analysis on opportunity costs is given special prominence in the final rule. *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,177 & n.10, 24,587, 25,026-32.

307 See *supra* notes 60-63 and accompanying text.

308 PRIA, *supra* note 51, at 1097.

309 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,701-02.

310 In modeling the effect of the final standards on new vehicle sales and the "scrappage" of used vehicles, the agencies assume that consumers value the first 2.5-years' worth of fuel savings. There are many reasons why 2.5 years is almost certainly too short a time period. *See, e.g.,* Ctr. for Biological Diversity et al., Comments on the Proposed SAFE Rule, Appendix A at 172-74 (Oct. 2018), https://www.regulations.gov/contentStreamer?documentId=EPA-HQ-OAR-2018-0283-5070&attachmentNumber=2&contentType=pdf; Policy Integrity Oct. 2018 Comments, *supra* note 10, at 38; Consumers Union, Consumer Fed. of Am. & Am. Council for an Energy-Efficient Economy, Joint Comments on SAFE Rule 25-29 (Oct. 25, 2018), https://www.regulations.gov/document/NHTSA-2018-0067-11731 (Attachment A). This report does not fully engage with all the problems of the 2.5 year-willingness-to-pay assumption.

Confusingly, the agencies refer to 30 months of "undiscounted" fuel savings. Final Rule, *supra* note 1, 85 Fed. Reg. at 24,701. The references to "undiscounted" amounts, and how discounting plays into their proxy estimate of opportunity cost, are never fully explained.

311 *See* Final Rule, *supra* note 1, 85 Fed. Reg. at 24,701-02. The agencies claim their estimate is "conservative" because 72 months is a "conservative" choice. *Id.* at 24,702, n.1834. They cite six numbers from reports or comments (77, 67, 71.4, 78, 68, 60), and say that 72 "is comfortably within the range of these estimates, but errs toward the lower-end and therefore provides a conservative estimate." *Id.* There are several problems with this. First, the mean of those six numbers is 70.2, and the median is 69.7. Thus, 72 is not the "lower end" of that range, since 70 would be the middle. If they had only offset months 30-70 as a proxy for opportunity costs, instead of months 30-72 as they did, their estimated opportunity cost values would have been lower. Second, their list of six estimates includes duplicates. They provide the wrong link for the Chicago Fed report (the actual link is https://www.chicagofed.org/~/media/others/events/2016/automotive-outlook-symposium/traub-060316-pdf.pdf), but the 77 month statistics attributed to the Fed as an estimate of average new vehicle ownership is actually simply from data from IHS Automotive, reporting Q1 for 2015. That is the same source as used by the State Comptrollers comments (i.e., IHS Markit), which use IHS's more recent estimate of 78 months. *See* EPA–HQ–OAR–2018–0283– 4153, at 2 (cited by 85 Fed. Reg. at 24,702 n.1834). So those two data points (77 and 78) are essentially duplicates, based on the same exact source. Throwing out the lower estimate (77) and taking only the higher estimate (78) leaves five data points: 67, 71.4, 78, 68, 60. For that range, the mean is 68.8 and the median is 68. Again, had the agencies used 68 or 69 months instead, their estimate of opportunity cost would be even lower. And again, 72 is not the "lower end" of the range, especially after duplicates are removed.

312 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,701-02.

313 The agencies have previously suggested that fuel efficiency improvements may result in forgone improvements in other vehicle features that may have occurred without the standards. *See* Draft TAR, *supra* note 43, at 4-28 ("[T]he potential for tradeoffs between reducing GHG emissions and improving other vehicle attributes deserves consideration."). But the agencies did not previously tie those costs to the benefits of fuel savings or conclude that tradeoffs between efficiency and other features would reduce consumer welfare.

314 *See, e.g.,* Energy Conservation Program for Consumer Products; Proposed Rule, 45 Fed. Reg. 43,976, 43,983 (June 30, 1980) (describing methodology for setting appliance standards, including establishing different classes of appliances "distinguished by capacity or a performance-related feature which affects energy efficiency but provides utility to the consumer"). DOE engages in a similar approach in its more recent appliance standards rulemaking. *See, e.g.* Energy Conservation Program: Energy Conservation Standards for Dehumidifiers, 81 Fed. Reg. 38,338, 38,346 (June 13, 2016) ("In establishing product classes, and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products."). Though see *supra* note 296 on recent DOE proposals to study possible lost consumer welfare.

315 Energy Conservation Program for Consumer Products; Proposed Rule, 45 Fed. Reg. at 43,987-88 (describing net energy savings that accrue to consumers even after refrigerators have been subcategorized so that consumers do not lose performance features); U.S. Dep't of Energy, Final Rule Technical Support Document: Residential Dehumidifiers at 10-2–17 (2016), https://www.regulations.gov/document?D=EERE-2012-BT-STD-0027-0046 (calculating private energy savings of new standards as compared to a no-new-standards case that assumes some but not optimal improvement in energy saving).

316 PRIA, *supra* note 51, at 1091.

317 *Id.* at 1097.

318 *See, e.g.,* Comments from Michalek & Whitefoot, *supra* note 61, at 9-10 (critiquing the agencies' opportunity cost estimates from the PRIA, despite Whitefoot being one of the main authors that the agencies had relied on).

319 Draft TAR, *supra* note 43, at 4-36.

[320] EPA, Consumer Willingness to Pay for Vehicle Attributes: What is the Current State of Knowledge? at 7-1 (2018) https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=OTAQ&dirEntryId=339388.

[321] *Id.*

[322] Greene et al., *supra* note 30, at 264, 273; *id.* at 274 (even after trimming outlines, "one standard deviation exceeds the mean of the [willingness to pay] estimates for most of the attributes . . . . [and] the interquartile range also exceeds the median").

[323] *Id.* at 274.

[324] Methodologies are available to address this concern that the agencies should have considered, including two-stage hedonic regression. *See* Qin Fan & Jonathan Rubin, *Two-Stage Hedonic Price Model for Light-Duty Vehicles*, 2157 Transp. Res. Rec. 119, 119 (2010).

[325] *See supra* notes 112-119 and accompanying text.

[326] FRIA, *supra* note 20, at 316.

[327] *See* Clean Car Standards, *supra* note 2, 77 Fed. Reg. at 62,714-15 (explaining that the agencies assume, and "continue to believe," that "vehicle attributes will not change as a result of these rules," and that this assumption about compliance costs obviates the need to estimate any potential opportunity costs; furthermore, the agencies did not have "sufficient confidence" in any potential estimates of opportunity costs, and so it would be "premature" to include such estimates).

[328] *See supra* notes 90-91 and accompanying text.

[329] Final Rule, *supra* note 1, 85 Fed. Reg. at 24702 n.1836.

[330] *See* David Cooke, Union of Concerned Scientists, The Trade-Off Between Fuel Economy and Performance: Implications for the Mid-Term Evaluation of the National Program 7 (2016).

[331] *See supra* notes 112-115 and accompanying text..

[332] Whitefoot, Fowlie & Skerlos, *supra* note 134, at 10,313; *see also* Helfand & Dorsey-Palmateer, *supra* note 95, at 450; *see* Bento et al., *supra* note 13, at 4 ("[B]oth the 2016 TAR and 2018 NPRM have likely overestimated compliance costs. Neither analysis considers the full extent of options that manufacturers have available to respond to these policies, including changes in vehicle prices, performance, and *other attributes*") (emphasis added).

[333] Whitefoot, Fowlie & Skerlos, *supra* note 134, at 10,308, 10,312 (finding significant heterogeneity across vehicles and manufacturers, and noting that competition for those consumers who value acceleration will be reduced; also finding less of a change in sales composition between trucks and cars).

[334] FRIA, *supra* note 20, at 317, 324.

[335] *Id.* at 319-20 ("[A]s one criterion target is reached after the application of a specific technology or technology package, other criteria may be better than their target values. For example, if the engine size is decreased until the low speed acceleration target is just met, it is possible that the resulting engine size would cause high speed acceleration performance to be better than its target. Or, a PHEV50 may have an electric motor and battery appropriately sized to operate in all electric mode through the repeated accelerations and high speeds in the US06 driving cycle, but the resulting motor and battery size enables the PHEV50 slightly to overperform in 0-60 acceleration, which utilizes the power of both the electric motor and combustion engine.") (citation omitted).

[336] This is particularly so for the acceleration of electric vehicles. *Id.* at 323 (citing CARB's comments as explaining that, for electric vehicles, the Argonne simulations showed that 76 of 88 strong electrified packages "resulted in notably faster 0 to 60 mph acceleration times and passing times").

[337] *See supra* note 103-109 and accompanying text.

[338] *See* Draft TAR, *supra* note 43, at 4-35 to 4-36 (other benefits include durability, corrosion resistance, smoother compressor transition, less noise, improved launch feel, improved automatic parking features, improved trailer hitch connection assistance, reduced cabin warm-up time, greater passenger comfort, adaptive headlight systems); Proposed Determination, *supra* note 43, at A-49 (citing evidence presented from Ford about the F-150).

[339] Thomas Tietenberg & Lynne Lewis, Environmental and Natural Resource Economics 375-376 (11th ed. 2018).

[340] Ins. Inst. for Highway Safety & Highway Loss Data Inst., *Flexing Muscle: Sports Car Ratings Show Range of Performance*, 52 Status Report, no. 5, 2016, at 1, https://perma.cc/4RDD-34RQ; Leon Robertson, *Road Death Trend in the United States: Implied Effects of Prevention*, 39 J. Pub. health pol'y 193, 200 (2018); Anne T. McCartt & Wen Hu, Effects of Vehicle Power on Passenger Vehicle Speeds, 18 Traffic Inj. Prevention 500 (2017); Wen Hu & Jessica B. Cicchino, *An Examination of the Increases in Pedestrian Motor-Vehicle Crash Fatalities During 2009–2016*, 67 J. of Safety Res. 37 (2018); NHTSA, *How Vehicle Age and Model Year Relate to Driver Injury Severity in Fatal Crashes, Traffic Safety Facts: Research Note* (2013), https://crash-stats.nhtsa.dot.gov/Api/Public/ViewPublication/811825 (showing increased speed increases fatalities).

[341] Hong Sok Kim, Hyung Jin Kim, Bongsoo Son, *Factors Associated with Automobile Accidents and Survival*, 38 Accident Analysis & Prevention 981, 981 (2006).

[342] *See* Jeff Bartlett, *Tesla Model S Aces Government Crash Test*, Consumer Reports (Aug. 21, 2013), https://perma.cc/64RE-9YM8.

[343] Anwaar Ahmed et al., *Estimating the Marginal Cost of Pavement Damage By Highway Users on the Basis of Practical Schedules for Pavement Maintenance, Rehabilitation and Reconstruction*, 11 Structure and Infrastructure Engineering 1069, 1080 (2015).

[344] *See* Jack N. Barkenbus, *Eco-Driving: An Overlooked Climate Change Initiative*, 38 Energy Pol'y 762, 763 (2010) (discussing how aggressive acceleration can increase emissions); *id.* at 764 ("Cars are more than simply a means of transportation to may, and are sometimes prized for capabilities that run counter to prudent eco-driving principles. Horsepower and acceleration are key examples. . . . Considerable advertising to consumers is still predicated on acceleration and horsepower. Is it any wonder, therefore, that upon purchase of these vehicles that Americans seek to maximize these features?").

[345] Gerarden et al., *supra* note 171, at 1498; Jason D. Lemp & Kara M. Kockelman, *Quantifying the External Costs of Vehicle Use: Evidence from America's Top-Selling Light-Duty Models*, 13 Transp. Res. Part D: Transport & Env't 491, 493-94 (2008). The magnitude of these externalities has been studied extensively in the fuel tax literature. *See e.g.,* Ian W. H. Parry & Kenneth A. Small, *Does Britain or the United States Have the Right Gasoline Tax?*, 95 Am. Econ. Rev. 1276 (2005).

[346] Final Rule, *supra* note 1, 85 Fed. Reg. at 24,702.

[347] *Id.* at 24,700 (explaining that the agencies now only assuming 90% of rebound-related risks are internalized by driver, with 10% externalized).

[348] On the other side of the ledger, the agencies also fail to count the positive indirect benefits of potential attribute tradeoffs. Most notably, some literature suggests that allowing manufacturers to trade off acceleration for fuel economy will not just reduce the compliance costs of meeting a given fuel economy target but will actually significantly decrease overall greenhouse gas emissions. Whitefoot, Fowlie & Skerlos, *supra* note 134, at 10,313 ("[W]e find that . . . GHG emissions . . . are significantly lower when these trade-offs are accounted for."). Some fuel economy technologies may be particularly suited to reducing emissions. For example, EPA explained during the Midterm Evaluation that at least some engine designs reduce carbon dioxide emissions. Midterm TSD, *supra* note 44, at 4-6 ("TDS engines reduce CO2 (albeit only slightly) over a range of 0-to-60 time reductions.").

[349] *See* Ctr. for Biological Diversity, 538 F.3d 1172, 1186, 1198 (9th Cir. 2008).

[350] Robert H. Frank, *The Demand for Unobservable and Other Nonpositional Goods*, 75 Am. Econ. Rev. 101, 101 (1985).

[351] Policy Integrity Oct. 2018 Comments, *supra* note 10, at 47-51.

[352] Frank, *supra* note 350, at 101.

[353] *Id.* at 107 ("When an individual's ability level cannot be observed directly, such observable components of his consumption bundle constitute a signal to others about his total income level, and on average, therefore, about his level of ability. . . . [I]mperfect information about ability might create incentives for people to rearrange consumption patterns to favor observable goods.").

[354] *See e.g.,* Anco Hoen & Karst T. Geurs, *The Influence of Positionality in Car-Purchasing Behaviour on the Downsizing of New Cars*, 16 Transp. Res. Part D Transp. Environ. 402 (2011) ("The stated choice experiments presented in this paper showed that cars and specific car attributes, such as size, engine capacity and interior, are positional goods, even though not all outcomes were consistent with the relative consumption theory. Willingness-to-pay for these car attributes differed between situations in which respondents were asked to imagine living in a world with, on average, either smaller or larger cars. Car size and engine size appear to particularly add to positionality.").

[355] Specifically, a majority of people surveyed would trade a decrease in their car's absolute value for an increase in its relative value compared to other people's cars: in other words, they are happy to have their car lose value so long as everyone else loses more value on average. *See, e.g.,* Fredrik Carlsson et al., *Do You Enjoy Having More than Others? Survey Evidence of Positional Goods*, 74 Economica 586, 588, 593 (2007) (reporting results of a Swedish survey); Francisco Alpizar, Fredrik Carlsson & Olof Johansson-Stenman, *How Much Do We Care About Absolute Versus Relative Income and Consumption?*, 56 J. of Econ. Behav. & Org. 405, 412 (2005) (reporting results of Costa Rican survey). Though some such surveys were conducted in other countries, positionality for cars likely would be stronger in the United States, given the American affinity for cars and the income distribution. *See* Reid R. Heffner, Kenneth S. Kurani & Thomas S. Turrentine, *Effects of Vehicle Image in Gasoline-Hybrid Electric Vehicles* 2 U.C. Davis Inst. of Transp. Stud. (UCD-ITS-RR-05-08, 2005) ("In the words of automobile psychologist G. Clotaire Rapaille, Americans are in 'a permanent search of an identity' and 'cars are very key . . . [they are] maybe the best way for Americans to express themselves.'") (citations omitted); Ed Hopkins & Tatiana Kornienko, *Running to Keep in the Same Place: Consumer Choice as a Game of Status,* 94 Am. Econ. Rev. 1085 (2004) (noting that positional effects increase as society's income increases, because the portion of income spent on conspicuous consumption increases); Carlsson et al., *supra*, at 588, 593 (finding support for hypothesis that "visible goods and their characteristics, such as the value of cars, are more positional than less visible goods and their characteristics, such as car safety"). *See also* Birgitta Gatersleben, *The Car as a Material Possession: Exploring the Link Between Materialism and Car Ownership and Use*, in Auto Motives 137-48 (Karen Lucas, Evelyn Blumenberg & Rachel R. Weinberger eds., Emerald Group Publishing Limited)

(2011), https://doi.org/10.1108/9780857242341-007; Bryan Lufkin, *What Google Street View Tells Us About Income*, BBC (Jan. 6, 2018), https://www.bbc.com/worklife/article/20180105-how-your-car-signals-your-income; Liza Barth, *Cars As Status Symbols*, Consumer Reports (Dec. 18, 2007), https://www.consumerreports.org/cro/news/2007/12/cars-as-status-symbols/index.htm; *Top 14 Status Symbol Cars at Bargain Prices*, MotorTrend (May 15, 2014), https://www.motortrend.com/news/top-14-status-symbol-cars-at-bargain-prices.

356 Ori Heffetz, *A Test of Conspicuous Consumption: Visibility and Income Elasticities*, 93 Rev. Econ. & Stat. 1101, 1106 (2011) (vehicle purchase had a visibility index of 0.73, second only to tobacco products (0.76); gasoline/diesel had a visibility index of 0.39, car repairs were at 0.42, and car insurance fell near the bottom at 0.23).

357 Theory also predicts that manufacturers will overinvest in researching status features, at the expense of non-status features. Ben Cooper et al., *Status Effects and Negative Utility Growth*, 111 Econ. J. 642 (2001).

358 Robert H. Frank, *Positional Externalities Cause Large and Preventable Welfare Losses*, 95 Am. Econ. Rev. 137, 137 (2005).

359 *Id.*

360 Robert H. Frank & Cass R. Sunstein, *Cost-Benefit Analysis and Relative Position*, 68 U. Chi. L. Rev. 323, 326 (2001) ("[W]hen a regulation requires all workers to purchase additional safety, each worker gives up the same amount of other goods, so no worker experiences a decline in relative living standards. If relative living standards matter, then an individual will value an across-the-board increase in safety more highly than an increase in safety that he alone purchases.").

361 Correcting collective action problems is a classic case for regulation. "Analytically, positional externalities are no different from ordinary environmental pollutants." *Id.* at 364. Such regulation is not about taking public action just because one consumer's increased consumption makes another consumer unhappy or envious; rather, regulation is justified to address a market failure. *Id.* at 365.

362 Hoen & Geurs, *supra* note 354, at 407 ("Willingness-to-pay for these car attributes differed between situations in which respondents were asked to imagine living in a world with, on average, either smaller or larger cars. Car size and engine size appear to particularly add to positionality. . . . Ignoring positionality may result in an overestimation of welfare costs associated with CO_2 measures that lead to downsizing of the average passenger car.").

363 *See* FCC v. Fox Television Stations, Inc., 556 U.S. 502, 515 (2009); Motor Vehicle Mfrs. Ass'n of the U.S. v.; State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43 (1983).

364 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,176.

365 *Id.* at 25,099.

366 *See, e.g., id.* at 24,604 (defining "up-front costs" to include the "opportunity cost of any other desirable feature"); *id.* at 25,171 (same); *id.* at 25,110-11 & n.2479 (discussing EPA's focus on upfront costs, claiming that fully valuing fuel savings "distorts" the analysis, and then citing to the analysis of opportunity costs); *id.* at 25,109 (explaining that EPA considers any "significant impact on vehicle utility and performance" when considering consumer costs); *id.* at 25,120 (basing EPA's regulatory decision on hard-to-quantify costs); *id.* at 24,214 (weighing "consumer demand for . . . other vehicle attributes" as part of NHTSA's statutory factors); *id.* at 25,141 (referencing "upfront . . . tradeoffs" in balancing NHTSA's statutory factors).

367 *See, e.g., id.* at 25,171 (comparing NHTSA's focus on upfront costs, including opportunity costs, to its skepticism that fuel savings exist that consumers could not purchase on their own); *id.* at 25,110-11 & n.2479 (claiming that valuing lifetime fuel saving on equal footing with upfront costs "distorts the comparison," and then citing to the analysis of opportunity costs). A focus on upfront costs, while devaluing longer term costs, is analytically equivalent to using an extremely high (and unjustified) discount rate.

368 *Id.* at 24,612 ("If either case is true—that the analysis is incomplete regarding consumer valuation of other vehicle attributes or discount rates used in regulatory analysis inaccurately represent consumers' time preferences—no market failure would exist to support the hypothesis of a fuel efficiency gap. In either case, the agencies' central analysis would overstate both the net private and social benefits from adopting more stringent fuel economy and CO2 emissions standards. . . . Because government action cannot improve net social benefits in the absence of a market failure, if no market failure exists to motivate the $26.1 billion in private losses to consumers, the net benefits of these final standards would be $42.2 billion."); *see also id.* at 24,701 (same); FRIA, *supra* note 20, at 1011 (same); *id.* at 116 (touting that, as opposed to consideration of private costs and benefits, "external net benefits—those incremental reductions and increases in the harms associated with market failure upon which there is little disagreement or doubt—are higher for less stringent alternatives"); Final Rule, *supra* note 1, 85 Fed. Reg. at 25,110-11 (claiming that fully valuing lifetime fuel savings "distorts" the analysis).

369 Final Rule, *supra* note 1, 85 Fed. Reg. at 24,701.

370 *See id.* at 24,177 n.10.

371 *Id.* at 24,612-13 ("In sum, the agencies do not take a position in this rule on whether a fuel efficiency gap exists or constitutes a failure of private markets . . . despite our expressed reservations.").

372 *See id.* at 24,201-08 (counting "retail fuel savings" as a forgone social benefit of the rollback).

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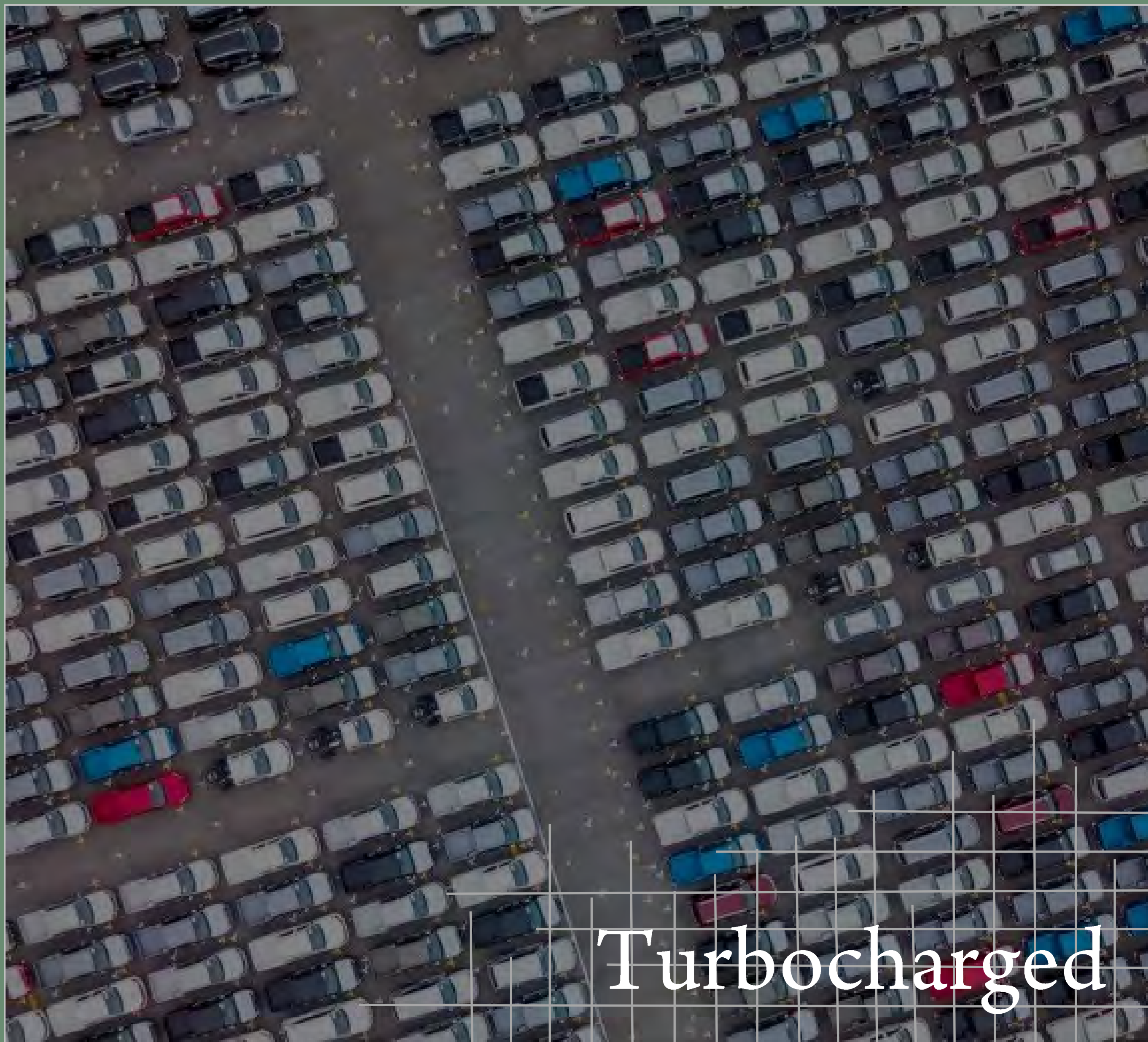

Turbocharged

How One Revision in the SAFE Rule Economic Analysis Obscures Billions of Dollars in Social Harms

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Executive Summary

This report is part of a series that documents how the assumptions underlying The Safer Affordable Fuel Efficient (SAFE) Vehicles Final Rule for Model Years 2021–2026 Passenger Cars and Light Trucks ("SAFE Rule")[1] are skewed to make the rule look less harmful than it actually is.[2] In this report, we focus on the rule's estimate of vehicle sale price elasticity, which substantially inflates the rollback's effect on new vehicle purchases.

In the SAFE Rule, the Environmental Protection Agency and the National Highway Traffic Safety Administration ("the agencies") drastically roll back the fuel-economy and greenhouse gas emission standards for light vehicles established under the Obama Administration ("baseline standards").[3] One of the agencies' main justifications for the SAFE Rule is that compliance with the baseline standards would have been too costly for both automakers and car buyers.[4] Despite their own projection that the rollback, on net, will harm society by increasing fuel expenditures, exacerbating vehicular pollution, and causing other substantial social costs,[5] the agencies nonetheless claim that the SAFE Rule reflects sound policy by lowering compliance costs, which will cause a "reduction in per-vehicle costs to consumers" that will "enhance the ability of the fleet to

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[1] 85 Fed. Reg. 24,174 (Apr. 30, 2020).

[2] Policy Integrity previously published a report detailing the errors in the agencies' suggestion that higher fuel economy requires a trade-off with other vehicle features such as horsepower and towing capacity, as well as a report analyzing trends in fuel prices, vehicle sales, automaker compliance, and safety to show that the light vehicle standards set by Obama Administration for Model Years 2022–2025 can be met at low cost while delivering large benefits to consumers and the economy. *See* Bethany Davis Noll, Peter Howard, Jason A. Schwartz & Avi Zevin, *Shortchanged: How the Trump Administration's Rollback of the Clean Car Standards Deprives Consumers of Fuel Savings* (June 4, 2020), https://policyintegrity.org/publications/detail/shortchanged-the-trump-administrations-rollback-of-the-clean-car-standards; Bethany Davis Noll, Peter Howard & Jeffrey Shrader. *Analyzing EPA's Vehicle-Emissions Decisions. Why Withdrawing the 2022-2025 Standards Is Economically Flawed* (May 1, 2018), https://policyintegrity.org/publications/detail/analyzing-epas-fuel-efficiency-decisions1. Additionally, Policy Integrity published a report highlighting errors in the agencies' estimates of vehicle prices in the SAFE Rule. *See* Sylwia Bialek & Max Sarinsky, *Overinflated: The SAFE Rule's Overstated Estimates of Vehicle-Price Impacts* (2020), https://policyintegrity.org/files/publications/Overinflated_the_SAFE_Rules_Overstated_Estimates_of_Vehicle-Price_Impacts.pdf.

[3] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 15, 2012).

[4] 85 Fed. Reg. at 24,176 ("The costs to both industry and automotive consumers would have been too high under the standards set forth in 2012.").

[5] *Id.* (concluding that the SAFE Rule's costs exceed benefits by between $13.1 billion–$22 billion, assuming a 3 percent discount rate). Although the agencies project that the rule will result in net benefits at a 7 percent discount rate, those benefits are only between $6.4 billion and $16.1 billion—much smaller than the projected net costs using a 3 percent discount rate. *Id.* Averaging the results at the two discount rates therefore shows that the rule is net costly. It is also worth emphasizing that these numbers reflect both calculation errors and unrealistically optimistic projections of the SAFE Rule's impacts, which collectively obscure tens of billions of dollars of net costs to society. *See infra* note 7.

turn over to newer, cleaner and safer vehicles."[6] Even assuming that this justification were sufficient to promulgate a rule that the agencies acknowledge will harm society on net, the claim—like so many others made by the agencies to justify the SAFE Rule[7]—is highly exaggerated and based on key errors underlying the rule.

Specifically, this report highlights a fundamental error in the agencies' projections about the SAFE Rule's impacts on car sales. The agencies project that the SAFE Rule will reduce compliance costs, which in turn will lower the sticker price of new vehicles[8] and produce an increase in new car sales. But due to a faulty assumption that abruptly appeared in their final analysis, the agencies drastically overstate the connection between sticker price and vehicle sales—an economic metric known as "own-price elasticity of demand" (or simply "price elasticity"). The agencies' chosen price elasticity conflicts with the economic literature, the recommendations of solicited experts, and the agencies' own analysis of other key inputs for assessing the rule's impacts. Particularly confounding is the fact that the agencies drastically—and with virtually no justification—amended their price elasticity estimate from the proposed version of the SAFE Rule.

Correcting the price-elasticity estimate reveals that the SAFE Rule will have far less of an impact on vehicle sales than the agencies theorize, undercutting a main justification for the rule. Indeed, holding the agencies' other assumptions constant, correcting this error wipes away all of the fleet-size increases that the agencies project over the next five to seven years. Correcting the error also shows that the SAFE Rule is far more socially harmful than the agencies acknowledge. While the SAFE Rule is already net-costly under the agencies' own projections, correcting this single error adds another $4–$8 billion in net costs to the rollback.

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[6] 85 Fed. Reg. at 24,176.

[7] While this report details the agencies' errors only with regard to price elasticity, many of their other assumptions—from their valuation of climate damages to their price and scrappage models—have been heavily criticized for disregarding key costs of the SAFE Rule. *See* , e.g., Ctr. for Biological Diversity et al., Petition for Reconsideration of EPA's Final Rule—The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks (June 29, 2020) (Docket No. EPA-HQ-OAR-2018-0283), https://ago.vermont.gov/wp-content/uploads/2020/08/20200629-UCS-et-al-SAFE-Part-II-Petition-for-Reconsideration_Print_Copy.pdf (highlighting calculation errors along with errors in sales and scrapping models, congestion costs, technology costs, and other aspects of the agencies' analysis) (hereinafter "Petition for Reconsideration"); Dave Cooke, *EPA Made So Many Mistakes with Clean Cars Rollback, Even Its Own Lawyers Want to Know What's Up*. Union of Concerned Scientists (July 30, 2020), https://blog.ucsusa.org/dave-cooke/epa-made-so-many-mistakes-with-clean-cars-rollback-even-its-own-lawyers-want-to-know-whats-up (for a broad overview of the issues), Robinson Meyer, *Trump's New Auto Rollback Is an Economic Disaster*, The Atlantic (Apr. 13, 2020) (criticizing inclusion of years 2018-2020 in the analyses); Richard L. Revesz, *Insight: Clean Car Standards Rollback Is 'Arbitrary and Capricious'*, Bloomberg (Apr. 14, 2020), https://news.bloomberglaw.com/environment-and-energy/insight-clean-car-standards-rollback-is-arbitrary-and-capricious (highlighting "obvious analytical flaws" in agencies' analysis and criticizing agencies for promulgating a net-costly rule); Richard L. Revesz & Avi Zevin, *Trump's Clean Car Standards Rollback Is Based on Too Many Lies to Count*, Slate (Apr. 1, 2020), https://slate.com/news-and-politics/2020/04/trumps-epa-clean-car-standards-rollback-lies.html (explaining fallacy of agencies' theories about opportunity costs).

[8] The agencies overstate the link between compliance costs and sticker price, such that the SAFE Rule will indeed produce a far smaller reduction in vehicle sticker price than the agencies project. *See* Sylwia Bialek & Max Sarinsky, *Overinflated: The SAFE Rule's Overstated Estimates of Vehicle-Price Impacts* (2020), https://policyintegrity.org/files/publications/Overinflated_the_SAFE_Rules_Overstated_Estimates_of_Vehicle-Price_Impacts.pdf.

Background on Price Elasticity and the Agencies' Approach

Price elasticity measures the sensitivity of the sales of a particular product to fluctuations in that product's price. While sales will typically increase when prices drop and decrease when prices rise, the strength of that relationship will depend on buyers' need for the product and the availability of substitutes. Sales of necessity products with few comparable substitutes are likely insensitive to price fluctuations. In economic terms, we say that such products are *inelastic*. By contrast, products that are less essential or that can be easily substituted by other products are typically *elastic*, meaning that their sales are more sensitive to price fluctuations.[9]

Automobiles generally fall into the former category. Because automobiles are essential goods in most areas of the United States (and lack any comparable substitute), both economic theory and observed behavior finds that vehicle sales are relatively inelastic—meaning that price fluctuations produce just modest changes in vehicle sales.[10] In the regulatory proposal underlying the SAFE Rule, for instance, the agencies projected that the price elasticity for new car and light truck sales "ranged from -0.2 to -0.3"—meaning, in other words, that a 1 percent increase in sticker price would decrease sales by only 0.2–0.3 percent.[11] While the agencies' analysis for their regulatory proposal was widely criticized for incorporating numerous unsound assumptions and reaching implausible results[12]—including, perhaps most notably, its conclusion that the rollback would violate basic supply-and-demand principles by causing a decline in fleet size while

[9] Robert S. Pindyck & Daniel L. Rubinfeld, Microeconomics 26–30 (1989) (providing background on price elasticity and using the example of butter and margarine to explain that products with close substitutes are more elastic).

[10] Saul H. Hymans, Consumer Durable Spending: Explanation and Prediction,'' Brookings Papers on Economic Activity (1970), available at https://www.brookings.edu/wp-content/uploads/1970/06/1970b_bpea_hymans_ackley_juster.pdf ("The automobile has apparently become so necessary in the American economy that its price elasticity is beginning to resemble that of food."). The agencies relied on this paper when setting the baseline standards. *See* 77 Fed. Reg. at 63,102 n.1300.

[11] The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 83 Fed. Reg. 42,986, 43,075 (proposed Aug. 24, 2018).

[12] For instance, EPA's own Science Advisory Board highlighted many "important weaknesses in both the[] theoretical underpinnings and the[] econometric implementation" of the assumptions underlying the agencies' analysis of their regulatory proposal, highlighting "implausible results regarding the overall size of the vehicle fleet," "implausible assumptions about the use of older vehicles, as well as with an assumed rebound effect that is large relative to the literature [and] considering other problems and inconsistencies," concluding that "these weaknesses are of sufficient magnitude that commenters … suggest that a corrected analysis could reverse the sign of result, indicating that the augural standards provide a better outcome than the proposed revision preferred by the agencies." EPA Sci. Advisory Bd., Consideration of the Scientific and Technical Basis of the EPA's Proposed Rule 1–2 (2020) (hereinafter "SAB Report").

simultaneously reducing compliance cost[13]—their price elasticity estimate was a rare element of this analysis that was not irrational.[14]

Yet in the final rule, the agencies abruptly reject their earlier elasticity estimate and drastically increase the price elasticity. Specifically, the agencies ditch their previous conclusion that changes in vehicle prices "have moderate effects on total sales"[15] by increasing their price elasticity estimate more than three-fold. Under their new estimate, the agencies now claim that the price elasticity for new vehicles is -1—meaning that new car sales decline by 1 percent for every 1 percent increase in sticker price.[16] While hardly their only modeling revision—the agencies made many alterations to their sales and scrappage models in the final version of the rule—this revision is significant for drastically affecting the agencies' findings about sales impacts and fleet size, and, as detailed below, making the SAFE Rule appear billions of dollars less harmful than it actually is by affecting key projections such as pollution emissions and traffic fatalities resulting from the rule.

The agencies offer minimal justification for this substantial revision, and the explanation that they do provide is without merit—it misunderstands the problem, cherry-picks a few studies from the relevant literature, and is inconsistent with their approach to estimating other key parameters for assessing the rule's impacts. As detailed below, a full review of the relevant economic literature confirms that vehicles are an inelastic good—with a price elasticity far below -1 in absolute terms—and that by arbitrarily and erroneously revising this metric, the agencies paper over billions of dollars of additional harm that the SAFE Rule will cause.

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[13] *See, e.g.*, *id.* at 1 (criticizing the "implausible results regarding the overall size of the vehicle fleet, implying that the revised standards would reduce the size of the vehicle fleet relative to the augural standards when economic theory suggests that the fleet should grow due to a decline in the prices of new vehicles"). In the final SAFE Rule, the agencies presume that purchasers value fuel savings from efficient vehicles during the first 30 months of ownership, 85 Fed. Reg. at 24,278, and thus include expected fuel savings in modeling consumer demand. While including consumers' valuation of fuel savings is appropriate when modeling demand, the agencies lack reasonable justification to cut off the amount of this valuation at 30 months. Assuming a higher valuation of fuel savings would dampen the impact of regulation on vehicle sales.

[14] This is not to say that the agencies' methodology for estimating price elasticity in their regulatory proposal was flawless. For instance, Policy Integrity criticized the methodology that the agencies used to construct their sales model in their regulatory proposal. *See* Inst. for Pol'y Integrity, Comments on Proposed Rule 60–61 (Oct. 26, 2018), *available at* https://policyintegrity.org/documents/Emissions_Standards_EPA_NHTSA_Comments_Oct2018.pdf (hereinafter "Policy Integrity Comments"). However, Policy Integrity did not disagree with the agencies' ultimate conclusion that price elasticity for new vehicles is relatively low.

[15] 83 Fed. Reg. at 43,075.

[16] 85 Fed. Reg. at 24,617.

The Agencies Cherry-Pick the Data, Relying on Older Studies that Look at Too Short a Timeframe to Produce an Unrealistically High Elasticity

The agencies offer only two sentences and a handful of citations as justification for their decision to drastically increase the price elasticity in their final analysis, but even that minimal explanation reveals significant errors in their approach.

Citing three economic studies, the agencies claim that "there is a broad consensus in the economic literature that the price elasticity of demand for automobiles is approximately -1.0."[17] But closer evaluation of these cited studies reveals that they are not representative of the full literature, are inappropriate for analyzing the SAFE Rule's long-term impacts, and hardly represent any "broad consensus."

Most significantly, the three studies that the agencies rely on focus on the elasticity of motor vehicles in the short-run,[18] but this is not the proper timeframe to assess the SAFE Rule's long-term impacts. Many products have differing price elasticities depending on the time-frame. A short-run elasticity is defined as the price elasticity within one year,[19] whereas a long-run elasticity measures effects beginning approximately 5–10 years into the future.[20] While ideally the agencies would model a short- to long-run transition, it is the long-run elasticity that ultimately provides the more appropriate rate for analyzing the aggregate impacts of the SAFE Rule, since the standards set forth in the rule have long-term impacts.

For instance, in a regulatory proposal from 2016, EPA explained that a "short run elasticity estimate . . . may not be appropriate for standards that apply several years into the future."[21] The SAFE Rule not only imposes standards through model year 2026, but the agencies also project the rule's sales impacts over thirty years.[22] For this reason, one of the experts that the agencies solicited to review their analysis, Dr. John Graham, advised the agencies that long-run price elasticity

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[17] *Id.* at 24,617 & n.1641 (citing Andrew N. Kleit, The Effect of Annual Changes in Automobile Fuel Economy Standards, 2 J. Reg. Econ. 151 (1990); Robert Bordley, An Overlapping Choice Set Model of Automotive Price Elasticities, 28 Transp. Res. Part B: Methodological 401 (1993); Patrick S. McCarthy, Market Price and Income Elasticities of New Vehicle Demands, 78 Rev. Econ. & Stat. 543 (1996)).

[18] Although the agencies do not say so specifically, a review of the three cited studies makes clear that they are providing short-run price elasticity estimates—not long-run estimates. Bordley (1993) and McCarthy (1996) say so explicitly. And while Kleit (1990) does not clearly specify the timeframe of its analysis, thirteen of the sixteen analyses cited in the paper that it relies upon for its elasticity estimate (Irvine (1983)) are short-run estimates. F. Owen Irvine, *Demand Equations for Individual New Car Models Estimated Using Transaction Prices with Implications for Regulatory Issues*, 49 S. Econ. J. 764 (1983).

[19] *See* Robert S. Pindyck & Daniel L. Rubinfeld, Microeconomics 30 (1989) (describing short-run elasticity as measuring "one year or less").

[20] *See* Thomas H. Klier & Joshua Linn, *The Effect of Vehicle Fuel Economy Standards on Technology Adoption*, 133 J. PUB. ECON. 41, 44 (2016).

[21] EPA, Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards Under the Midterm Evaluation A-40 (2016).

[22] *See* 85 Fed. Reg. at 24,617 tbl.VI-154. Short-run price elasticity rates, by contrast, look at sales impacts for only about one year. *See* Robert S. Pindyck & Daniel L. Rubinfeld, Microeconomics 30 (1989).

provides the "proper focus" for analyzing the SAFE Rule's impacts, explaining that the available literature, as a whole, supports an elasticity that is much lower in absolute terms than the agencies' estimate of -1.0.[23]

Echoing Dr. Graham's analysis, EPA's Science Advisory Board explained in its report on this rule that "the long-run price elasticity for new vehicles is likely to be smaller than the short-run price elasticity … since a consumer can easily hold on to their existing vehicle a bit longer… [whereas] an old vehicle will not be functional forever."[24] The agencies similarly recognized when setting the baseline standards in 2012 that price elasticity for motor vehicles is "smaller in the long run," because "though people may be able to change the timing of their purchase when price changes in the short term, they must eventually make the investment" in a new car even if higher prices remain long-term.[25] In that prior rulemaking, the agencies also recognized that "long-run elasticity may better reflect behavior" over the lifetime of the fuel-efficiency program, but explained that recent estimates of long-run price elasticity were unavailable at that time.[26]

That is no longer the case, however, as considerable research on the elasticity of motor vehicles has been published over the last several years. And those estimates reveal that the long-run price elasticity for new vehicles is far lower (in absolute terms) than the -1.0 estimate that the agencies rely upon, and is much closer to the -0.2 to -0.3 range that they applied in their regulatory proposal. Three relevant studies published in the past two years find that the market's long-run elasticity is -0.13,[27] -0.27,[28] and -0.4,[29] respectively. The other two available estimates produced over the past two decades are -0.61[30] and -1.0,[31] respectively. And prior estimates likewise tend to find that long-run elasticity is far lower than the -1.0 short-run estimate that the agencies rely

[23] CAFE Model Peer Review B-35 (revised July 2019), *available at* https://www.regulations.gov/document?D=NHTSA-2018-0067-0055 (second attachment).

[24] SAB Report at 22; *see also* Robert S. Pindyck & Daniel L. Rubinfeld, Microeconomics 32–33 (1989) (explaining that, for durable goods such as automobiles, "the short-run income elasticity of demand will be much larger than the long-run elasticity").

[25] 77 Fed. Reg. at 63,102 n.1300. Although the agencies fail to recognize in the SAFE Rule that short-run elasticity estimates for motor vehicles are generally higher than long-run estimates, one paper that they cite found precisely this, producing a short-run elasticity estimate of -0.79 and a long-run elasticity estimate of -0.61. Sean P. McAlinden et al., The Potential Effects of the 2017-2025 EPA/NHTSA GHG/Fuel Economy Mandates of the US Economy, Center for Automotive Research 27 (2016), cited in 85 Fed. Reg. at 24,617 n. 1642.

[26] 77 Fed. Reg. at 63,102 n.1300.

[27] Antonio M. Bento et al., *Estimating the Costs and Benefits of Fuel-Economy Standards*, 1 ENVTL. & ENERGY POLICY & ECON. 129 (2020).

[28] James H. Stock et al., Comments on Notice of Proposed Rulemaking for The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks 20 (Oct. 26, 2018), *available at* https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-6220.

[29] Benjamin Leard, Estimating Consumer Substitution Between New and Used Passenger Vehicles, Resources for the Future Working Paper 19-02 (2019).

[30] McAlinden et al. (2016), *supra*.

[31] Steven Berry et al., *Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Car Market*, 112 J. POLITICAL ECON. 68 (2004).

upon.[32] All told, a full review of the literature supports a long-run price elasticity of roughly -0.6. Focusing only on more recent estimates lowers that estimate even further, to -0.5 (for estimates since 2000) or even -0.4 (for estimates since 2010).

Estimates of Vehicle Price Elasticity

Author(s)	Year	Time Period	Short-Run	Long-Run
McAlinden et al. (2016) – cited in SAFE Rule				
Atkinson	1952	1925-1940	-1.33	-
Nerlove	1957	1922-1941; 1948-1953	-0.9	-1.2
Suits	1958	1929-1941; 1949-1956	-	-0.57
Chow	1960	1921-1953	-	-0.7
Suits	1961	1929-1941; 1949-1956	-	-0.675
Hymans, Ackley, and Juster	1970	1954-1968	-1.14	-0.46
Hess	1977	1952-1972	-1.63	-
Trandel	1991	1983-1985	-1.43	-
Levinsohn	1988	1983-1985	-0.82	-
McCarthy	1996	1989	-0.87	
Bordley	1993	Assumed	-1	
Fischer, Harrington, and Parry	2007	Not indicated	-1	-0.82
Irvine (1983) – basis for estimate in Kleit (1990), which was cited in SAFE Rule				
Dyckman	1975	1929-1962	-1.45	
Hamburger	1967	1954-1964	-1.17	
Evans	1969	1948-1964	-3.1	-1.5
Hymans	1970	1954-1968	-1.07	-0.36
Rippe and Feldman	1976	1958-1973	-1.14	-0.6
Carlson	1978	1965-1975	-1.1	
Additional Estimates in the Record – cited by agencies in SAFE Rule or prior rulemakings				
Goldberg	1998	1984-1990	-0.9	
Juster and Wachtel	1972	1949-1967	-0.7	
Lave and Train	1979	1976	-0.8	
McAlinden et al.	2015	1953-2013	-0.79	-0.61
Recent Estimates – not cited by agencies in SAFE Rule or prior rulemakings				
Berry et al.	2004	1993		-1
Gillingham and Stock	2018	1967-2016		-0.27
Leard	2020	2013		-0.4
Bento et al.	2020	Not indicated		-0.13
Dou and Linn	2020	1996 to 2016	-1.5	

[32] *See* Petition for Reconsideration, *supra* note 7, at 44.

Averages				
Mean			-1.2	-0.6
Median			-1.1	-0.6
Averages of Recent Estimates				
Mean published since 1980			-1.0	-0.5
Median published since 1980			-1.0	-0.5
Mean published since 2000			-1.1	-0.5
Median published since 2000			-1.0	-0.5
Mean published since 2010			-	-0.4
Median published since 2010			-	-0.3
Averages Without Inconsistent Estimates				
Mean			-1.1	-0.5
Median			-1.1	-0.6
Mean: Published since 2000			-1.1	-0.4
Median: Published since 2000			-1.0	-0.4

Source: Petition for Reconsideration at 43–45

The agencies never clearly acknowledge that they are using a short-run estimate of price elasticity, and attempt to paper over the distinction between short-run and long-run elasticity. In one footnote—their only acknowledgment in the final rule of the theoretical distinction between short-run and long-run price elasticity—the agencies, citing a 2016 study, appear to suggest that empirical estimates of the two parameters are very similar.[33] But this study does not capture several more recent estimates showing a very low long-run elasticity, and a comprehensive analysis of all the available literature shows that the long-run elasticity is far lower than the agencies suggest. In any event, the elasticity averages in this footnote's cited study— -0.72 for long-run, and -0.79 for short-run[34]—are both well below the -1.0 estimate that the agencies adopt. If anything, therefore, the agencies' citation to this single study serves to further highlight the implausibility of their elasticity estimate.

Furthermore, the studies that the agencies rely on are fairly old, as all three were published in the early-to-mid 1990s.[35] In fact, some of the studies rely on much older data than that: One of the three cited papers relies exclusively on a 1983 estimate, which in turn was based on various estimates relying on data going all the way back to 1929, when the Ford Model A was still in

[33] *See* 85 Fed. Reg. at 24,617 n.1642 ("[A] recent review of 12 studies examining vehicle price elasticities conducted by the Center of Automotive Research ('CAR') found an 'average short-run elasticity of -1.09' and focusing 'only those models which also employ time series methods, the average short-run own-price elasticity is higher yet, at -1.25.' CAR's own analysis found a -.79 short-run elasticity. Appendix II of the CAR report shows that the long-run elasticities ranged from -.46 and -1.2 with an average of -.72.'").

[34] *Id.*

[35] *See id*. at 24,617 n.1641.

production.[36] While older studies supply useful information and should be considered, newer studies, when they are available, are typically more reliable because they rely upon more up-to-date data and employ more advanced estimation techniques. With cars, for instance, the market has changed over the past quarter-century with the proliferation of SUVs and hybrid vehicles, and may be affected by macroeconomic indicators such as increases in gross domestic product. And here, notably, the agencies disregard a number of newer studies. A recent literature review identified five studies published since 2000 estimating the price elasticity of motor vehicles, all of which the agencies overlook in the SAFE Rule.[37] And as noted above, these studies produce a median long-run elasticity estimate of -0.5.[38] The agencies offer no justification for—or even acknowledgement of—their decision to overlook these relevant estimates.

The agencies' disregard for the available literature—focusing on just a few older studies that measure elasticity under an inapplicable short-run timeframe—not only produces an unreasonably high elasticity estimate, but is also inconsistent with their approach to modeling other elements of this same rule. When estimating rebound elasticity—that is, the degree to which individuals increase driving when the per-mile price of gasoline declines due to improved vehicle efficiency—the agencies purport to rely on "the totality of empirical evidence" and "examin[e] the widest possible range of research" rather than "restricting the available evidence by categorically excluding or according less weight" to studies "that do not meet selection criteria."[39] In particular, the agencies discuss the importance of "recent estimates" in projecting the rebound effect.[40] In contrast, the agencies rely on just a few studies to drastically increase price elasticity from their earlier estimate, and disregard the most recent and authoritative evidence.

The agencies are also inconsistent in selecting the timespan of key parameters. With the rebound effect, the agencies acknowledge that "the most appropriate measure for the agencies to rely on is the current long-run fuel economy rebound effect"[41]—which, as detailed above, is a reasonable approach because the agencies use this parameter to estimate the impacts of the SAFE Rule over many years.[42] Yet again, however, this is entirely inconsistent with the agencies' approach to price elasticity, which is derived from short-run estimates without any comparable emphasis on the rule's long-term effects.

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[36] *See* Irvine (1983), cited in Kleit (1990). For a review of the economic studies that Irvine relies upon to produce his estimate, including their years of publication and underlying data, *see* Petition for Reconsideration, *supra* note 7, at 44.

[37] Petition for Reconsideration, *supra* note 7, at 44 (displaying "Recent Estimates").

[38] *See id.*

[39] 85 Fed. Reg. at 24,674.

[40] *Id.* at 24,672.

[41] *Id.*; accord *id.* at 24,674–75 ("[T]he agencies agree with many commenters that both the extended time span encompassed by their analysis of the impacts of CAFE and CO2 standards and the long expected lifetimes of vehicles subject to this final rule means that estimates of the long-run rebound effect are most relevant for purposes of the final rule analysis.").

[42] Despite correctly using a long-run rebound effect, the agencies arbitrarily use an inflated rebound effect of 20 percent, whereas available estimates suggest that the effect is approximately 10 percent. Policy Integrity Comments at 99–126.

In other words, the agencies opportunistically use short-run estimates only when it suits their interests. According to our modeling, had the agencies used a short-run estimate of rebound when analyzing the rule's impacts—an incorrect approach, to be sure, but one that would at least be consistent with their faulty approach to estimating price elasticity—they would have concluded that the rule is net costly to the tune of $47.9–$59.2 billion at a 3 percent discount rate, or by $7.4–$18.3 billion at a 7 percent rate.[43] The agencies properly choose a long-run rebound when doing so makes the SAFE Rule less harmful, yet incorrectly and inconsistently use a short-run price elasticity when doing so inflates the rule's sales impacts and obscures substantial costs of the rule.

Through these inconsistent approaches, the agencies are able to select a price-elasticity parameter that suits their analysis and makes the SAFE Rule appear far less socially detrimental than it truly is. Indeed, as detailed in the next section, the agencies' unrealistic parameter for price elasticity masks billions of dollars of social harm.

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[43] For this illustrative analysis, we applied a 5 percent rebound rate, which is consistent with the short-run estimates in Kenneth Gillingham et al., *The Rebound Effect and Energy Efficiency Policy*, 10 REV. ENVTL. ECON. & POL'Y 68 (2016). All other parameters of the agencies' analysis—including their price elasticity of -1.0—were kept constant.

By Inflating the Price Elasticity in Their Final Analysis, the Agencies Obscure Billions of Dollars in Social Costs Along With Other Flaws in Their Analysis

By increasing the elasticity in their final analysis to an unsupported and unrealistic -1.0, the agencies are able to claim that the SAFE Rule will produce a far greater increase in vehicle sales than a fair analysis would show, and thereby obscure billions of dollars in social costs that the rule can be realistically expected to cause. Particularly when combined with the numerous other errors that the agencies make,[44] this error rebuts the agencies' key justifications for the SAFE Rule.

Just how much does this one revision affect their analysis? Using the agencies' economic model, Policy Integrity ran the numbers to find out. In reviewing these results, keep in mind that the agencies' own analysis of the rule—assuming the unrealistic price elasticity of -1.0—already shows that the rule is harmful to society, producing net social costs of $13.1–$22 billion at a 3 percent discount rate and net benefits of only $6.4–$16.1 billion at a 7 percent discount rate.[45] Simply averaging the results from the two discount rates shows that the rule is net costly by billions of dollars under the agencies' own analysis.[46]

Using a more realistic price elasticity estimate reveals that the rule is far more harmful than the agencies acknowledge. With a price elasticity of -0.6—the median long-run elasticity throughout all available literature—the rule is net costly by $18.1–$27.3 billion at a 3 percent discount rate and net beneficial by just $2.7–$12.1 billion at a 7 percent discount rate. And with a price elasticity of -0.4—the median long-run elasticity of recent estimates—the rule scores even worse: between $20.7–$30 billion in net costs at the 3 percent rate, with net benefits at the 7 percent rate of only $0.8–$10.2 billion. Therefore, **inflating the price elasticity obscures at least $4–$8 billion in net costs**, and results in a rule that is net costly by approximately $10 billion according to an average of the two discount rates.[47]

[44] *See supra* note 7.

[45] *Id.* at 24,176.

[46] *See* Revesz, *supra* note 7 ("[T]he approach that puts the Trump administration's action in the most favorable plausible light would be to average the impacts under the two rates. And the rollback fails under this standard."). It is also worth keeping in mind that the agencies' numbers rely on several miscalculations regarding congestion cost. Simply correcting these miscalculations (without correcting for the conceptual errors and unrealistic assumptions that the agencies rely upon) shows that the SAFE Rule is billions of dollars more costly than the agencies acknowledge, wiping out the benefits that the agencies claim at a 7 percent discount rate. *See* Petition for Reconsideration at 5–9.

[47] Again, this average does not even account for the agencies' miscalculations in their own analysis, which would make the result net costly by billions of additional dollars. *See id.*

Cost-Benefit Analysis Results Depending on Price Elasticity

	3% Discount Rate		7% Discount Rate	
Elasticity	NHTSA's CAFE Rule	EPA's CO_2 Rule	NHTSA's CAFE Rule	EPA's CO_2 Rule
-1 (agencies' approach)	-13.1	-22.0	16.1	6.4
-0.8 (approximate lower-bound estimate for short-run elasticity)	-15.6	-24.7	14.1	4.6
-0.6 (long-run median for all estimates)	-18.1	-27.3	12.1	2.7
-0.4 (long-run median for recent estimates)	-20.7	-30.0	10.2	0.8
-0.2 (approximate lower-bound estimate for long-run elasticity)	-23.2	-32.7	8.2	-1.0

* All figures are in $ billion.

There's more. Applying the correct price elasticity range substantially reduces the SAFE Rule's sales impacts such that the analysis—without further modifications—would now conclude that the rule likely results in an aggregate decrease in fleet size over the next five to seven years. But as noted above, this outcome violates basic economic principles of supply and demand, since a reduction in vehicle prices should not decrease fleet size. For this reason, after the agencies initially concluded at the regulatory proposal stage that this rule would decrease fleet size, EPA's Science Advisory Board and numerous commenters highlighted the fallacy of their logic.[48] These comments focused largely on the agencies' flawed scrappage model, which illogically concluded that the regulatory rollback would increase the scrappage of older vehicles.[49]

Yet rather than correct their scrappage model in the final SAFE Rule—as many commenters urged them to—the agencies just make small tweaks to that model[50] while drastically inflating price elasticity to flip their erroneous conclusion regarding fleet size. As detailed above, however, this revision to price elasticity is inconsistent with the literature. Rather than artificially inflate price elasticity in order to correct their fleet-size results, the agencies should have actually corrected their scrappage model.

[48] *See supra* notes 10–11 and accompanying text.

[49] *See, e.g.*, SAB Report at 1 ("Two of the new modules recently added to the Department of Transportation's Volpe CAFE Model, the sales and scrappage equations, have important weaknesses in both their theoretical underpinnings and their econometric implementation. Together, the new modules generate implausible results regarding the overall size of the vehicle fleet, implying that the revised standards would reduce the size of the vehicle fleet relative to the augural standards when economic theory suggests that the fleet should grow due to a decline in the prices of new vehicles.").

[50] *See, e.g.*, Petition for Reconsideration at 22–24, 45–49 (highlighting some errors that remain with the scrappage model).

Policy Integrity made two simple adjustments to the agencies' model to illustrate what the effects of such a change may look like. Specifically, Policy Integrity 1) set the price elasticity at -0.4, which as detailed above is a far superior estimate, and 2) reduced the scrappage elasticity to an amount that results in a fleet-size increase in every period.[51] Because lower scrappage means more older cars that lack the safety and efficiency features of newer models, this revision reveals even further costs to the SAFE Rule. In fact, we found that such a revision would likely reduce net benefits by another $1 billion or more—on top of the $4–$8 billion in costs from correcting the price elasticity alone.

However, even leaving aside the flaws in the scrappage model and other errors in the sales model, it is clear that the agencies' selection of -1.0 as the price elasticity is improper, vastly exaggerates the rule's sales impacts, and masks billions of dollars in social cost.

Conclusion

The agencies' assumptions about price elasticity—abruptly inserted into their final analysis with little presage or rationale—are unsupported, unrealistic, and inconsistent with their approach to estimating other key parameters. Yet through this revision, the agencies paper over billions of dollars in costs, not to mention the effects of other errors in their modeling of the SAFE Rule. While the rule is net costly even under the agencies' faulty assumption of a high price elasticity, correcting this error reveals that the rule is far more costly than the agencies acknowledge. When combined with additional errors identified in other Policy Integrity reports,[52] we see that the systematic errors made by the agencies imply that the SAFE Rule is not cost-benefit justified under any plausible discount rate.

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[51] Specifically, Policy Integrity adjusted the scrappage elasticity to approximately 80 percent of the agencies' estimates, making the analysis of both rules conclude that fleet size increases over both the short- and long-term. This was a simple parametric adjustment. An alternative methodology would be to hold fleet size constant, as recommended by both the EPA and economist Howard K. Gruenspecht. *See* Summary points from EPA review of CAFE model (NPRM version)–Effect of EPA code revisions, Meeting with Office of Management and Budget/OIRA 6/18/2018, slides 2-3, https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0453 (fifth Attachment at PDF pages 4-5); Howard K. Gruenspecht, Differentiated Regulation: The Case of Auto Emissions Standards, 72 Am. Econ. Rev. 328, 328–29 (1982); *see* generally Policy Integrity Comments at 89–91. This latter methodology requires a structural change to the model and is beyond the scope of this report.

[52] *See supra* note 2 and accompanying text.

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Tune Up

Fixing Market Failures to Cut Fuel Costs and Pollution from Cars and Trucks

Institute *for* Policy Integrity
NEW YORK UNIVERSITY SCHOOL OF LAW

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Table of Contents

Executive Summary

The Biden administration is currently seeking to bolster the federal government's role in addressing climate change by reducing greenhouse gas emissions from the transportation sector, which is currently the largest source of these pollutants in the country. Federal fuel economy and vehicle emissions standards will thus be crucial tools in addressing climate change as well as improving the health of millions of Americans who are exposed to toxic tailpipe pollutants.

In addition to reducing pollution, these efforts can also save consumers money at the pump. Economists have long observed that consumers do not always select vehicles that will save them the most money over time, instead purchasing a slightly cheaper car or truck that will cost them more in the long run through greater fuel usage. This phenomenon is known as the "energy efficiency gap" or "energy efficiency paradox." Certain industry groups, car manufacturers, and economists have argued that the energy efficiency gap can be explained by rational behavior. Under their theories, stronger federal vehicle standards could not produce real, net cost savings for individual Americans.

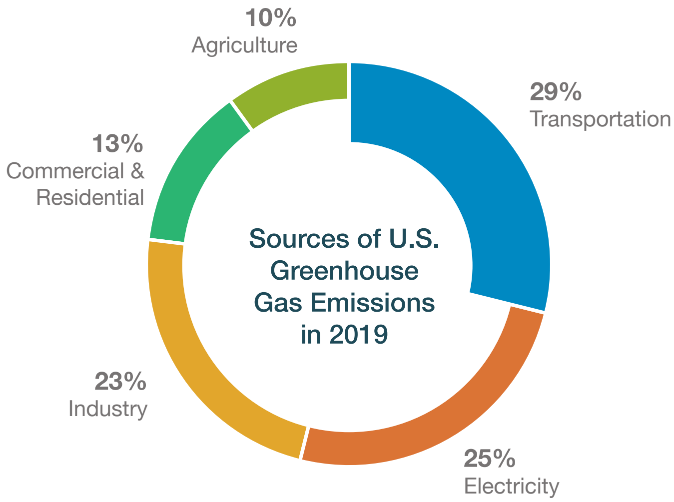
But as this report demonstrates, there is considerable economic research demonstrating that multiple market failures contribute to or exacerbate the energy efficiency gap in the markets for new passenger cars, SUVs, and pickup trucks, as well as for heavy-duty vehicles like tractor-trailers, motor homes, and buses. Key market failures include loss aversion, information costs and asymmetries, myopia and inattention, positional externalities, manufacturer market power, first-mover disadvantages, split incentives, and network externalities.

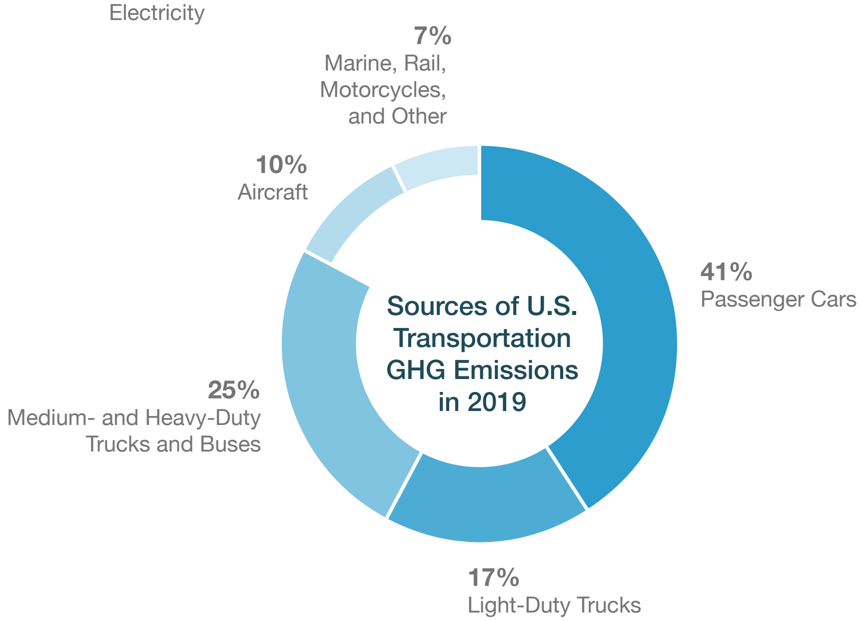
Given the plethora of evidence for these market failures, the Biden administration should continue the longstanding practice of incorporating private fuel savings in any evaluation of the costs and benefits of stronger standards for cars and trucks. In doing so, the federal government will not only be improving the health of Americans but keeping money in their pocket.

Introduction

The U.S. transportation sector is currently the largest source of greenhouse gas pollution in the country, accounting for 29 percent of total emissions in recent years.[1] It has also seen the biggest relative increases in greenhouse gas pollution.[2] For the Biden administration to meet its goal of meaningful action on climate change, cars, trucks, and other vehicles will need to improve their fuel economy dramatically and quickly.[3]

In addition to addressing climate change, better fuel economy will lead to reductions in other pollutants as well, which will have major health and environmental benefits. The transportation sector is one of the biggest sources of toxic pollutants like nitrogen oxides and fine particulate matter.[4] Nearly half of Americans live in areas with harmful levels of these pollutants, and as many as 50,000 premature deaths occur every year in the United States from motor vehicle emissions of these substances.[5] Improvements in vehicle fuel economy can have national security benefits as well, decreasing U.S. reliance on foreign oil and improving our energy independence. Properly valued, these compelling climate, health, and security benefits alone justify much stronger emissions and fuel economy standards for both cars and trucks.[6]





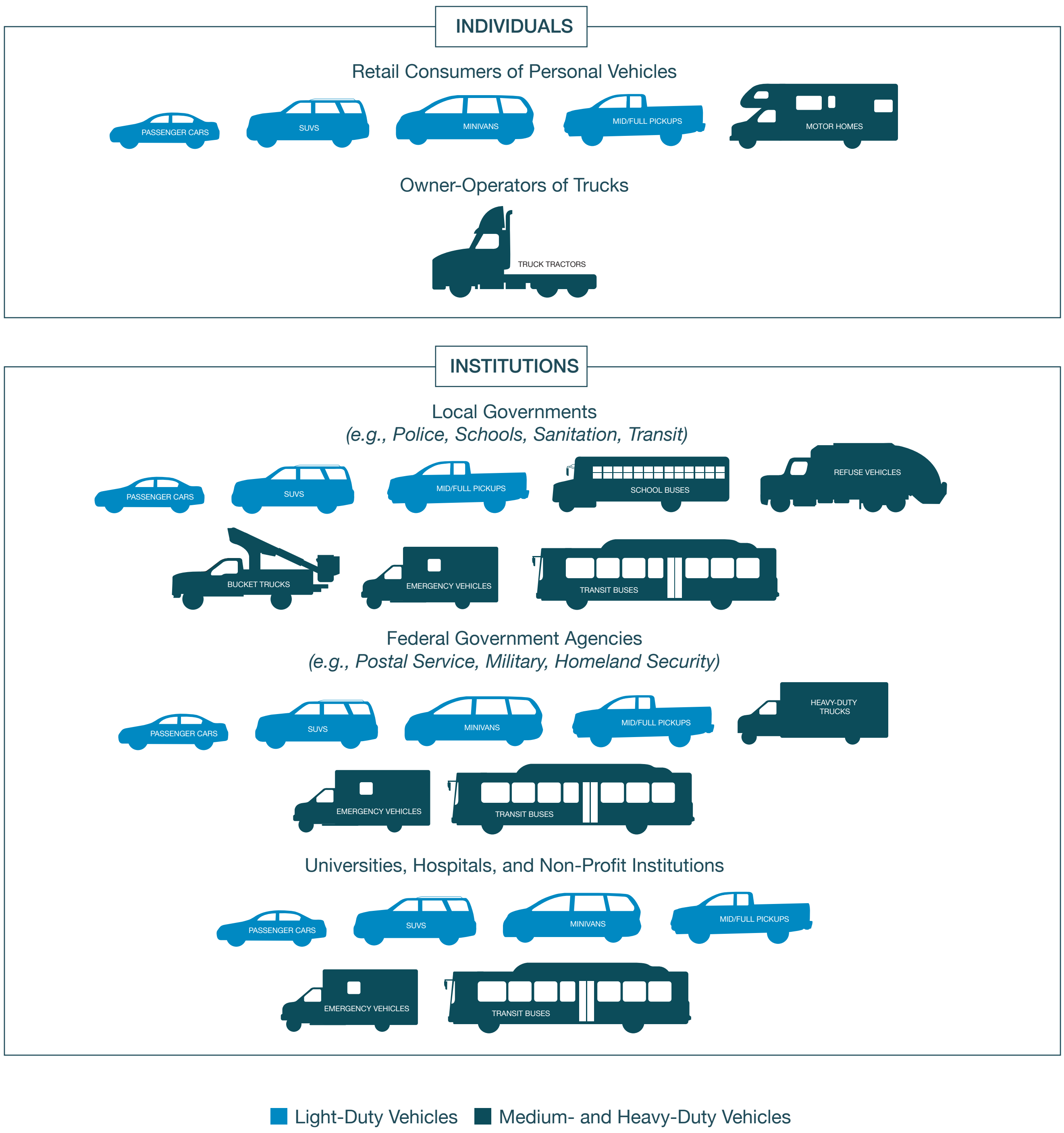
Beyond those public benefits, fuel economy and vehicle emission regulations also provide enormous private benefits to consumers by saving them money, since greater vehicle efficiency reduces the fuel costs per mile of driving.[7] Without sufficiently strong fuel economy regulations, consumers have not been able to demand the kinds of efficient cars and trucks that will collectively save them the most money over time. Economists have long observed that consumers do not always spend an extra dollar now to purchase a more efficient car or truck model that would save them much more than a dollar in fuel costs over the vehicle's life, even when discounted to present values.[8] This phenomenon is known as the "energy efficiency gap" or "energy efficiency paradox."

Despite the name, the energy efficiency gap is not such a mystery. Multiple well-known market failures explain why consumers are not able to demand the optimal amount of fuel economy in the unregulated marketplaces for new cars and trucks. Vehicle manufacturers can also contribute to the energy efficiency gap because of market failures that lead them to underinvest in energy efficient technologies, further exacerbating the problem.[9] Regulations that address these market failures, therefore, achieve not just social benefits but private benefits for consumers as well. Key market failures include loss aversion, information costs and asymmetries, myopia and inattention, positional externalities, manufacturer market power, first-mover disadvantage, split incentives, and network externalities. This report provides an overview of these key market failures and the relevant economic literature that supports them.

The Environmental Protection Agency (EPA) and National Highway Traffic Safety Administration (NHTSA) are responsible for issuing vehicle emission standards and fuel economy standards, respectively, for passenger cars as well as light-duty, medium-duty, and heavy-duty vehicles.[10] The agencies classify vehicles into these categories by weight. Passenger cars and light-duty trucks, such as pickup trucks, minivans, and SUVs, weigh less than 8,500 pounds.[11] Medium and heavy-duty vehicles weigh more than 8,500 pounds, such as large pickups, utility vans, school buses, city delivery vehicles, garbage trucks, construction vehicles, transit buses, motor homes, and tractor-trailers.[12]

Examples of Which Consumers Buy Which Cars and Trucks

This graphic shows some representative examples of the types of consumers that buy various cars and trucks. The examples are not comprehensive or universal.



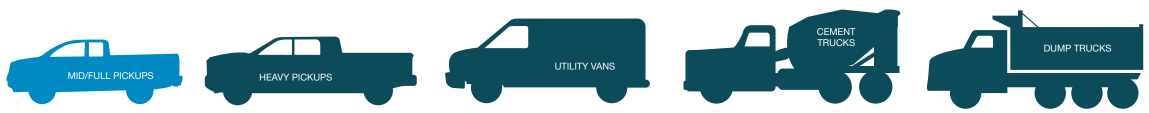
Examples of Which Consumers Buy Which Cars and Trucks (Continued)

This graphic shows some representative examples of the types of consumers that buy various cars and trucks. The examples are not comprehensive or universal.

SMALL AND FAMILY BUSINESSES

Independent Trucking Companies

Construction, Landscape, Home Service Companies



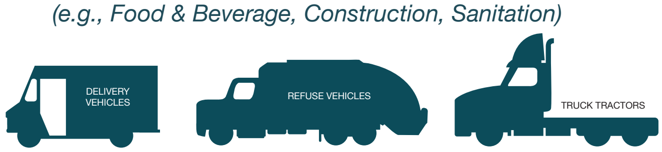
Smaller Commercial Fleets
(e.g., Company Cars and Trucks)

LARGER BUSINESSES

Rental Car Companies

Freight, Delivery, and Transit Companies

Commercial Fleets
(e.g., Food & Beverage, Construction, Sanitation)



Utilities
(e.g., Electricity, Natural Gas, Telecommunications)

■ Light-Duty Vehicles ■ Medium- and Heavy-Duty Vehicles

Purchasers of these vehicle types include individual consumers, independent truck drivers, small businesses, local governments, and large corporations, which all buy some share of each vehicle type.[13] For instance, both newer "transportation network companies" like Uber and Lyft and more traditional rental car companies primarily use passenger car and light-duty vehicles,[14] while in the trucking industry, small, family-owned fleets make up approximately 75 percent of the market and individual owners operate about 15 percent of trucks on the road.[15] Because of this overlap in purchasers among vehicle classes, the various market failures that result from the behaviors of individuals, institutions, and large and small corporations will apply to some degree across all categories of vehicles.

For decades, EPA and NHTSA have recognized that regulations that increase vehicle efficiency can deliver massive cost savings to consumers by correcting for failures in both the car and truck markets.[16] Recently, however, industry and a few economists have pushed back on the characterization of these cost savings, arguing that since consumers theoretically should be able to achieve them on their own in the market, the fact that consumers do not demand more efficient vehicles must mean they do not value the cost savings.[17]

As this report demonstrates, these arguments have several flaws and limits, and should not lead EPA and NHTSA to ignore private fuel savings in their cost-benefit analyses of vehicle emission and fuel economy standards.[18] There is abundant empirical evidence that market failures lead to inefficiencies that can be corrected through government regulation, saving Americans money while addressing health and environmental harms from motor vehicle pollution.

The Prior Debates over Raising Fuel Economy Standards

In 2012, EPA and NHTSA jointly issued a set of regulations known as the "Clean Car Standards." The rulemaking harmonized greenhouse gas emission and fuel economy standards for passenger cars and light-duty trucks in model years 2017 through 2021 as well as model years 2022 through 2025,[19] with the latter model years subject to a second review to determine whether they remained appropriate.[20] The Clean Car Standards were expected to result in an increase in fuel economy and decrease in greenhouse gas emissions of approximately 5 percent per year on average.[21] At the time the regulations were first issued, EPA and NHTSA conducted a rigorous cost-benefit analysis that showed the Clean Car Standards would result in over $450 billion in net benefits, with any upfront increase in vehicle purchase price significantly outweighed by fuel savings totaling approximately $475 billion.[22] The agencies also detailed many of the key market failures that explained the energy efficiency gap and the need for government intervention.[23] These include consumer loss aversion, myopia, and lack of information, all of which are explained further below.[24]

EPA and NHTSA subsequently tightened greenhouse gas emission and fuel economy standards for medium- and heavy-duty vehicles in 2016 for model years 2018 to 2025.[25] These standards were a key aspect of President Obama's Climate Action Plan and were expected to save vehicle owners over $170 billion in fuel costs.[26] In finalizing the 2016 rule, the agencies affirmed that market failures in purchases of medium- and heavy-duty vehicles contributed to an energy efficiency gap that could be rectified through regulatory intervention.[27] Some of these issues were comparable to those in the car and light-duty truck market, such as lack of information, while others were more prominent in the medium- and heavy-duty truck market, such as network externalities and split incentives, which are discussed in more detail later in this report.[28]

When the 2022 to 2025 passenger car and light-duty truck standards were reevaluated for a second time in 2016, EPA and NHTSA confirmed that the Clean Car Standards would result in substantial net benefits, based in part on the fact that "the reduced operating costs from fuel savings over time are expected to far exceed the increase in up-front vehicle costs."[29] Thereafter, in January 2017, EPA issued a Final Determination that the Clean Car Standards remained appropriate and would result in substantial improvements in economic welfare.[30] Consumer fuel savings alone exceeded the costs of the regulation even without considering any environmental benefits.[31]

Despite these repeated assessments demonstrating the clear benefits from stronger fuel economy standards, in 2018 the Trump administration decided to repeal the Clean Car Standards, though they left the medium- and heavy-duty vehicle regulations in place.[32] EPA and NHTSA subsequently issued a new rule for passenger cars and light-duty trucks that required only 1.5 percent increases in fuel economy through 2026—considerably lower than the 2012 Clean Car Standards' target of 5 percent increases per year.[33] The administration relied on a deeply flawed economic analysis to justify its actions and claimed the prior Clean Car Standards would impose high consumer costs and safety costs while achieving only limited environmental benefits.[34] In the rollback, the agencies also sought to cast doubt on the market failures that explain the energy efficiency gap, even going so far as to suggest that fully valuing the lifetime fuel savings to consumers "distorts" the analysis, and musing about whether they could somehow ignore the billions of dollars in increased fuel costs that consumers would face under the rollback.[35]

As this report shows, well-established economics research demonstrates not only the existence of the energy efficiency gap, but how market failures contribute to the problem. These failures include loss aversion, lack of information, infrastructure network externalities, and a lack of incentives for manufacturers to develop more efficient vehicles. By promulgating government standards for fuel economy and greenhouse gas emissions, EPA and NHTSA can address these issues and generate considerable savings for vehicle purchasers.

The Biden Administration is now in the process of rewriting the Trump-era fuel economy rule for light-duty vehicles.[36] The current administration is also expected to announce ambitious new climate plans around Earth Day on April 22.[37] Greenhouse gas pollution reductions from the entire transportation sector, including medium- and heavy-duty trucks, will be crucial in meeting such goals. New fuel economy regulations will also provide additional incentives for a greener transportation sector beyond the current infrastructure stimulus bill, which is intended to galvanize the adoption of electric vehicles and expand charging stations throughout the United States. But beyond the urgent need to address climate change, stronger fuel economy standards for cars and trucks will save consumers significant amounts of money. Based on the extensive economics research demonstrating how market failures cause the energy efficiency gap, the Administration should fully incorporate private fuel savings in assessing the costs and benefits of new regulations and so spur efficiency increases that will deliver environmental gains along with significant cost savings for consumers.

Problematic Attacks on the Cost Savings from Vehicle Standards

As EPA and NHTSA have sought to reduce vehicle emissions and improve fuel economy in the past, a few industry groups, vehicle manufacturers, and economists have suggested that the energy efficiency gap reflects actual consumer preferences for less efficient vehicles and is not evidence of a market failure.[38] In making this argument, they have offered various alternative explanations for the gap, such as inherent tradeoffs between other vehicle features and fuel economy, consumer application of high discount rates to fuel savings, financial constraints, and preferences for time-tested technologies. The first three phenomena have been identified in the markets for both individual consumer purchases as well as commercial vehicles, while the fourth issue has been suggested as a problem primarily in the heavy-duty truck market.

Similar arguments were a theme in the Trump administration's justification to roll back the Clean Car Standards, and they have been levied against past efforts to increase fuel economy standards for both light-duty and heavy-duty vehicles. Yet each of the arguments is incomplete or based on limited support. They should not lead EPA or NHTSA to hesitate in developing stronger standards for car or trucks, and the agencies should continue to fully value the private cost savings from better fuel economy.

The passenger car, light-duty truck, and medium- to heavy-duty vehicle markets offer purchasers a range of vehicle options at a variety of price points. Consumers and commercial businesses must evaluate a vehicle's fuel economy in addition to other features before making a selection. According to some economists and industry groups, purchasers are frequently forced to choose between better fuel economy and other attractive attributes when deciding what vehicle to buy. This line of thinking suggests that observations of the energy efficiency gap are not evidence of market failures but instead simply reveal consumers' preferences for these other features over improved fuel economy.

Yet many fuel-efficient technologies can increase vehicle performance and are entirely compatible with other features,[39] as a plethora of evidence has shown.[40] In fact, research has demonstrated that the probability of a light-duty vehicle obtaining a negative evaluation of its operational characteristics is lower when that vehicle has fuel-saving technologies—in other words, more fuel-efficient light-duty vehicles are less associated with negative performance reviews.[41] Any possible performance tradeoffs are also likely to decline over time, with technological advancements and manufacturer learning.[42] While in the short run manufacturers may face some constraints in overhauling a vehicle's design, in the long run they have greater flexibility to improve their designs and reduce compliance costs in ways that obviate any need for tradeoffs.[43] The only situation that would force vehicle manufacturers to trade off energy efficiency against other features would be if there is a technical or engineering constraint that made it impossible to add both those features and the technologies that improve fuel economy, or if the technology for improving fuel economy necessarily increases the marginal cost of adding additional features.[44] Researchers have found only isolated examples of inherent tradeoffs in practice, and there is no evidence that such problems alone could explain the energy efficiency gap.[45]

In fact, many technologies, such as high-strength aluminum alloy bodies,[46] turbocharging,[47] and certain hybridization technologies, can improve both fuel economy and other vehicle performance metrics.[48] Additional examples include increasing the number of gear ratios in new transmissions, which help the engine both run more efficiently and in the optimal "power band" for performance.[49]

Furthermore, EPA and NHTSA have accounted for such concerns about tradeoffs by assuming in their compliance cost estimates that manufacturers will install whatever additional technologies are needed to maintain key performance levels even as fuel economy is increased.[50] If manufacturers in fact were to trade off reduced performance for increased fuel economy, then the actual costs of achieving that fuel economy would drop substantially, and consumers would see lower purchase prices.[51] The literature consistently shows that if manufacturers are allowed to use attribute-tradeoffs to comply with regulatory standards, compliance costs could be "significantly lower" than what the agencies estimate.[52] The fact that estimated fuel savings from recent regulations vastly outweigh estimated compliance costs for both cars and trucks even after factoring in additional costs to maintain vehicle performance attributes strongly suggests that attribute tradeoffs alone cannot explain the energy efficiency gap.[53]

Another hypothesized reason for the energy efficiency gap is that consumers might be applying exceedingly high discounts to future fuel savings.[54] But such an explanation for the energy efficiency gap would have to posit that consumers routinely discount future fuel savings at rates as high as 24 percent.[55] This is eight times higher than the 3 percent discount rate historically applied to assess how private consumers trade off their consumption over time[56] and almost four times higher than the rate commonly applied to assess how private industry values returns on investments.[57]

It is not rational, however, for consumers to apply such high discount rates to future fuel savings. Typically, the interest rate on a loan reveals the rate at which consumers are willing to trade off future spending versus current consumption—and surely most vehicle purchasers would balk at a loan with a 24 percent interest rate. As detailed below, current car loan interest rates are far lower, averaging around 5 percent in recent years.[58] There is no reason why—absent some market failure—individual, institutional, or corporate consumers of cars or trucks would adopt vastly different attitudes towards their future finances depending on whether the money is spent buying fuel or paying a loan.[59]

Some opponents of stronger vehicle standards have posited that the energy efficiency gap can be explained by financial constraints on the part of consumers and trucking companies.[60] According to this view, fixed budgets and high upfront costs prevent purchasers from paying for a car or truck that has both fuel economy improvements and all the additional features they want. Yet 85 percent of new passenger vehicles are financed by loans,[61] and both commercial and institutional purchasers of heavy-duty vehicles should have ready access to credit as well.[62] The wide availability of vehicle financing for individual and corporate consumers means that budget constraints should not force consumers to sacrifice future fuel savings or require them to choose between fuel savings and other features, such as greater horsepower.[63] A rational consumer would be willing to pay for the additional cost of greater fuel economy through a slightly higher monthly loan payment, which will be more than offset over time by the fuel savings—and, similarly, a rational bank or lender would be willing to offer such a loan affordably, knowing that the long-term fuel savings will help the consumer make the monthly loan payments.[64] In fact, some banks even offer consumers rate reductions in loans for fuel-efficient vehicles.[65]

Reliability issues and maintenance of newer, more efficient vehicles are other frequently cited explanations for the energy efficiency gap, particularly with regard to heavy-duty vehicles.[66] But although some focus group research has suggested that truck drivers, fleet managers, and chief operating officers of transportation companies do harbor such fears about energy efficient vehicles and may therefore make purchasing decisions that ultimately forgo net cost savings,[67] this tendency is symptomatic of a market failure known as the first-mover disadvantage, which is explained in more detail in the next section. Mandatory efficiency standards can decrease these issues by requiring widespread adoption, which will improve adaptation over time, incentivize more robust networks for servicing newer technologies, and lead to decreased costs from better management of logistics and maintenance.

Nor are isolated examples of rational decision-making in vehicle purchases sufficient to show that market failures are not responsible for the energy efficiency gap. For instance, in a recent article on adoption of fuel-efficient technologies in the medium- and heavy-duty truck market, the authors observed that truck drivers on high-speed interstate highways had more fuel-efficient technologies on their vehicles than those driving on the local highways used for shorter routes.[68] These observations, they suggest, indicate that the market is functioning competitively and that "regulatory agencies' claims of large private benefits from requirements to adopt such energy-efficient technology should be subjected to special scrutiny."[69] But this is one limited case in which one regional segment of the trucking industry has adopted particular energy efficiency technologies once they have been proven reliable—and after fuel economy standards for heavy-duty trucks had already been adopted.[70] As discussed in the next section, there are a whole host of market failures that make it difficult for trucking companies, without any assistance from regulatory standards, to make perfectly informed, rational decisions when deciding whether to purchase vehicles with better fuel economy.

Arguments that the energy efficiency gap reflects purely rational consumers preferences are thus, on the whole, supported by incomplete evidence that does not explain the wide gulf between observed and optimal vehicle purchasing decisions. EPA and NHTSA should not eliminate private fuel savings in regulatory cost-benefit assessments on the basis of such limited research.

How Market Failures Explain the Energy Efficiency Gap

If vehicle purchasers were all adequately informed and free to make rational, welfare-maximizing choices in a fully competitive market without concern for negative externalities, consumers might on their own perfectly balance their future fuel cost savings against the increased purchase price for a more efficient vehicle. But in the real world, consumers face a host of market failures that bias their information, disrupt their rational decision-making, constrain their choices, and subject them to uncompensated costs.

Extensive empirical evidence identifies multiple market failures that contribute to the energy efficiency gap among consumers.[71] In light of this research, "there is general agreement that the actual fuel savings realized over time should be fully valued in cost-benefit analyses."[72] Some of the most glaring market failures include loss aversion, information costs and asymmetries, myopia and inattention, positional externalities, manufacturer market power, first-mover disadvantages, split incentives, and network externalities. This section provides an overview of these key market failures.

Some of these market failures may be more or less likely to apply to particular categories of vehicle consumers. For example, given their incentives to maximize profit and their greater resources, large businesses may seem to have an advantage over individuals in collecting adequate information and processing that information fully and rationally. However, not only may small and large businesses face their own unique informational failures (see below on the first-mover disadvantage), but the decisionmakers at businesses are, ultimately, people—people who may at times suffer from the same behavioral failures as any other consumer (see below on inattention) and unique failures (see below on split incentives). Similarly, governmental and institutional consumers of vehicles may sometimes act more like individuals or sometimes more like businesses, and experience various market failures accordingly when buying cars or trucks.

Furthermore, within each broad category of consumers, not every consumer will necessarily face every market failure. But on the whole, the economic research suggests that many purchasers are likely to make information processing errors and experience a range of other obstacles.[73] While some individuals may be able to purchase the most optimally efficient vehicle on their own, overall consumers appear unable to maximize their fuel cost savings without the assistance of government regulations.[74]

Loss Aversion. Economists have described loss aversion as "a behavioral pattern in which individuals facing risky choices place greater weight on losses compared to gains of an equivalent monetary value."[75] In the case of fuel economy, consumers may irrationally emphasize the upfront "losses" of purchasing a more expensive, more fuel-efficient vehicle over the somewhat more uncertain gains of future fuel savings.[76] As a result, they may not purchase more efficient vehicles, even if they (and society) would have saved more over time than the additional amount they pay upfront. Recent economics research has demonstrated that loss aversion may also contribute to the energy efficiency gap in the trucking industry, with fleet managers underinvesting in more efficient vehicles because they placed "greater weight on losses compared to gains of an equivalent monetary value."[77] Loss aversion can thus affect individuals as well as businesses and institutions buying new cars and trucks, and can be compounded by a lack of information and the costs of obtaining information.[78]

Information Costs and Asymmetries. Empirical evidence suggests that consumers struggle to rationally utilize available fuel economy information when making their vehicle purchases and may find it too difficult to obtain other important data to guide their decisions. In one study of highly educated purchasers, half of respondents were unable to determine how much they would be willing to pay for a 50 percent increase in fuel economy, and only a couple individuals were able to offer explanations of their decisions that the interviewers found to be economically rational.[79] More recent surveys have found fewer than 1 in 4 individual purchasers made *any* calculations to compare fuel savings in purchasing their vehicles, and the calculations that were done by this group varied widely in their comprehensiveness.[80] When combined with a predisposition to avoid a risk of loss, "the decision to buy or not buy a fuel economy technology appears to be a risky bet that loss averse consumers are likely to decline."[81]

Behavioral economics research has found that the cost of obtaining detailed and actionable information regarding vehicle fuel economy may lead consumers to purchase vehicles without fully weighing fuel economy, potentially leading to lower fuel economy than they would optimally prefer.[82] Consumers may also lack information to fully value some benefits of more efficient vehicles—like the benefit of not having to stop as often (or at all) to refuel—until after the consumer has already purchased and experienced the good.[83] Reliable information about fuel savings can also be costly to obtain for heavy-duty vehicle buyers, particularly as small-business owners and individuals make up a vast majority of vehicle operators.[84] Because insufficient information can mute consumer demand for fuel economy, this can also lead manufacturers to underinvest in fuel economy.

Myopia and Inattention. Consumers may also use heuristics and rules of thumb that underemphasize or miscalculate the value of the fuel they will save by purchasing more efficient vehicles, even if consumers would value those savings given a more focused, systematic, or accurate evaluation of the costs and benefits of a purchase decision.[85] Recent research on consumer myopia and inattention provides powerful evidence for this market failure.[86] Economists were able to analyze a "natural experiment" in how purchasers value fuel economy after two car companies misstated the miles per gallon achievable by numerous vehicle models.[87] The mistake prompted the largest correction in fuel economy ratings in U.S. history, impacting 1.6 million car purchases.[88] In examining how consumers subsequently responded to price adjustments in the affected models, the researchers found that "consumers systematically undervalue fuel economy in vehicle purchases to a larger degree than reported by much of the recent literature."[89] The study underscores that "that it is possible for a policy that shifts consumers into more efficient vehicles to be welfare-improving, even if environmental externalities are fully internalized."[90] Another example of myopia can be seen with hybrid vehicles. Across all hybrid electric versions offered from 2004 to 2015, even when the hybrid version "is visually identical to a gasoline version of the same model and requires no significant compromises in performance, trunk space or other vehicle attributes," and when fuel savings would "more than pay for [the] price premiums," "fewer than 20% of consumers opt for the [hybrid electric vehicle] option."[91]

Though myopia and inattention may more commonly plague individual consumers, economists have also found that managers at certain companies can exhibit similar kinds of inattention and so fail to implement many energy efficiency initiatives despite positive paybacks.[92] Businesses may also face a kind of myopia called short-termism, in which certain corporate employees have an incentive to favor short-term profits over long-term investments if, for example, their personal compensation or career prospects are tied to near-term earnings.[93] Employees given such incentives may have reason to purchase cheaper, less efficient vehicles.[94] To the extent short-termism is exacerbated by an informational asymmetry either between employees (who know that lower vehicle purchase prices will favorably boost short-term earnings reports) and investors (who may not know that more efficient vehicle purchases could have increased their long-run returns), or is caused by myopia, the phenomenon is a market failure.[95] Economic studies suggest that short-termism can affect managers' choices about energy efficiency specifically,[96] and about environmental sustainability more broadly.[97]

Positional Externalities. Recent economic studies have also identified cars as "positional" goods whose value is partially determined according to how much status a good imparts in relation to the amount of the good others have, rather than according to innate characteristics of the good itself.[98] In practice, this means that consumers do not necessarily want the biggest and fastest vehicle, so long as their vehicle is bigger and faster than their friends' and neighbors' vehicles.[99] Positional goods can lead to an arms race among purchasers, with consumers spending more resources on status attributes like horsepower without improving their relative status.[100] In fact, every time some consumers increases their own status by buying a bigger, faster car, the purchase inflicts a negative externality on other consumers by decreasing their relative status.[101] Along the way, consumers deprioritize investments in efficiency that may not improve their relative status, and so they impose costs on society through increased pollution and other negative externalities. Regulation can ameliorate this market failure by allowing consumers to maintain their relative position with respect to positional vehicle features while mandating better fuel economy.[102] Consumers will not suffer any positional loss, while society will see decreased external harms from the behavior. This market failure is more likely to affect individual consumers, though institutions and businesses could fall into the positional arms race as well, as when luxury corporate cars are offered to employees as status-boosting perks.

Manufacturer Market Power. Because of the limited competition in at least some segments of the vehicles market, manufacturers may be able to act strategically when pricing vehicles and when producing vehicles with combinations of different fuel economy and other vehicle features in order to push consumers towards purchases that lead to higher manufacturer profits at the expense of optimal fuel economy.[103] There are a relatively small number of firms producing several types of vehicles and engines across the light-duty and heavy-duty markets.[104] This market failure therefore could influence purchases by all consumer groups and across several vehicle classifications.

First-Mover Disadvantage. Supply-side problems in the market may lead vehicle manufacturers to underinvest in fuel-efficient technologies, compounding the issues with consumer valuation of fuel economy.[105] These problems can occur for two reasons: "uncertainty of future consumer demand for improved fuel economy and irreversibility of the large capital investments required."[106] Because of uncertain consumer demand and high, irreversible capital investments, "being a first mover may appear to have a greater downside risk than upside risk; that is, there is a 'first mover disadvantage.'"[107] Economists have also noted that the first-mover disadvantage can be especially pronounced when returns to society are greater than those to the investor, as is the case with fuel-efficient technologies that reduce oil use and greenhouse gas emissions.[108] Because of these issues, manufacturers may not see a private return that fully reflects the benefits of their investment.[109] Federal vehicle standards can help in several ways. They reduce manufacturers' risks, perceived or real, in investing in fuel economy, and lower "the costs of the fuel efficiency technologies through economies of scale, learning curves, and more rapid innovation."[110] Short-termism can also compound the first-mover disadvantage, as manufacturers have to balance the immediate costs and risks of research against the longer-term profits from future sales.[111] Since each manufacturer faces muted incentives to be the first to research and deploy new technologies, without regulations, no manufacturer is likely to produce vehicles with the socially optimal level of fuel economy.[112] Because manufacturers are responding to consumer demand for fuel economy that multiple other market failures have already depressed, this first-mover dynamic can exacerbate the energy efficiency gap.[113] By affecting manufacturers, this aspect of first-mover disadvantage decreases fuel economy for all consumer groups.

First-mover effects can also affect vehicle purchasers, including corporate and institutional purchasers. For example, some focus group studies of medium- and heavy-duty truck purchasers have found that they may hesitate to purchase more fuel-efficient vehicles because they are unsure about their reliability.[114] Because a firm's knowledge about reliability and fuel savings is also useful to other fleets, and because a firm's choice of vehicles may reveal information to competitors, this can create first-mover issues and knowledge spillover effects.[115] Without regulatory incentives, firms may underinvest in purchasing such efficiency-enhancing technology as they all wait for their competitors to go first and bear the costs of testing the implementation of new technology.

Split Incentives. When the purchaser of a vehicle does not have to pay the costs of fuel usage, this can create a market failure known as split incentives or the principal-agent problem.[116] Economists have found that split incentives can lead to undervaluation of fuel economy in the trucking industry, as parties that own or operate tractor-trailers are frequently not responsible for fuel costs.[117] A similar dynamic can occur in other contexts, such as in the large rental vehicle fleets, since rental companies do not pay for fuel costs. Government intervention can ensure that purchasers make societally optimal investments in energy efficiency technologies when they receive inadequate market incentives because of principal-agent problems.[118]

Network Externalities. The benefits of a new technology sometimes depend on widespread adoption by others, creating a situation where "proven" technologies are chosen even though others would save more money in the long run.[119] This problem has been observed among heavy-duty trucking firms, which have hesitated to invest in alternative types of vehicles due to a lack of refueling infrastructure, while fuel companies are reluctant to build the infrastructure until more vehicles are in operation.[120] Network externalities can affect investments in natural-gas refueling, electric vehicle charging, maintenance facilities, and replacement parts.[121] In turn, these externalities can affect a range of consumers and vehicles, from individuals to businesses, and from passenger cars to heavy-duty trucks. Because consumers buying alternative fuel or more efficient vehicles must make predictions about the future development of these critical networks in order to estimate their long-term savings, various market failures from information asymmetries and costs, myopia, and loss aversion all come into play here. Fuel economy standards help resolve the coordination, first-mover, and informational problems facing the developers of this network infrastructure, thereby providing greater certainty that consumers can achieve long-term cost savings.[122]

Taken together, the considerable evidence of these market failures underscores the importance of including private fuel savings in cost-benefit assessments of fuel economy and vehicle emissions standards. Their potential influence across all types of vehicles and purchasers should prompt EPA and NHTSA to consider fuel savings regardless of whether the agencies seek to regulate passenger cars or light-, medium-, and heavy-duty trucks.

EPA and NHTSA's Authority to Include Fuel Savings in Cost-Benefit Assessments

Incorporating private consumer benefits from stronger fuel economy and greenhouse gas emission standards is in accordance with longstanding agency practices.[123] For over forty years, under administrations of both political parties, NHTSA has consistently included fuel savings in its cost-benefit analyses for fuel economy regulations.[124] Similarly, over the past six presidential administrations, EPA has regularly used the value of the fuel saved to calculate the benefits that are produced from its vehicle emission standards.[125]

Numerous government guidance documents on cost-benefit analyses also make clear that including fuel savings can ensure that regulations are based on sound economics. For example, the Office of Management and Budget's *Circular A-4*—a guide for agencies on regulatory cost-benefit analysis issued under President George W. Bush and endorsed by both the Obama and Trump Administrations—includes a specific discussion regarding how to evaluate fuel economy that suggests agencies should use the value of fuel saved when determining the benefits of a regulation.[126]

Similarly, EPA's *Guidelines for Economic Analysis* ("Guidelines") supports using fuel savings to calculate the benefits of regulations.[127] The Guidelines instruct EPA to consider the social value of goods saved when market distortions may lead to an incomplete measure of their benefits. In this case, the agency should use the price of fuel rather than consumers' valuation of fuel economy since the latter is subject to multiple market failures.

The Guidelines' discussion of the appropriate discount rate to use when evaluating regulation also supports incorporating fuel savings in cost-benefit assessments. As explained above, the energy efficiency gap could perhaps be characterized as reflecting consumers' use of very high discount rates when evaluating vehicles with increased fuel economy—rates multiple times higher than normally assumed for rational consumer behavior.[128] However, because the purpose of regulation is to maximize societal benefits, the Guidelines direct EPA to calculate the value of future savings using the rate that society discounts future costs and benefits.[129] The appropriate rate would consequently mirror present interest rates, rather than consumers' use of irrationally high discount rates. The Department of Transportation's guidance documents on cost-benefit analysis also indicate that agencies should fully value fuel savings in assessing their regulations. In its *Benefit-Cost Analysis Guidance for Discretionary Grant Programs*, the Department of Transportation explains that the benefits for programs that avoid vehicle use should be calculated based on vehicle operating costs, including avoided fuel costs.[130]

In developing new fuel economy regulations, the Biden administration should follow these longstanding agency practices and include private fuel savings in their cost-benefit analyses. These agency guidance documents and recommendations are clear that best economic practices require incorporating such benefits when market failures prevent consumers from obtaining the full value of fuel savings on their own.

The Biden Administration Can Help Spur Technological Innovation

After the 2020 election, car manufacturers made numerous commitments to produce more fuel-efficient and environmentally friendly vehicles. Shortly after Biden was declared the winner by most major media outlets, General Motors withdrew from a lawsuit over California's right to set more stringent tailpipe emission limits.[131] In January 2021, the company announced that it intends to end all gasoline passenger car and truck sales by 2035.[132] Volvo subsequently pledged to make its entire car line-up fully electric by 2030.[133] Even the Alliance for Automotive Innovation, a trade group representing major automakers that had been opposed to mandatory increases in fuel economy, last month backed nationwide rules to achieve vehicle emissions reductions roughly midway between the Trump and Obama standards.[134] These developments suggest that the market is already anticipating the need to meet stronger federal standards under the Biden Administration. But as this report has explored, due to a variety of market failures, on its own the market will consistently tend to undershoot the level of fuel efficiency that will best serve the American consumer—let alone the level of efficiency necessary to protect public health and the environment. Through even stronger regulations, NHTSA and EPA can address these market failures and spur even greater innovation in the transportation sector.

Economic studies and historical evidence demonstrate that government can play a major role in technological innovation. In the absence of a forcing mechanism like regulation, risk-averse manufacturers—which face first-mover disadvantages, switchover disruptions, and other barriers—are likely to apply only small, incremental innovations to fuel economy, instead of pursuing more major advances that may have greater potential to improve both fuel economy and performance simultaneously.[135] There is also robust evidence that countries and sectors with stronger environmental controls experience greater innovation than would occur absent these government mandates.[136] Consequently, the Biden Administration should consider the importance of spurring technological innovation in promulgating new fuel economy and vehicle emissions regulations.

The state of California and several car companies had previously struck a deal that set fuel economy goals at a level in between the Obama and Trump administration's proposed standards.[137] But given the significant market failures at the root of the energy efficiency gap and the multitude of other environmental and health harms from vehicle emissions, those existing targets likely do not represent the standards that are most beneficial to society. Just as all cars and trucks need regular tune ups to operate at their peak efficiency, the car and truck fleets and markets nationwide need regular tune ups to maximize net benefits—not just for climate change, public health, and energy security, but for consumer savings as well. The Biden administration should analyze how more ambitious vehicle regulations can remedy the numerous market failures that contribute to the energy efficiency gap and significantly reduce consumer costs along with pollution.

Endnotes

1 *See Inventory of U.S. Greenhouse Gas Emissions and Sinks*, Env't Prot. Agency, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks (last visited Apr. 19, 2021).

2 *See Carbon Pollution from Transportation*, Env't Prot. Agency, https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation (last visited Apr. 10, 2021).

3 *See* Brady Dennis & Juliet Eilperin, *Biden Faces 'Moment of Truth' as He Weighs Key U.S. Climate Promise*, Wash. Post (Mar. 23, 2021), https://www.washingtonpost.com/climate-environment/2021/03/23/biden-paris-climate-pledge/.

4 *See* Environmental Defense Fund, Clean Cars, Clean Air, Consumer Savings: 100% New Zero Emission Vehicle Sales by 2035 Will Deliver Extensive Economic, Health and Environmental Benefits to all Americans 4 (Jan. 2021), http://blogs.edf.org/climate411/files/2021/01/FINAL-National-White-Paper-Protective-Clean-Car-Standards-1.26.21.pdf.

5 *See* David Farnsworth, Camille Kadoch & Nancy Seidman, *Cleaner by the Mile: Electric Trucks Can Have Outsized Environmental and Health Benefits*, Utility Drive (Apr. 14, 2021), https://www.utilitydive.com/news/cleaner-by-the-mile-electric-trucks-can-have-outsized-environmental-and-he/598369/ (citing Fabio Caiazzo et al., *Air Pollution and Early Deaths in the United States. Part I: Quantifying the Impact of Major Sectors in 2005*, 79 Atmospheric Env't 198 (2013)); *see also* Environmental Defense Fund, *supra* note 4 (attributing 20,000 premature deaths to the transportation sector every year).

6 *See* Kristin Igusky, *4 Reasons Why the Trump Administration Should Keep Fuel Standards in Place*, World Res. Inst. (Mar. 14, 2017), https://www.wri.org/blog/2017/03/4-reasons-why-trump-administration-should-keep-fuel-standards-place.

7 Fuel economy and vehicle emissions regulations generate additional private benefits by reducing consumers' time spent refueling, and by allowing drivers to go farther on the same amount of fuel. This report focuses largely on the fuel cost savings for consumers. The term "consumers" refers to both individual drivers of passenger vehicles or trucks and to the companies or institutions that purchase vehicles for their employees to drive. In the case of commercial and institutional purchasers, not only will those entities save money, but some of those savings may be passed on to other consumers or taxpayers.

8 In this scenario, future cost savings have been discounted at a reasonable discount rate. The energy efficiency gap is characterized by consumers not spending an additional dollar today to save more than a dollar in discounted, present value fuel savings.

9 These market failures, discussed later in the report, include issues like spillover effects and first mover disadvantages.

10 *See* NHTSA, Phase 2 Fuel E¬fficiency Standards for Medium- and Heavy-Duty Engines and Vehicles: Final EIS Summary S-1 (Aug. 2016), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/mdhd2-final-eis-summary.pdf.

11 *See* 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624, 62,624 n. 1 (Oct. 15, 2012) [hereinafter Clean Car Standards].

12 *See* NHTSA, Phase 2 Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, *supra* note 10, at S-4.

13 *See, e.g.*, U.S. Gen. Serv. Admin., FY 2019 Federal Fleet Report, https://www.gsa.gov/cdnstatic/FY2019FederalFleetReportFinal.xlsx (dated July 2020) (showing the vehicle classes purchased by federal agencies); U.S. Dept. of Energy, State & Alternative Fuel Provider Covered Fleets, https://epact.energy.gov/covered-fleets (last accessed April 16, 2021) (showing over 300 local government and institutional fleets with over 50 light-duty vehicles); U.S. Dept. of Energy, FOTW #1003, https://www.energy.gov/eere/vehicles/articles/fotw-1003-november-13-2017-cars-constituted-larger-fraction-light-duty (Nov. 13, 2017) (showing new light-duty sales to rental, corporate, utility, and government fleets).

14 California Air Resources Board, 2018 Base-year Emissions Inventory Report 9 (Dec. 2019), https://ww2.arb.ca.gov/sites/default/files/2019-12/SB%201014%20-%20Base%20year%20Emissions%20Inventory_December_2019.pdf?utm_medium=email&utm_source=govdelivery (anticipating the growth of transportation network companies to overall greenhouse gas emissions from car and light-duty truck vehicles); *Strong Fleet Sales Help Prop Up Slow September,* Cox Automotive (Oct. 3, 2019), https://www.coxautoinc.com/market-insights/september-2019-fleet/ (last visited Apr. 15, 2021) (explaining that rental, government, and commercial fleets make up over 17 percent of all new vehicle sales); EPA, Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average

Fuel Economy Standards 4-116 (2012) (noting that rental, corporate, and government fleets make up "about 20% of new vehicle sales").

15 The top 200 largest companies only control about 11 percent of trucks on the road. *See* National Academy of Sciences, Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles 17 (2010), https://www.nap.edu/read/12845/chapter/4 (finding that "small fleets make up 75 percent of Class 4 through 8 trucks").

16 *See* Bethany Davis Noll, Peter Howard, Jason Schwartz & Avi Zevin, *Shortchanged: How the Trump Administration's Rollback of the Clean Car Standards Deprives Consumers of Fuel Savings*, Inst. Pol'y Integrity 22–24 (June 4, 2020), https://policyintegrity.org/files/publications/Clean_Car_Standards_Rollback_and_Fuel_Savings_Report.pdf.

17 *See, e.g.*, Arthur G. Fraas, Randall W. Lutter & Derek C. Wietelman, *The Energy Paradox in Seemingly Competitive Industries: The Use of Energy-Efficient Equipment on Heavy-Duty Tractor Trailers*, 129 Energy Pol'y 467 (2019); Alliance of Automobile Manufacturers, Supplemental Comments on the SAFE Vehicles Rule 9 (May 30, 2019); Toyota Motor North America, Inc., Supplemental Comments on Safer Affordable Fuel-Efficient Vehicles Rule 4 (Mar. 25, 2019); Julian Morris & Baruch Feigenbaum, *The Economic Consequences of Fuel Economy Standards*, Reason 10–11 (Mar. 2020) https://reason.org/wp-content/uploads/economic-consequences-fuel-economy-standards.pdf.

18 National Academy of Sciences, Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy—2025-2035 11-351 (2021) (summarizing the economics literature in this area and concluding that "there is general agreement that the actual fuel savings realized over time should be fully valued in cost-benefit analyses.").

19 *See* Clean Car Standards, *supra* note 11, at 62,624.

20 *See* Richard K. Lattanzio, Linda Tsang & Bill Canis, *Vehicle Fuel Economy and Greenhouse Gas Standards: Frequently Asked Questions*, Cong. Res. Service (Aug. 26, 2019), https://www.everycrsreport.com/files/20190826_R45204_3f145570e778207a10e64af12ad4c13ff785f545.pdf.

21 *See EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks*, 4 Env't Prot. Agency (Aug. 2012), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EZ7C.PDF?Dockey=P100EZ7C.PDF.

22 *See* Clean Car Standards, *supra* note 11, at 62,629 (reporting that EPA's CO2 standards would achieve $451 billion in lifetime net benefits at a 3% discount rate, or $326 billion at a 7% discount rate); *see id.* at 62,663 (reporting that the standards would achieve $475 billion in fuel savings at a 3% discount rate, or $364 billion in fuel savings at a 7% discount rate).

23 *See id.* at 62,914–16, 63,114–20 (explaining some of the reasons for the energy efficiency gap and how the regulation can correct for these market failures).

24 *See id.* at 62,914.

25 *See* Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles— Phase 2, 81 Fed. Reg. 73,478 (Oct. 25, 2016).

26 *See* Paul Haven & Ori Gutin, *Fact Sheet: Vehicle Efficiency and Emissions Standards*, Env't & Energy Study Inst. 3 (Aug. 2015), https://www.eesi.org/files/FactSheet_Vehicle_Emissions_081815.pdf.

27 *See* Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2, 81 Fed. Reg. at 73,859.

28 *See id.* at 73,859-62.

29 EPA, NHTSA & CARB, 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 at ES-4, 12-74, 13-102 (2016), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF [hereinafter Draft TAR].

30 *See* EPA, Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation 29 (2017), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100QQ91.pdf.

31 *See id.* at 6-7.

32 *See* Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022-2025 Light-Duty Vehicles, 83 Fed. Reg. 16,077, 16,078 (Apr. 13, 2018). The conclusion that the Clean Car Standards were "not appropriate" was not supported by the evidence. *See* Bethany Davis Noll, Peter Howard & Jeffrey Shrader, *Analyzing EPA's Vehicle-Emissions Decisions: Why Withdrawing the 2022-2025 Standards Is Economically Flawed*, Inst. Pol'y Integrity (2018), https://policyintegrity.org/files/publications/Analyzing_EPAs_Fuel-Efficiency_Decisions_Policy_Brief.pdf.

33 *See* The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, 85 Fed. Reg. 24,174, 24,258 (Apr. 30, 2020) [hereinafter SAFE Rule].

34 *See Shortchanged*, *supra* note 16, at 9.

35 *See* SAFE Rule, *supra* note 33, at 25,110–11 ("[C]onsider[ing] fuel savings, spread over the lifetime of the vehicle . . . compared to the upfront vehicle costs . . . distorts the comparison."); *id.* at 24,612 ("If either case is true—that the analysis is incomplete regarding consumer valuation of other vehicle attributes or discount rates used in regulatory analysis inaccurately represent consumers' time preferences—no market failure would exist to sup-

port the hypothesis of a fuel efficiency gap. In either case, the agencies' central analysis would overstate both the net private and social benefits from adopting more stringent fuel economy and CO2 emissions standards. . . . Because government action cannot improve net social benefits in the absence of a market failure, if no market failure exists to motivate the $26.1 billion in private losses to consumers, the net benefits of these final standards would be $42.2 billion.").

36 Jennifer A Dlouhy & Keith Laing, *Automakers Withdraw Support for Trump-Era Emissions Rule*, Bloomberg Green (Feb. 2, 2021), https://www.bloomberg.com/news/articles/2021-02-02/automakers-push-fuel-economy-targets-modeled-on-california-pact.

37 *See* Jeff Mason, *Biden's Climate Duo of Kerry and McCarthy Puts U.S. Back in Global Warming Fight*, Reuters, (Apr. 16, 2021), https://www.reuters.com/business/environment/bidens-climate-duo-kerry-mccarthy-puts-us-back-global-warming-fight-2021-04-16/.

38 Some opponents of stronger standards have also claimed that EPA may underestimate costs such as the opportunity cost of other features or higher implementation costs. *See Shortchanged*, *supra* note 16, at 17 (noting the lack of evidence for this claim versus the considerable evidence that compliance costs and vehicle price effects have been overestimated).

39 *See* NHTSA & EPA, SAFE Rule Final Regulatory Impact Analysis 326 (Mar. 2020) https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/final_safe_fria_web_version_200330.pdf [hereinafter SAFE FRIA] (explaining that multiple options exist for "technology [to] provide both improved fuel economy and performance").

40 *See* EPA, Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Standards under the Midterm Evaluation: Technical Support Document at 4-20 (2016), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3L4.pdf discussing, e.g., Hsing-Hsiang Huang, Gloria Helfand, Kevin Bolon, Robert Beach, Mandy Sha & Amanda Smith, *Re-Searching for Hidden Costs: Evidence from the Adoption of Fuel-Saving Technologies in Light-Duty Vehicles*, 65 Transp. Res. 194, 194 (2018) (finding that "automakers have typically been able to implement fuel-saving technologies without harm to vehicle operational characteristics" like "acceleration, handling, ride comfort, noise, braking feel, and vibration"). *See also* Draft TAR, *supra* note 29.

41 *See* Gloria Helfand et al., *Searching for Hidden Costs: A Technology-Based Approach to the Energy Efficiency Gap in Light-Duty Vehicles*, 98 Energy Pol'y 590, 605 (2016) ("Though we are unable to demonstrate causality or robustness, we find that technologies are more likely to be associated with reducing negative reviews of operational characteristics than with increasing them.").

42 *See* Gloria Helfand et al., *Power and Fuel Economy Tradeoffs, and Implications for Benefits and Costs of Vehicle Greenhouse Gas Regulations*, Env't Prot. Agency 17 (powerpoint presentation, 2018), https://www.regulations.gov/contentStreamer?documentId=EPA-HQ-OAR-2018-0283-6963&attachmentNumber=17&contentType=pdf, *also available at* https://www.epa.gov/sites/production/files/2018-10/documents/sbca-benefit-cost-ghg-regs-helfand-2018-03.pdf ("The tradeoff between power & fuel economy has dropped over time."). *See also Shortchanged*, *supra* note 16, at 15 (explaining that "recent technological advancements have likely disrupted any historical tradeoffs between fuel economy and vehicle features"). Furthermore, there may be technical limits on increasing performance traits like acceleration, as well as diminishing marginal willingness to pay among consumers for additional performance traits. *See id.*

43 *See* Antonio M. Bento et al., *Flawed Analysis of U.S. Auto Fuel Economy Standards*, 362 Sci. 1119, 1119 (2018), https://doi.org/10.1126/science.aav1458.

44 *See* Gloria Helfand & Ann Wolverton, *Evaluating the Consumer Response to Fuel Economy: A Review of Literature*, 5 Int'l Rev. Env't & Rsch. Econ. 103, 130 (2011), https://www.nowpublishers.com/article/Details/IRERE-0040 ("Only if there are limits on the total amount of efficiency that can go in a vehicle does economic theory predict that the marginal benefit of fuel economy should not equal its marginal cost.").

45 *See* Christopher Knittel, *Automobiles on Steroids: Product Attribute Trade-Offs and Technological Progress in the Automobile Sector*, 101 Am. Econ. Rev. 3368, 3379 (2012); Thomas Klier & Joshua Linn, *The Effect of Vehicle Fuel Economy Standards on Technology Adoption*, 133 J. Pub. Econ. 41, 49 (2016). These two publications are often cited to support the notion of inherent tradeoffs. However, the authors never make any connection between opportunity costs and the energy efficiency paradox. The publications use historical data to observe possible tradeoffs that manufacturers may have made in the past between installing fuel economy technologies versus increasing the horsepower or weight of vehicles. *See also* EPA & NHTSA, Final Rulemaking to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Regulatory Impact Analysis 9-3 (2011) [hereinafter 2011 Heavy-Duty FRIA] ("[A]n additional explanation—adverse effects on other vehicle attributes—did not elicit supporting information in the public comments.")

46 *See* Draft TAR, *supra* note 29, at 4-35 to 4-36.

47 *See* SAFE FRIA, *supra* note 39, at 239 (relaying comments from industry that "manufacturers may apply turbocharging to improve not just fuel economy, but also to improve vehicle performance"); *see also id.* at 317.

48 *See id.* at 320 ("[A] PHEV50 may have an electric motor and battery appropriately sized to operate in all electric mode through the repeated accelerations and high speeds in the US06 driving cycle, but the resulting motor and battery size enables the PHEV50 slightly to over-perform in 0-60 acceleration."); *see also id.* at 324 (concluding it is "an appropriate outcome" that certain electrification or hybridization options lead to a "small increase in passing performance").

49 *See id.* ("[I]f a new transmission is applied to a vehicle, the greater number of gear ratios helps the engine run in its most efficient range which improves fuel economy, but also helps the engine to run in the optimal 'power band' which improves performance.").

50 *See, e.g.*, SAFE FRIA, *supra* note 39, at 318–20 (explaining that the agencies' model for estimating compliance costs for light-duty vehicle regulations already accounts for such tradeoffs by holding key attributes "constant" to "maintain performance neutrality"); EPA & NHTSA, Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2, Regulatory Impact Analysis 8-7 (Aug. 2016), https://nepis.epa.gov/Exe/ZyPDF.cgi/P100P7NS.PDF?Dockey=P100P7NS.PDF [hereinafter "2016 Heavy-Duty FRIA"] (explaining that "the technology cost estimates developed here take into account the costs to hold other vehicle attributes, such as size and performance, constant").

51 *See* David Cooke, Union of Concerned Scientists, The Trade-Off Between Fuel Economy and Performance: Implications for the Mid-Term Evaluation of the National Program 7 (2016).

52 Research suggests that manufacturers will instead produce different vehicles with mixes of fuel economy and other attributes, allowing those consumers who are willing to pay for extra attributes on top of fuel economy to do so, while those consumers who do not value extra attributes like acceleration as much can purchase cheaper but more efficient vehicles. *See* Kate S. Whitefoot, Meredith L. Fowlie & Steven J. Skerlos, *Compliance by Design: Influence of Acceleration Trade-Offs on CO_2 Emissions and Costs of Fuel Economy and Greenhouse Gas Regulations*, 51 Env't Sci. & Tech. 10,307, 10,308, 10,312, 10,313 (2018), https://www.regulations.gov/contentStreamer?documentId=NHTSA-2018-0067-11903&attachmentNumber=1&contentType=pdf (finding significant heterogeneity across vehicles and manufacturers, and noting that competition for those consumers who value acceleration will be reduced; also finding less of a change in sales composition between trucks and cars); *see also* Bento et al., *supra* note 43, at 1121 ("[B]oth the 2016 TAR and 2018 NPRM have likely overestimated compliance costs. Neither analysis considers the full extent of options that manufacturers have available to respond to these policies, including changes in vehicle prices, performance, and other attributes") (emphasis added).

53 *See also Shortchanged*, *supra* note 16, at 32–33 (explaining that the agencies' constant-performance assumption in their compliance cost model in fact unavoidably increases performance attributes, such as when adding technology to maintain initial acceleration also improves passing acceleration).

54 *See* SAFE Rule, *supra* note 33, at 24,612. (explaining that the "central analysis" in the Final Rule "does not account for the possibility that imposing stricter standards may require manufacturers to make sacrifices in other vehicle features that compete with fuel economy, and that some buyers may value more highly").

55 *See id.* at 24,605 (reporting that, in one of the agencies' three preferred studies (Allcott & Wozney), consumers are only fully valuing future fuel savings if consumers were applying "discount rates of 24 percent or higher.").

56 *See* Office of Mgmt. & Budget, Circular A-4: Regulatory Analysis 33 (2003).

57 *See* Council of Economic Advisors, Discounting for Public Policy: Theory and Recent Evidence on the Merits of Updating the Discount Rate 10–11 (Jan. 2017), https://obamawhitehouse.archives.gov/sites/default/files/page/files/201701_cea_discounting_issue_brief.pdf (explaining that the pre-tax rate of return to private capital, previously estimated at 7%, should be lowered below 7%).

58 *See* Yowana Wamala, *Average Auto Loan Interest Rates: Facts & Figures*, ValuePenguin (Mar. 1, 2021), https://www.valuepenguin.com/auto-loans/average-auto-loan-interest-rates (examining national average car loan interest rates for a typical 5-year loan).

59 *See Finance Rate on Consumer Installment Loans at Commercial Banks, New Autos 60 Month Loan,* FRED Economic Data, https://fred.stlouisfed.org/series/RIFLPBCIANM60NM (last visited Apr. 14, 2021) (providing historical interest rates on five-year car loans, with current rates set at approximately five percent).

60 *See* SAFE Rule, *supra* note 33, at 24,612.

61 *See id.* at 24,706–07.

62 *See* 2011 Heavy-Duty FRIA, *supra* note 45, at 9-8 ("The agencies received no evidence indicating that constrained access to capital might explain the efficiency gap in this [heavy-duty] market."); 2016 Heavy-Duty FRIA, *supra* note 50, at 8-7 (reporting one study that did not find capital constraints to be a problem for medium- and large-sized businesses, though noting another study where access to capital was a challenge for smaller businesses).

63 *See* Heather Klemick, Elizabeth Kopits, Keith Sargent & Ann Wolverton, *Heavy-Duty Trucking and the Energy Efficiency Paradox*, Nat'l Ctr. for Env't Econ. 12, 20 (Jan. 2014), https://19january2017snapshot.epa.gov/sites/production/files/2014-12/documents/heavy-duty_trucking_and_the_energy_efficiency_paradox.pdf.

64 If a consumer anticipates selling the car before the end of its life, the value of the remaining fuel savings would be reflected in the car's resale value, and so should still accrue to the vehicle's initial purchaser.

65 *See* Comments from University of California, Berkeley's Environmental Law Clinic, 16–17 (Sep. 5, 2018), https://www.regulations.gov/document?D=EPA-HQ-OAR-2018-0283-0879 (citing a November 2016 memorandum commissioned by EPA, identifying over 60 financial institutions that offer loan rate reductions to consumers that purchase fuel-efficient vehicles); Memorandum from Hsing-Hsiang Huang & Gloria Helfand to EPA, Lending Institutions That Provide Discounts for More Fuel-Efficient Vehicles (Nov. 2016), https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0827-5832 ("EPA believes this information is valuable in illustrating the current practice of lenders providing green auto loans that factor in the consumer fuel savings from more efficient vehicles into the lending terms.").

66 *See, e.g.*, Volvo Group, Comments on Proposed Advanced Clean Truck Regulation (Dec. 9, 2019), https://www.arb.ca.gov/lists/com-attach/74-act2019-WjtXMgZzWFQCZ1I9.docx (arguing that the heavy-duty vehicle market faces different energy efficiency issues than the light-duty market because "different buyer motivations, lower vehicle volumes and diverse market segmentation mean that the economy of scale wheels will turn much more slowly").

67 *See* Klemick, *supra* note 63, at 12.

68 *See* Fraas, *supra* note 17, at 467–68.

69 *Id.* at 474. This study should be interpreted carefully, as it suffers from: small sample size according to the authors and limited spatial variation; a narrow definition of the principal-agent problem; and measurement error in their key principal-agent variable due to difficulty measuring truck-trailer ownership. In comparison, the authors present stronger evidence of incomplete information.

70 *Compare id.* (reporting observations along particular east-coast highways from 2015-2017) *with* Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, 76 Fed. Reg. 57,106 (Sept. 15, 2011) (establishing greenhouse gas emissions and fuel efficiency standards for medium- and heavy-duty engines and vehicles starting with model year 2014).

71 *See* David Greene, Anushah Hossain, Julia Hofmann, Gloria Helfand & Robert Beach, *Consumer Willingness to Pay for Vehicle Attributes: What Do We Know?*, 118 Transp. Rsch. Part A: Pol'y & Prac. 258 (2018), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6260949/ (meta-analysis of the academic literature regarding consumers' willingness to pay for fuel economy and other attributes); *see also* Marcel Stadelmann, *Mind the gap? Critically reviewing the energy efficiency gap with empirical evidence*, 27 Energy Res. & Soc. Sci. 117, 120, 126 (2017).

72 *See* National Academy of Sciences, *supra* note 18, at 11-351.

73 *See* David L. Greene, *Implications of Behavioral Economics for the Costs and Benefits of Fuel Economy Standards*, 6 Current Sustainable/Renewable Energy Rep. 177, 182 (2019) (describing research on how people make fuel economy decisions that found few study participants made any fuel calculations at all when purchasing a vehicle).

74 *See* National Academy of Sciences, *supra* note 18, at 11-346 (2021) (discussing evidence for the existence of the energy efficiency gap and concluding that "there is general agreement that the actual fuel savings realized over time should be fully valued in cost-benefit analyses" of fuel economy standards).

75 Note that this is distinct from risk aversion, which can be rational. *See* Heather Klemick et al., *Heavy-Duty Trucking and the Energy Efficiency Paradox: Evidence from Focus Groups and Interviews*, 77 Transp. Rsch. Part A: Pol'y & Prac. 154, 163–64 (2015).

76 David L. Greene, *Consumers' Willingness to Pay for Fuel Economy and Implications for Sales of New Vehicles and Scrappage of Used Vehicles*, Env't Defense Fund 5 (Oct. 21, 2018), https://www.edf.org/sites/default/files/CARB_Report_Greene_UTenn_Consumer_Behavior_Modeling.pdf (describing behavioral economic explanations for the fuel efficiency paradox, including loss aversion).

77 Klemick et al., *supra* note 75, at 163–64 (finding that "[f]leet managers' concern about uncertainty is consistent with loss aversion, a behavioral pattern in which individuals facing risky choices place greater weight on losses compared to gains of an equivalent monetary value and that "firms in our sample do not behave as risk neutral profit-maximizers with full information when investing in tractor fuel economy").

78 *See* Kellen Mrkva et al., *Moderating Loss Aversion: Loss Aversion Has Moderators, But Reports of its Death Are Greatly Exaggerated*, 30 J. Consumer Psych. 407–28 (2020).

79 David L. Greene, *Implications of Behavioral Economics for the Costs and Benefits of Fuel Economy Standards*, 6 Current Sustainable/Renewable Energy Rep. 177, 182 (2019) (noting that the result "is especially surprising because three of the ten groups were comprised of (1) college or graduate students nearing graduation, (2) computer hardware or software engineers, and (3) professionals in the financial services sector").

80 *See id.* at 183.

81 *Id.* at 190.

82 *See* James Sallee, *Rational Inattention and Energy Efficiency*, 57 J. Law & Econ. 781, 782–85 (2014). With incomplete information, it is possible that some consumers may overestimate their savings from purchasing more efficient

vehicles, while other consumers underestimate those savings. Several studies, however, show a bias pointing toward underestimation, especially in combination with loss aversion. *See supra* notes 78-79; *see also* Policy Integrity Comments on the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, 35–40 (Oct. 26, 2018), https://policyintegrity.org/documents/Emissions_Standards_EPA_NHTSA_Comments_Oct2018.pdf (noting the limitations of studies by Allcott & Wozny, Sallee et al., and Busse et al.).

83 These kinds of "experience goods" can create market failures. *See* Cass R. Sunstein, *Rear Visibility and Some Unresovled Problems for Economic Analysis (with Notes on Experience Goods)*, 10 J. Benefit-Cost Analysis 317 (2019). Experience goods have been associated with plug-in hybrids. *See* Margaret Taylor & K. Sydny Fugita, *Consumer Behavior and the Plug-In Electric Vehicle Purchase Decision Process: A Research Synthesis* 9, 49 Lawrence Berkeley Nat'l Lab'y (Jan. 31, 2018).

84 2016 Heavy-Duty FRIA, *supra* note 50, at 8-4 to 8-5 (noting that information acquisition may be especially difficult for smaller businesses with less capacity to do in-house testing of new technologies).

85 Gloria Helfand & Reid Dorsey-Palmateer, *The Energy Efficiency Gap in EPA's Benefit-Cost Analysis of Vehicle Greenhouse Gas Regulations: A Case Study*, 6 J. Benefit Cost Analysis 432, 439 (2015).

86 *See* Kenneth Gillingham, Sébastien Houde & Arthur van Benthem, *Consumer Myopia in Vehicle Purchases: Evidence from a Natural Experiment*, Nat'l Bureau of Econ. Res. (May 2019), https://www.nber.org/system/files/working_papers/w25845/w25845.pdf.

87 *See id.* at 2.

88 *See id.*

89 *Id.*

90 *Id.* at 4.

91 EPA Science Advisory Board, Consideration of the Scientific and Technical Basis for the EPA's Proposed Rule Titled The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks 21 (Feb. 27, 2020), https://yosemite.epa.gov/sab/sabproduct.nsf/LookupWebReportsLastMonthBOARD/1FACEE5C03725F268525851F006319BB/$File/EPA-SAB-20-003+.pdf (citing D. Duncan et al., *Most Consumers Don't Buy Hybrids: Is Rational Choice a Sufficient Explanation?* 10 J. Benefit-Cost Analysis 1 (2019)).

92 *See* Suresh Muthulingam et al., *Energy Efficiency in Small and Medium-Sized Manufacturing Firms*, 15 Mfg. & Serv. Operations Mgmt. 596, 612 (2013) (finding that manager inattention contributed to the non-adoption of energy efficiency initiatives, since initiatives that appear lower on a list of efficiency recommendations, and initiatives that require more managerial attention, are less likely to be adopted); Fraas et al., *supra* note 17 (finding that poor management has a statistically significant negative effect on the adoption of fuel improving technologies using non-compliance with federal standards as a proxy variable for poor management).

93 A similar dynamic could exist in government if officials are rewarded for short-term cost savings rather than long-term fiscal health.

94 This incentive could be muted by a firm's accounting practices if costs and expenses are amortized over time.

95 *See* Sheila Bair, *Short-Termism and the Risk of Another Financial Crisis*, Wash. Post (July 8, 2011) (op-ed by the former Chair of the FDIC, in which she calls short-termism a "market failure"); Marc Jarsulic et al., *Long-Termism of Lemons*, Ctr. for Am. Progress Rep. 11–12 (Oct. 2015), https://cdn.americanprogress.org/wp-content/uploads/2015/10/21060054/LongTermism-reportB.pdf (including a section called "short-termism as a market failure" attributed to "asymmetric information between managers and investors" and "behav[ing] myopically"); Lynne L. Dallas, *Short-Termism, the Financial Crisis, and Corporate Governance*, 37 J. Corp. L. 265, 310–16 (2012) (reviewing various explanations for short-termisms, including asymmetric information and myopia).

96 *See* Stephen J. DeCanio, *Barriers Within Firms to Energy-Efficient Investments*, 21 Energy Pol'y 906, 907–08 (1993) (explaining how tying management compensation to short-term performance can lead to underinvestment in energy efficiency, and also how stock markets and investors may not be able to detect inefficient management decisions); Suresh Muthulingam et al., *Adoption of Profitable Energy Efficiency Related Process Improvements in Small and Medium Sized Enterprises* 1, 7 (Working Paper, 2008) (finding that managers fail to implement energy efficiency improvements with short payback periods for several reasons, including myopia and a stronger focus on upfront costs than on net benefits, attributed partially to short-termism).

97 *See* Yujing Gong & Kung-Cheng Ho, *Corporate Social Responsibility and Managerial Short-Termism*, Asia-Pacific J. Accounting & Econ. (2018).

98 Robert H. Frank, *The Demand for Unobservable and Other Nonpositional Goods*, 75 Am. Econ. Rev. 101, 107 (1985) ("When an individual's ability level cannot be observed directly, such observable components of his consumption bundle constitute a signal to others about his total income level, and on average, therefore, about his level of ability. . . [I]mperfect information about ability might create incentives for people to rearrange consumption patterns to favor observable goods.").

99 Specifically, a majority of people surveyed would trade a decrease in their car's absolute value for an increase in its relative value compared to other people's cars: in other words, they are happy to have their car lose value so long as everyone else loses more value on average. *See, e.g.*, Fredrik Carlsson et al., *Do You Enjoy Having More than Others? Survey Evidence of Positional Goods*, 74 Economica 586, 588, 593 (2007) (reporting results of a Swedish survey and finding support for the hypothesis that "visible goods and their characteristics, such as the value of cars, are more positional than less visible goods and their characteristics, such as car safety"); Francisco Alpizar, Fredrik Carlsson & Olof Johansson-Stenman, *How Much Do We Care About Absolute Versus Relative Income and Consumption?*, 56 J. Econ. Behav. & Org. 405, 412 (2005) (reporting results of Costa Rican survey). Though some such surveys were conducted in other countries, positionality for cars likely would be stronger in the United States, given the American affinity for cars and the income distribution. *See* Reid R. Heffner, Kenneth S. Kurani & Thomas S. Turrentine, *Effects of Vehicle Image in Gasoline-Hybrid Electric Vehicles* 2 U.C. Davis Inst. Transp. Stud. (2005) ("In the words of automobile psychologist G. Clotaire Rapaille, Americans are in 'a permanent search of an identity' and 'cars are very key . . . [they are] maybe the best way for Americans to express themselves.'") (citations omitted); Ed Hopkins & Tatiana Kornienko, *Running to Keep in the Same Place: Consumer Choice as a Game of Status*, 94 Am. Econ. Rev. 1085 (2004) (noting that positional effects increase as society's income increases, because the portion of income spent on conspicuous consumption increases); *see also* Birgitta Gatersleben, *The Car as a Material Possession: Exploring the Link Between Materialism and Car Ownership and Use*, *in* Auto Motives 137-48 (Karen Lucas, Evelyn Blumenberg & Rachel R. Weinberger eds., 2011), https://doi.org/10.1108/9780857242341-007; Bryan Lufkin, *What Google Street View Tells Us About Income*, BBC (Jan. 6, 2018), https://www.bbc.com/worklife/article/20180105-how-your-car-signals-your-income; Liza Barth, *Cars As Status Symbols*, Consumer Rep. (Dec. 18, 2007), https://www.consumerreports.org/cro/news/2007/12/cars-as-status-symbols/index.htm; *Top 14 Status Symbol Cars at Bargain Prices,* MotorTrend (May 15, 2014), https://www.motortrend.com/news/top-14-status-symbol-cars-at-bargain-prices.

100 Theory also predicts that manufacturers will overinvest in researching status features, at the expense of non-status features. *See* Ben Cooper et al., *Status Effects and Negative Utility Growth*, 111 Econ. J. 642 (2001).

101 Until recently, fuel economy has been a relatively low-visibility, and therefore low-status, attribute. With the rise of luxury electric vehicles, fuel economy may be increasingly becoming a status symbol among very specific segments of consumers.

102 *See* Robert H. Frank & Cass R. Sunstein, *Cost-Benefit Analysis and Relative Position*, 68 U. Chi. L. Rev. 323, 326 (2001) ("[W]hen a regulation requires all workers to purchase additional safety, each worker gives up the same amount of other goods, so no worker experiences a decline in relative living standards. If relative living standards matter, then an individual will value an across-the-board increase in safety more highly than an increase in safety that he alone purchases.").

103 *See generally* Carolyn Fischer, *Imperfect Competition, Consumer Behavior, and the Provision of Fuel Efficiency in Light-Duty Vehicles*, Res. for the Future (2010), https://www.rff.org/documents/1472/RFF-DP-10-60.pdf.

104 *See id.* at 3 (explaining that "the largest four firms accounted for 75.5 percent of the value of shipments in the automobile market and 95.7 percent of the light-duty and utility vehicle market"); *see also* Winston Harrington & Alan Krupnick, *Improving Fuel Economy in Heavy-Duty Vehicles*, Res. for the Future (2012), https://media.rff.org/documents/RFF-DP-12-02.pdf (explaining that the heavy-duty trucking industry "is dominated by a small number of large manufacturers" and is even smaller than it would seem at first glance because of "affiliations, partnerships, and outright ownership of one company by another").

105 National Research Council, Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles 318–19 (2015), http://nap.edu/21744 (explaining that manufacturers may face a first-mover disadvantage for developing new fuel-efficiency technologies, and regulation can help overcome that perceived disadvantage as well as bring down costs through economies of scale and learning, and thus may "lead to a more optimal provision of fuel economy in the marketplace").

106 *Id.* at 319.

107 *Id.*

108 *Id.*

109 *Id.*

110 *Id.*

111 *See supra* on short-termism and myopia and text accompanying notes 85 to 97.

112 *See* 2016 Heavy-Duty FRIA, *supra* note 50, at 8-8 ("Manufacturers may be hesitant to offer technologies for which there is not strong demand, especially if the technologies require significant research and development expenses and other costs of brining the technology to a market of uncertain demand."); *id.* at 8-9 ("HDV manufacturers may delay in investing in the development and production of new technologies, instead waiting for other manufacturers to bear the initial risks of those investments.").

[113] Because it creates externalities and coordination issues that raise the cost of developing beneficial technologies, the first-mover disadvantage facing manufacturers may also be an independent justification for government regulation of fuel economy, beyond its contribution to the energy efficiency gap.

[114] *See* Klemick, *supra* note 63, at 12.

[115] *See id.* at 15; *see also* 2011 Heavy-Duty FRIA, *supra* note 45, at 9-3 ("[I]nformation has aspects of a public good, in that no single firm has the incentive to do the costly experimentation to determine whether or not particular technologies are cost-effective, while all firms benefits from the knowledge that would be gained from that experimentation."); 2016 Heavy-Duty FRIA, *supra* note 50, at 8-5 (noting that smaller businesses with less capacity to test new technologies in house are more likely to seek information from competitors).

[116] *See* David Vernon & Alan Meier, *Identification and Quantification of Principal–Agent Problems Affecting Energy Efficiency Investments and Use Decisions in the Trucking Industry*, 49 Energy Pol'y 266, 267 (2012) ("There are numerous market failures and barriers to investment in energy efficiency in the trucking industry. Split incentives described by principal–agent problems are an important class of existing market failures that obscure price signals.").

[117] *See id.* at 270–71 (finding that "[t]he separation of fuel cost payment and driver behavior . . . appears to be widespread. Up to 91% of trucking fuel consumption is exposed to this usage PA [principal-agent] problem); *see also* 2011 Heavy-Duty FRIA, *supra* note 45, at 9-5 (discussing both the split between truck owners, who may channel more investment into vehicle durability than fuel-efficiency, and truck operators; as well as the fact that truck renters may not readily observe fuel economy as opposed to rental costs); *id.* at 9-6 (citing a NAS report on the split incentives between tractor and trailer operators); 2016 Heavy-Duty FRIA, *supra* note 50, at 8-5 to 8-6 (summarizing the literature on splits between tractor operators and trailer owners, and between tractor operators and carrier subcontractors who pay for fuel).

[118] *See generally* Kenneth Gillingham & Karen Palmer, *Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence*, 8 Rev. Env't Econ. & Pol'y 18–38 (2014) (explaining how principal-agent problems and other market failures can explain the energy efficiency gap and provide a basis for regulatory intervention).

[119] Todd D. Gerarden, Richard G. Newell & Robert N. Stavins, *Assessing the Energy-Efficiency Gap* 24 Nat'l Bureau Econ. Res. (Jan. 2015), https://www.nber.org/system/files/working_papers/w20904/w20904.pdf.

[120] *See* Klemick et al., *supra* note 75, at 161 (explaining that a lack of infrastructure for natural gas refueling "gives rise to a classic 'chicken or egg' problem emblematic of network externalities: trucking firms hesitate to invest in natural gas vehicles due to lack of infrastructure, while fuel companies are reluctant to build the infrastructure until more vehicles are in operation").

[121] *See id.*; *see also* Shanjun Li et al., *The Market for Electric Vehicles: Indirect Network Effects and Policy Design*, 4 J. Ass'n Env't Res. Econ. 89 (2017) (analyzing how "EVs [electric vehicles] face several significant barriers to wider adoption, including the high purchase cost, limited driving range, the lack of charging infrastructure, and long charging time"); 2016 Heavy-Duty FRIA, *supra* note 50, at 8-7 to 8-8 (noting network externalities for natural gas fueling, repair facilities, and replacement parts).

[122] Resolving the coordination and informational problems facing the developers of network infrastructure may also be an independent justification for government regulation of fuel economy, beyond its contribution to the energy efficiency gap.

[123] *See Shortchanged*, *supra* note 16, at 24–28.

[124] *See id.* at 24–25.

[125] *See id.* at 26–27.

[126] *See id.* at 22 (explaining the relevant language from Circular A-4).

[127] *See generally* EPA, Guidelines for Preparing Economic Analyses 6–18, 19 (Dec. 17, 2010), https://www.epa.gov/sites/production/files/2017-08/documents/ee-0568-50.pdf [hereinafter EPA Guidelines].

[128] *See* National Research Council, *supra* note 105, at 315 ("Short payback periods imply high discount rates for fuel economy, which may indicate undervaluation of fuel economy"); *id.* at 317 (discussing studies that compared implicit consumer discount rates of 13%-42% with rational discount rate of 6%).

[129] *See* EPA Guidelines, *supra* note 127, at 6-1.

[130] *See* U.S. Department of Transportation, Benefit-Cost Analysis Guidance for Discretionary Grant Programs 9, 13, 30 (2018), https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/14091/benefit-cost-analysis-guidance-2018.pdf.

[131] *See* Dlouhy, *supra* note 36.

[132] *See* David Shepardson, *GM Aims to End Sale of Gasoline, Diesel-Powered Cars, SUVs, Light Trucks by 2035*, Reuters (Jan. 29, 2021), https://www.reuters.com/article/us-gm-emissions-idUSKBN29X2AY.

[133] *See* Anmar Frangoul, *Volvo Says It Will Be "Fully Electric" by 2030 and Move Car Sales Online*, CNBC (Mar. 2, 2021), https://www.cnbc.com/2021/03/02/volvo-says-it-will-be-fully-electric-by-2030-move-car-sales-online.html.

[134] *See* Dlouhy, *supra* note 36.

[135] *See* Draft TAR, *supra* note 29, at 4-32.

[136] *See* Erik Hille & Patrick Möbius, *Environmental Policy, Innovation, and Productivity Growth: Controlling the Effects of Regulation and Endogeneity*, 73 Env't Res. Econ. 1315, 1317 (2019) (reviewing literature supporting the Porter hypothesis and finding in an analysis of 14 manufacturing sectors across 28 OECD countries that "more stringent environmental regulation induces innovation").

[137] *See* Doug Obey, *Auto Sector GHG Stance Signals Ongoing Industry Split, Observers Say,* InsideEPA (Feb. 9, 2021), https://insideepa-com.proxy.library.nyu.edu/daily-news/auto-sector-ghg-stance-signals-ongoing-industry-split-observers-say.

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