Estimating the Value of Deregulating Automobile Manufacturing Using Market Prices for Emissions Credits

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Executive Summary

The Trump Administration's Safer Affordable Fuel Efficient (SAFE) Vehicles Rule gives automakers greater freedom to build and sell vehicles consumers demand. It does this by revising the standards established in 2012 that require a certain average miles per gallon (mpg) in vehicle fleets produced.

The Council of Economic Advisers (CEA) estimates that, by 2026, the SAFE Vehicles Rule will reduce the quality-adjusted price of a new vehicle by $2,200. By lowering vehicle prices, the Rule will increase the real incomes of Americans by $53 billion per year over the 2021-2029 period, making it one of the largest deregulatory actions finalized by the Trump Administration thus far. The savings from the SAFE Vehicles Rule disproportionately benefit lower income consumers, with the savings in the lowest income quintile exceeding those of the highest quintile by 66 percent.

In addition, this analysis shows that the standards set by the SAFE Vehicles Rule better align environmental benefits and compliance costs. Based on our analysis of the available information, over the 2012-2016 period, automakers paid an average of $86 for each vehicle whose lifetime carbon emissions exceeded the standard by one ton. This cost per ton is more than 70 percent larger than the estimated worldwide benefit from avoiding a ton of emissions and more than ten times higher than the benefit to the United States. As with numerous other actions taken by the Trump Administration, the revised SAFE Vehicles Rule strikes a better balance between the costs of carbon emissions and the benefits of economic growth and prosperity.

Introduction

The Safer Affordable Fuel Efficient (SAFE) Vehicles Rule revises standards that require a certain average miles per gallon (mpg) in vehicles produced. Under the SAFE Vehicles Rule, the fuel economy standards grow in stringency through 2026, but do so at a lower rate than was prescribed by prior policy.

The Council of Economic Advisers (CEA) estimates that, by 2026, the Rule will reduce the quality-adjusted price of a new vehicle by $2,200. By lowering vehicle prices, the Rule will increase the real incomes of Americans by $53 billion per year over the 2021-2029 period, making it one of the largest deregulatory actions finalized by the Trump Administration thus far.

In addition, the SAFE Vehicles Rule brings in line the costs of compliance and its environmental benefits. Over the model year 2012-2016 period, automakers paid an average of $86 for each vehicle whose lifetime carbon emissions exceeded the standard by one ton. This cost per ton is more than 70 percent larger than the estimated worldwide benefit from avoiding a ton of emissions (the social cost of carbon) and more than ten times higher than the benefit to the United States.[1] As such, the cost of the prior standards greatly surpassed the benefits. This conclusion holds even when including local health benefits of reduced fuel consumption.

The CEA's approach in this analysis assumes that the price at which automakers buy and sell credits reveals the private cost of meeting the standards, as it should incorporate both the cost of building marginally more efficient vehicles and the willingness of consumers to buy them. To estimate prices, we draw from public records of nearly $700 million in credit transactions that occurred over seven years, which provide a simple and transparent basis for our cost estimates.

The Federal Standard and Its Enforcement

Manufacturers of new vehicles sold in the United States are subject to two legally separate Federal standards: one for fuel economy (CAFE) and another for greenhouse gas (GHG) emissions. The Federal Corporate Average Fuel Economy (CAFE) standard is required by the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act, and is established by the National Highway Traffic Safety Administration at the Department of Transportation (DOT). The GHG standard stems from the Clean Air Act (CAA) and is established by the Environmental Protection Agency (EPA).

Although the CAA is older, a Federal standard for GHG emissions did not begin until model year 2012, following a Supreme Court decision determining that the EPA has the authority under the CAA to regulate GHG emissions (75 FR 25327). GHG emissions, specifically those of carbon dioxide (CO_2), are essentially proportional to fuel consumption and the two agencies coordinate their standards around

[1] The domestic social cost of carbon is used in EPA/DOT (2020) and is consistent with the guidance on regulatory analysis provided by OMB Circular A-4, which states that regulatory analysis should focus on benefits and costs accruing to citizens and residents of the United States. EPA/DOT (2012) and EPA (2017) used a global social cost of carbon.

that proportion. As a result, a decision by a manufacturer that affects the fuel economy of its fleet also affects its GHG emissions and, therefore, compliance with both standards.[2] That said, the cost of complying with each standard could differ because of standard-specific details such as compliance options, penalties, and the rules governing credits.

Manufacturers may comply with either standard by purchasing credits from manufacturers that exceed the corresponding standard (75 FR 25330).[3] Absent frictions in trading credits among manufacturers, the fleet standard is effectively a standard for the average vehicle sold in the entire market regardless of the distribution of sales among manufacturers.

We have data on the value of GHG credits but not on the value of CAFE credits. We therefore focus on the GHG standard going forward. If CAFE credits have independent value, indicating compliance costs unique to the CAFE standards, then our estimate understates the cost of jointly complying with the standards, which would be better approximated by the sum of the GHG and CAFE credit prices (Leard and McConnell 2020).

Figure 1 shows the GHG standards by model year, expressed in miles per gallon (mpg) and averaged between passenger cars and light trucks.[4] The levels shown for the SAFE Vehicles Rule are based on deviations from the levels originally reported for the 2012 Rule and hold the mix of models sold constant at the level in the 2012 final Rule.[5] To be clear, the standards do not require that every vehicle achieves the standard, only that the manufacturer's sales-weighted average vehicle achieves it (assuming no purchasing of credits).

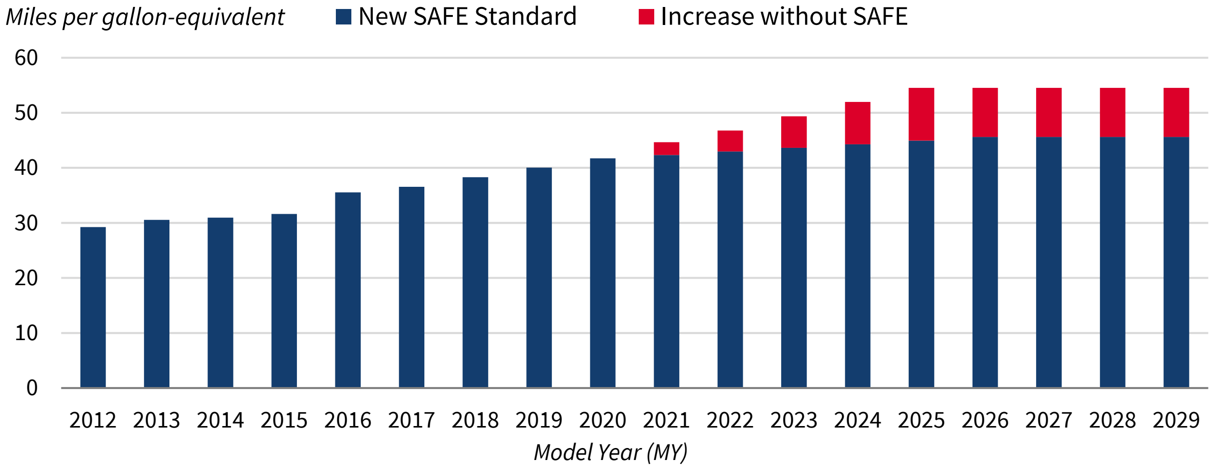
[2] A fleet is the aggregate sales of a manufacturer for a model year, separated by passenger cars and light trucks, which includes sport utility vehicles and pickup trucks.

[3] CAFE credit trading began with model year 2011 (International Council on Clean Transportation 2014) and GHG credit trading began in 2012 (Leard and McConnell 2017). Trading and the existence of two closely related standards requires a different economic analysis than appears in much of the literature that examines CAFE standards prior to 2011 (Goldberg 1998, CBO 2003, Anderson and Sallee 2011, Jacobsen 2013).

[4] Given the relationship between CO2 emissions and fuel consumption and that the two agencies coordinate their standard around the relationship, Figure 1 also approximately represents the CAFE standards for model years 2012 and following.

[5] The average mpg level associated with the 2012 Rule has changed since it was initially promulgated because of changes in underlying vehicle fleet, not because of changes in the actual standard. This is possible because the standards differ by vehicle type (i.e. passenger vehicles vs. light trucks) and footprint, so changes in the fleet can change the average mpg associated with the standard even if vehicle-specific standards have not changed. For consistency, we base our mpg levels for both rules using the fleet assumed in the original 2012 Rule. We note that this base fleet is different than what is used in EPA/DOT (2020).

Figure 1. Mpg-Equivalence of GHG Standards, MY2012–MY2029

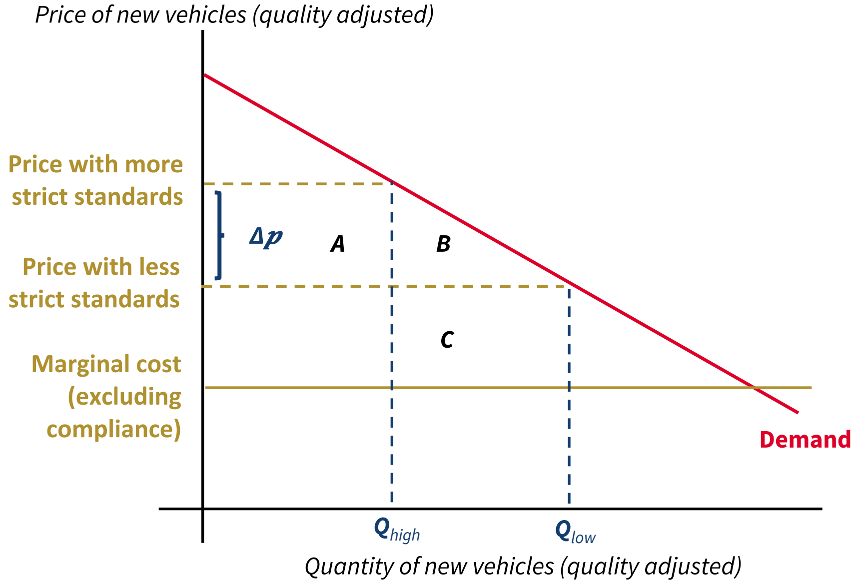


Sources: Environmental Proteciton Agency; National Highway Transit Safety Administration.
Note: SAFE = Safe Affordable Fuel Efficient Vehicles Rule.The mpg-equivalent is calculated from the required stringency of grams of carbon dioxide per vehicle-mile standards imposed by the EPA's GHG emission rules. The graph contrasts the standards of the 2012 Rule and the standards under the 2020 SAFE Rule. Standards are calculated for the combined passenger car and light truck fleets.

The Economics of Compliance

More stringent GHG standards increase quality-adjusted automobile prices. In a supply and demand diagram (Figure 2) the gold line represents the marginal cost of producing another vehicle and the red line represents consumers' willingness to pay for vehicles. The GHG standard drives a wedge between the marginal cost of producing a vehicle (excluding regulatory compliance costs) and the marginal willingness of consumers to purchase one, raising the price of the vehicle above the marginal cost of production. This increase in price is represented by Δp. As will be shown, the 2012 Rule would have increased the cost per vehicle by roughly $2,200 by model year 2026 relative to the SAFE Rule.

Figure 2. Vehicle Market Equilibrium with CAFE and GHG Standards



On average, the market complies with a tighter GHG standard by some combination of shifting sales from less fuel efficient vehicle models to more efficient ones and enhancing the fuel efficiency of each model. Compliance can be represented in an isoquant diagram (Figure 3), which represents a stylized market with just two kinds of new vehicles. The horizontal axis measures the number of high-emissions vehicles sold and the vertical axis measures the number of low-emissions vehicles sold. Along a ray from the origin, the market achieves the same average emissions and fuel economy performance, say 40 mpg, because the two types of vehicles are sold at the same proportion. A GHG/CAFE standard of 40 mpg therefore requires that the market make sales that are along or above the corresponding ray. Tightening the GHG standard requires the market to shift to the steeper ray representing fewer emissions (greater fuel efficiency).

Figure 3. Substitution Among New Vehicles in Response to Tighter GHG Standards

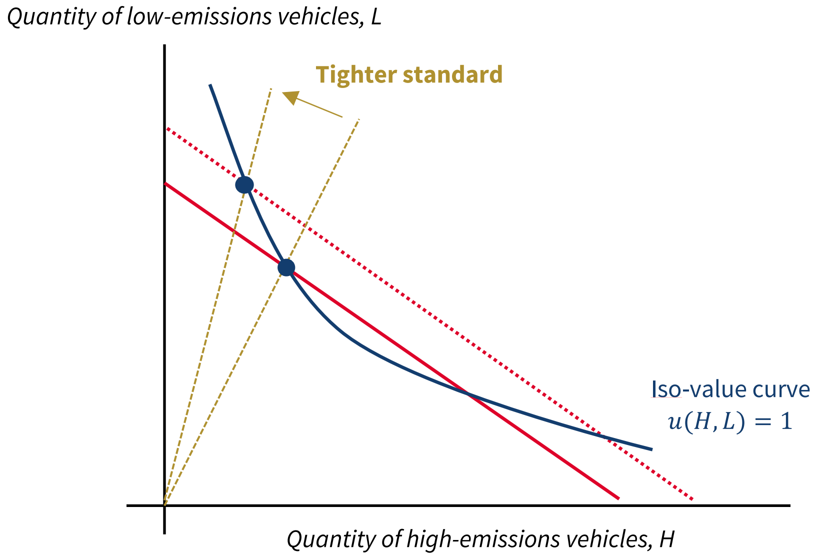


Figure 3 also has an iso-value curve that shows the combinations of vehicle sales that give consumers the same value, including the values that consumers put on fuel savings, horsepower, safety, and other attributes.[6] The iso-value curve is convex because the two types of vehicles are not perfect substitutes for each other, so inducing consumers to buy more of one type requires that its price (relative to the other type) decrease, and increasingly so as a larger shift is desired.

The straight lines in Figure 3 are iso-cost lines: the combination of sales that involve the same cost of producing all of the vehicles. The slope of the iso-cost line reveals the relative private costs of producing low-emissions vehicles as it shows how, absent regulation, the industry can substitute high-emissions vehicles for each low-emissions vehicle at the same aggregate industry cost. Shifting the iso-cost line to the right (but holding the slope constant) corresponds to greater total spending on vehicles.

Raising the GHG standard (moving to a steeper ray as shown by the gold arrow) therefore increases the cost of delivering the same value to consumers as shown by the outward shift in the iso-cost line, from the solid red line to the dotted red line. This is the same cost increase shown in Figure 2 as an addition to the wedge between price and marginal cost. Figure 3 also shows how the first increase in fuel-efficiency (moving from the blue square to the closest circle) is cheaper than later increases (moving from the closest circle to the further circle). That is, increasing the mpg standard from 40 to 41 adds a

[6] The analysis of companion Figures 2 and 3 is adapted from Chapter 18 of Jaffe et al (2019), which further explains why Laspeyres and other index number formulas used in national accounting would record the tightening of standards shown in Figure 3 as a reduction in real GDP. The standards drive up the price of H vehicles while L vehicles sell at a relative discount. As consumers shift from H to L vehicles, the latter sales contribute less in the quantity index because they are selling at a discount.

bigger wedge to Figure 2 than increasing the standard from 30 to 31.[7] The escalation of marginal costs for meeting progressively tighter regulations is relevant given the increases in the standard that have already occurred.

Revealed-Preference Estimates of Net Private Benefits and Effects on Real Income

Inferring costs and benefits based on actual firm behavior—in this case the price at which automakers buy and sell GHG credits—eliminates a great deal of guesswork. Credit prices incorporate a wealth of otherwise hard-to-observe information, such as the extra cost of building a more efficient vehicle and the willingness of consumers to pay for such vehicles. This approach, also known as a revealed preference approach, differs from much of the existing literature on the costs of CAFE and GHG standards, which examines volumes of automotive engineering data and assess consumer's driving habits, fuel-purchasing routines (including attempts to value consumer time spent pumping fuel), and decisions about when to scrap a vehicle.[8]

In the revealed preference approach, we replace engineering assumptions with economic assumptions such as cost-minimization and pass-through of costs, in which case credit prices convey the information needed to estimate the private costs and benefits of complying with the standards.[9] To the extent that manufacturers minimize the cost of producing a given model and can freely trade credits, the observed credit price is equal to the marginal cost of reducing the manufacturer's fleet-wide emissions.[10] To the extent that the cost of GHG credits is reflected in the prices consumers pay for vehicles (pass-through), the cost also reflects consumers' willingness to have vehicles with more weight or other attributes that produce additional emissions as measured by the GHG program. This includes many dimensions of consumer preferences, including the value that consumers place on fuel savings over the life of a vehicle. See the Appendix for further analysis of this point.

The costs and valuations permit quantifying the private net costs of changing the standards because the market complies with a stricter standard through some combination of changing vehicle attributes and adjusting prices to shift sales to lower-emission vehicles. These private net costs are pivotal for understanding the effects of the SAFE Vehicles Rule. Prior analyses of the standards show that private costs and benefits dwarf environmental costs and benefits (Bento et al. 2018).

[7] Note that the costs shown in Figure 3 are convex in the wedge, which itself is convex in the GHG standard. As a result, costs are even more convex in the standards.
[8] See, for example, the Regulatory Impact Analysis in EPA/DOT (2012) and EPA/DOT (2020).
[9] EPA/DOT (2016 and 2020) assume one-for-one pass through of compliance costs to consumer prices, as we do.
[10] Note that trading was quite limited in the initial years of the program, that these data are not widely available for every trade, and that some companies announced intentions to not trade even when it represented a lower cost way to comply.

GHG Credit Transaction Data

The price at which automakers buy or sell GHG credit prices is not publically available. However, because credit revenue is substantial for Tesla, it reports the revenues in its financial reports to the Securities and Exchange Commission. The reports indicate that Tesla earned $695 million in revenues (in 2018 dollars) from the sale of GHG credits from 2012 to 2018.[11] Over the same period, EPA data show that Tesla was the second largest seller of GHG credits, after Honda, since GHG credit trading began in 2012. Tesla's sales have accounted for nearly a quarter of all sales in the U.S. credit market (EPA 2019). Combined, the revenue and sales numbers suggest that roughly $3 billion in credit transactions have occurred across the industry since the GHG credit trading program began.

Using Tesla's credit sales and revenues, we calculate the average credit price over the 2012-2016 period.[12] We associate this price with the standards of the 2012-2021 period because GHG credits earned during model years 2010 through 2016 can be used through the model year 2021. Because credits can be banked and traded across automakers and fleets, all model years 2012 through 2021 are effectively a single fleet for GHG compliance purposes.[13] Focusing on the 2012-2016 price also has the advantage of being the period before President Trump's election, which would have changed expectations about the value of the credits later in the 2012-2021 period.

When calculating the credit price, we adjust Tesla's 2012-2016 credit revenues to incorporate their timing, using a 7 percent interest rate to standardize all revenues as if they were earned in 2016, which is when the industry's fleet shifted from performing above the standard and accumulating credits to performing below the standard and drawing down credits. Dividing total revenues by the quantity of credits sold over the period gives an average price of $86 per ton of CO_2 emissions, or $116 per mpg per vehicle (in 2018 dollars).[14] [15]

The $116 credit price is a lower-bound estimate of the actual average price at which Tesla sold its credits. Automakers are not required to report the timing of transactions, which complicates efforts to identify credit sales in individual years. However, automakers cannot sell credits that they do not have. Over the 2012-2016 period, at most Tesla could have sold all the credits that it earned through model

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[11] In several years, Tesla's annual SEC filing did not report revenues separately for Zero Emissions Vehicle credits and GHG credits, but this breakout is available from the company's quarterly SEC filings and was reported by Forbes (see the article "Tesla's Lucrative ZEV Credits May Not Be Sustainable"). This allows us to ensure that we are not including ZEV revenues in our GHG revenues.

[12] We note that Leard and McConnell (2018) were the first to match Tesla credit revenue with trade volumes to infer credit prices.

[13] Because the GHG standard increased in each of the years 2012-2021, we expect manufacturers to accumulate GHG credits in the early years and spend them in the later years. EPA records show this to be the case, with most manufacturers having a credit shortfall in model year 2017 (see figure 5.17 in EPA (2019)).

[14] In 2014 Kia and Hyundai forfeited credits in a settlement with the EPA, which were valued at $51 per ton (in 2018 dollars and with interest until 2016). Because the price is not based on a market transaction, we do not include it in our estimation of the 2012-2016 price.

[15] When calculating the credit price, we take into account the small number of GHG credits that Tesla sold in the Canadian GHG market and whose revenues would presumably be included in the credit revenues reported to the SEC.

year 2015, which is the quantity that we used to estimate the 2012-2016 price. If Tesla sold any less, the estimated price would be higher because the same revenue would be divided by a smaller number of credits.

The $116 price is a reasonable estimate of the industry-wide marginal compliance cost, even if manufacturers' incur transaction costs to buy and sell credits. Because its models more than comply with the standards, Tesla has no use for credits except to sell them. If facing a transaction cost, the buyer of Tesla's credits must have a compliance cost higher than the observed price in order to justify paying the transaction cost and the price of the credit. More broadly, transaction costs would create a range of per mpg costs where firms have no incentive to trade credits. This range, which encompasses the credit price, would include firms with costs above or below the price (but not above or below compliance costs plus per credit transaction costs). It is unclear, then, whether transaction costs would cause us to over or understate the marginal cost of complying with the GHG standard. As noted before, however, absent transaction costs, the GHG price clearly understates the marginal cost of complying with both standards since it ignores any compliance costs specific to the CAFE standard.

Estimating the Marginal Cost of Compliance Curve

Our credit price data and a prior study provide two relevant points that allows us to project what the market equilibrium price of credits would be for any given standard.[16] The Tesla credit data described above provide one observation on compliance costs: credits cost $116 per mpg per vehicle when the standard was about 35 mpg, the average over the 2012-2021 period.[17] The second data point is for model year 2006, for which Anderson and Sallee (2011) estimate the average marginal cost of tightening CAFE standards by one mpg to be $18 per vehicle. The CAFE standard during that year was 24.8 mpg.[18]

With two observations on compliance costs at different standards, we can project the relationship between the standard measured in miles per gallon and the marginal effect of the standard on the marginal (production and opportunity) cost of manufacturing a vehicle (Figure 4).[19] The horizontal axis measures the standard while the vertical axis measures additions to the marginal cost of each vehicle. The area under the curve measures the additional per vehicle cost of the standard. The SAFE Vehicles Rule will raise standards for 2021-2026 at a rate of 1.5 percent per year. Using fleet data from the 2012 Rule rather than the SAFE Vehicles Final Rule, the standards reach 45.6 mpg in 2026, while the 2012 Rule

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[16] CEA's theoretical analysis of models with constant elasticity of substitution between types of vehicles has shown a linear credit-supply schedule (with respect to mpg) to be a good approximation of the actual schedule, except when the standard is especially tight, in which case linear supply underestimates compliance costs. This suggests that our estimate of the marginal cost of complying with the 2012 Rule is likely conservative.

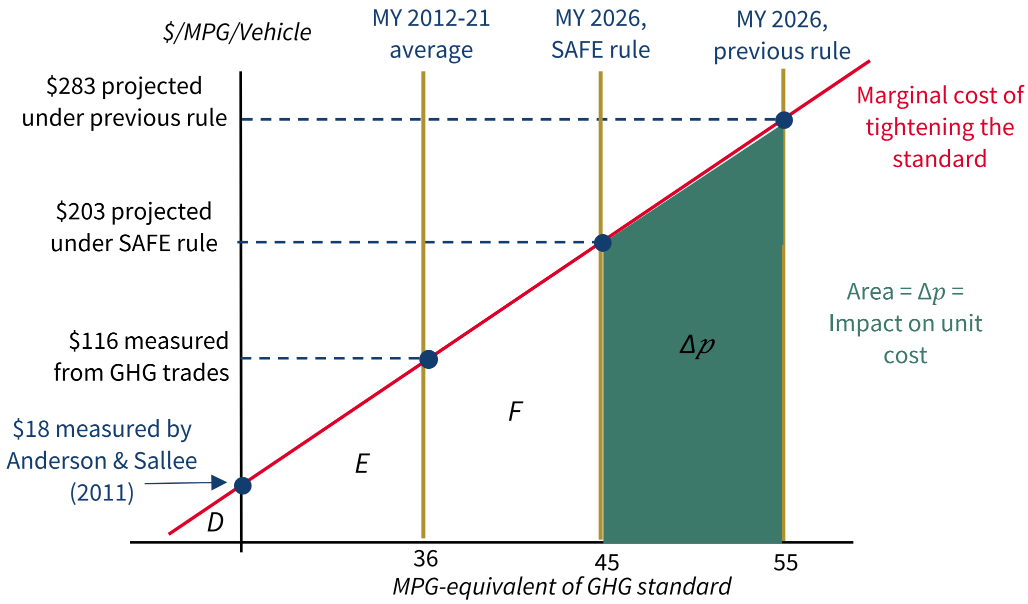
[17] Some manufacturers let credits expire in 2014, which may suggest that the standard may not have been binding at that time. However, 2009 credits could not be traded among automakers. In addition, the credits that expired were 2009 credits that could only be banked for five years, unlike credits earned in model years 2010-2016, which could be banked and used through model year 2021.

[18] Although this estimate of the marginal cost of compliance is for CAFE standards, it remains our best estimate of the cost of compliance of a GHG standard of 24.8 MPG as there was not a GHG standard at the time

[19] Figure 4 is labeled with fuel economy standards rather than emissions standards because miles per gallon are more familiar to readers than tons of GHG.

prescribed a standard of 54.5 mpg for model year 2025, which we assume will also apply to model year 2026.

Figure 4. GHG-Credit Market Equilibrium for Various Standards



Sources: EPA/NHTSA; Leard and McConnell (2017); CEA calculations.

If going from 24.8 to 35.8 mpg increased the marginal cost of tightening the standard from $18 to $116, then the marginal cost of further increasing the standard must be greater than $116. From the linear credit-supply assumption, CEA projects that the credit price would be $203 per mpg for model year 2026 under the standards established in the SAFE Vehicles Rule (a standard of 45.6 mpg) as compared to about $283 per mpg for model year 2026 under the tighter standard originally put in place by the 2012 Rule (a standard of about 54.5 mpg). For each year of the 2021-2029 period, we use the average of the two marginal costs, which can then be multiplied by the mpg difference in the standards to give the per vehicle savings from the SAFE Rule. The resulting value is equivalent to the green area in Figure 4.

Further Discussion of Assumptions

CEA does not make explicit assumptions about technological trends, fuel prices, or other factors that could affect the costs and benefits of a standard. Because credits can be saved and sold later, their current value depends on expectations about their future value. Manufacturers will hold credits if they expect them to gain value in the same way that an investor would buy and hold a commodity expected to rise in price. Credit prices over the 2012-2016 period, therefore, reflect longer-term expectations about the supply and demand of credits, which in turn depend on evolving consumer preferences, expectations about future fuel prices, and prospects for technological change, among other factors.

A shift in preferences towards more efficient vehicles, for example, would cause manufacturers to make and sell more compliant vehicles, reducing the demand for credits and increasing their supply. In the extreme, if consumers had a sufficient willingness to pay for compliant vehicles, the standard would not bind and credit prices would be zero. Higher fuel prices would have a similar effect—sufficiently high prices would increase consumers' willingness to pay higher prices for more efficient vehicles, causing manufacturers to produce them even in the absence of standards.

Similarly, technological change could make it easier to comply via manufacturing vehicles with higher fuel efficiency rather than via purchasing credits. If the cost of improving efficiency declines over time, it will lower the expected future price of credits by incentivizing compliance via manufacturing. The lower expected future price, in turn, will make manufacturers want to sell credits in the present, thus lowering their prices. Actual preferences, fuel prices, and technology in the 2020s could differ from expectations held by manufacturers in the 2012-2016 period. CEA's estimates of the cost of more stringent standards should be viewed as conditional on expectations held at the time that credit prices were observed.

CEA also does not assume that credit markets are characterized by perfect competition, where no single automaker can affect the credit price. An automaker who is a net buyer of credits could seek to lower the credit price by reducing the emissions of its fleet, and therefore the market demand for credits. This would cause the market credit price to fall below the automaker's marginal cost of compliance through manufacturing. A similar divergence (but different in sign) would occur for a net seller who changes its fleet's emissions to increase the credit price. The average automaker, however, is neither a net buyer nor a net seller of credits over the full period. The market price of credits therefore remains a good estimate of the sales weighted average marginal cost, which is the cornerstone of our analysis. It is an unbiased estimate of the average marginal cost if vehicle sales are uncorrelated with positions taken in the credit market. It would be a conservative estimate if larger manufacturers were net buyers, in which case the credit price would be less than the average marginal cost.

The estimates of private costs based on revealed preference assume that consumers understand fuel savings and other attributes of fuel efficient vehicles as well as the offsetting costs of reduced vehicle safety and higher purchase prices. The estimates do not incorporate costs or benefits not directly borne by consumer or producers such as those related to GHG emissions.

Findings for Aggregate Private Costs, Automobile Prices, and Real Income

CEA estimates that Figure 2's areas A, B, and C represent $26 billion per year in costs to new automobile consumers and producers. Relative to the SAFE Vehicles Rule, the 2012 Rule results in roughly 300,000 fewer new vehicles delivered to consumers every year at a similar total cost, including fuel costs and opportunity costs of vehicle features.

The rectangular area A accounts for the largest portion and is the product of the number of vehicles sold and the effect of changing the standards on costs per vehicle. The marginal cost of compliance curve shown in Figure 5 allows us to calculate the per vehicle cost of the 2012 Rule (for model year 2025) relative to the cost the SAFE Vehicles Rule. Doing so indicates that phasing in the higher standard would eventually increase average quality-adjusted prices by about $2,200.[20] For the years 2021-2029, the average annualized quality-adjusted price increase would be about $1,600. This amount corresponds to Δp in Figure 2.[21]

Applying the $1,600 average annual savings to the more than 16 million new vehicles sold annually in the United States gives an annualized average increase in consumer benefits of $25 billion each year for model years 2021-2029, equivalent to the area A in Figure 2.[22]

Figure 2's areas B and C are also part of the cost of increasing the standards. Estimating them requires an estimate of the impact of increasing the standards on vehicle sales. To identify the new quantity of vehicles sold annually, CEA uses a price elasticity of demand for new vehicles of -0.4 (Berry, Levinsohn, and Pakes 2004), model-year specific increments to vehicle costs (derived as above) relative to the average 2018 vehicle sales price, and model-year specific projections of vehicle sales.[23] The sales impact is roughly 300,000 vehicles per year, which makes area B about $0.3 billion per year. The area C requires an estimate of the effect of the SAFE Vehicle Rule standards, relative to no standards, on per vehicle costs. This baseline private cost per vehicle is shown in Figure 4 as the areas D, E, and F. Applying it to the change in vehicle sales gives an estimate of Figure 2's area C at about $0.4 billion per year.

Because the emissions and fuel-efficiency requirements are imposed on the supply chain rather than on the final consumer, it follows from the pass-through assumption that costs of the regulation are reflected in consumer prices. The $26 billion in annual private costs in the market for vehicles is therefore measured as a productivity loss in the sense that the economy produces less private value when assessed at market prices, using the same factors of production (capital and labor).

The productivity loss is experienced by market participants who supply less capital in the long run and less labor in the short run.[24] This means even less real income and, to the extent that factor markets are distorted by taxes, additional private costs. Using a marginal cost of public funds of 0.5, the decline in labor and capital supplied adds $13 billion in private cost (0.5 x $26 billion). If the full market value of the factors supplied is considered, assuming a marginal tax rate of 0.48 (CEA 2019), the total GDP loss in factor markets is about $27 billion ($13 billion / 0.48).

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[20] To the extent that compliance with tighter standards is achieved entirely by adding or changing model designs in ways that reduce emissions and increase fuel economy without other perceptible effects on consumers' valuation of the vehicles, the average price increase is the same as the average quality-adjusted price increase.
[21] If we assume a flat $116 per mpg per vehicle in compliance costs, the SAFE Rule saves consumers $1,032 per car, which is similar to the EPA/DOT (2020) RIA estimate.
[22] We use a 7 percent real discount rate for the purposes of annualizing ten-year cost profiles. All of the dollar amounts are in 2018 dollars.
[23] The average vehicle price is from the Kelley Blue Book. Model year 2020-2029 sales forecast are from Table VI-189 of EPA/DOT (2020).
[24] We adopt the "balanced growth" assumption that productivity has income and substitution effects on labor supply that offset in the long run. As people earn more they demand more leisure (the income effect) but rising wages has the opposite effect by increase the value of work relative to leisure, which encourages more work and less leisure (the substitution effect).

In total, the higher standards reduce real income and GDP by $53 billion per year ($26 billion in the regulated market and $27 billion in factor markets), about 0.3 percent.[25] This makes the SAFE Vehicles Rule one of the single most impactful deregulatory actions that the Trump Administration has finalized thus far (CEA 2019).

Standards that Strike a Better Balance

The SAFE Vehicles Rule is a good example of the Trump Administration's regulatory approach that strikes a better balance between the incremental costs and benefits of regulation. Building a vehicle that complies with a binding emission standard is more costly than building a non-compliant vehicle. Holding vehicle quality constant, the higher costs of manufacturing must be weighed against the social benefit of less emissions or other social benefits or costs.

Prior to deregulation, transactions in GHG credit markets show that emissions standards for vehicles cost the private sector roughly $86 per ton (converted to 2018 dollars) of GHG emissions avoided over the life of the vehicle.[26] According to the 2016 Technical Support Document for the Proposed Determination of the 2022-2025 standards, the global economic cost from emissions released in 2020 was $50 per ton in 2018 dollars (EPA 2016). The SAFE Vehicles Regulatory Impact Analysis uses a $7 domestic damage from emissions in 2020 (EPA/DOT, 2020) as required by EO 13783 and Circular A-4. Lowering emissions standards should therefore strike a better balance between the marginal cost of reducing greenhouse gas emissions and the marginal social (and in this case global) benefit of those reductions.

The balance is illustrated in Figure 5, which shows the net private and social costs of fuel efficiency standards. The approximate cost includes the cost of manufacturing more efficient vehicles as well as the global cost from greater GHG emissions and the health cost from burning more fuel. Increasing the fuel efficiency standard by one mpg leads to higher compliance costs and reduces GHG and particulate emissions over the lifetime of the vehicle. Less fuel consumption also reduces particulate emissions, leading to health benefits.[27]

We do not include private fuel savings or the private value of a vehicle's safety attributes, which should already be reflected in the credit prices used to determine the private cost of compliance. This is because the value that consumers place on fuel savings affects their willingness to pay for a more

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[25] As with many of the other regulations that CEA has analyzed previously (CEA 2019), the SAFE Vehicles Rule has an effect on real income whose dollar amount significantly exceeds the dollars of net (private and social) benefits. This is primarily because net benefits account for opportunity costs—for example, the value of leisure if not working—while real income does not.

[26] In contrast, reforestation can reduce carbon in the atmosphere for $10 (Gillingham and Stock 2018).

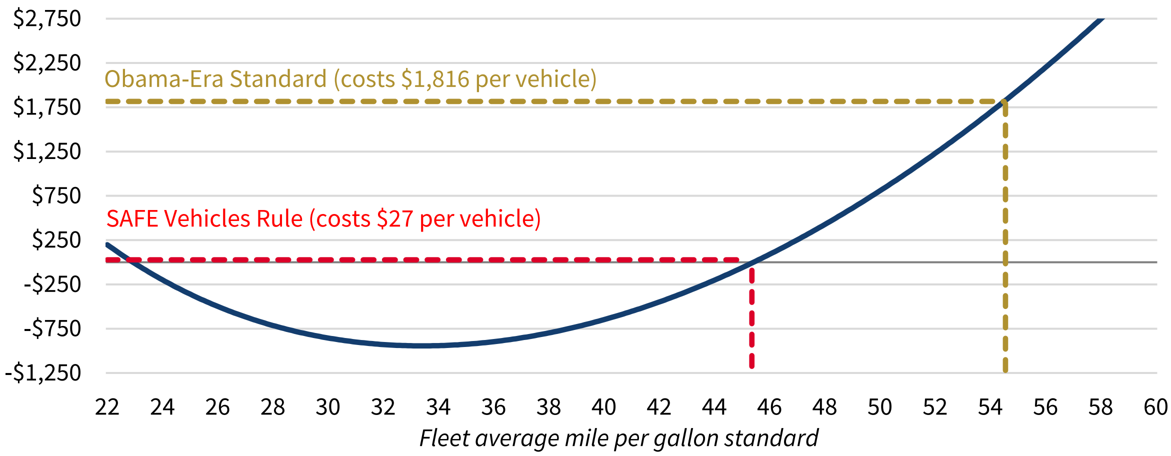
[27] For both environmental and health benefits, we assume values that underscore the conclusion that the SAFE Rules generates benefits in excess of cost over a range of assumptions. For GHG emissions, we use the global benefit from emissions reductions. For health benefits from burning less fuel, we use values from EPA (2016), which are larger than those in the SAFE Rule Regulatory Impact Analysis.

efficient vehicle and, therefore, whether automakers prefer to build vehicles that are more efficient or instead buy more credits.[28]

As shown in Figure 5, the 2012 Rule had a fleet standard of 54.5 miles per gallon, which results in consumer costs that exceed global environmental benefits by around $1,800 per vehicle. However, the SAFE Vehicles Rule standard of 45.6 miles per gallon balances environmental and health benefits with consumer costs.

Figure 5. Private and Social Cost of Emissions Standards

Private and social cost of emissions standards relative to no standard (dollars per vehicle)



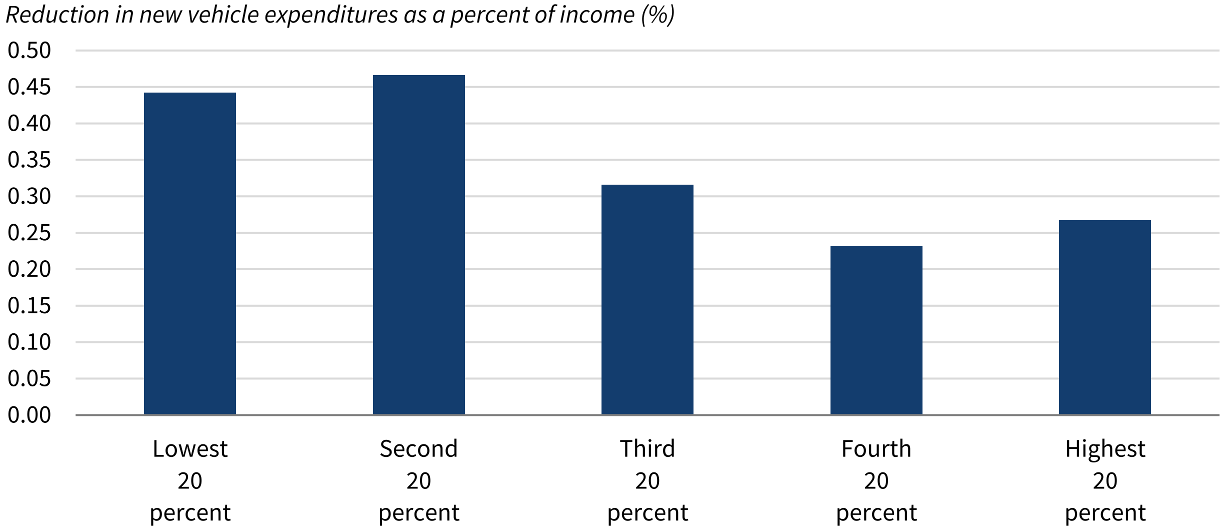
Sources: Environmental Protection Agency; National Highway Transit Safety Administration; CEA calculations.
Note: Costs per vehicle are relative to a non-binding 23 MPG-equivalent fleet GHG standard. Lifetime MPG-equivalents are calculated assuming a lifetime VMT of 195,264 miles and 0.008887 MT of carbon dioxide per gallon of gasoline. A value of $50 is used for the social cost of carbon. Non-GHG health benefits are $0.095 per gallon and are based on EPA (2016).

The Distribution of Savings among Consumers

The estimated $26 billion in consumer savings from the SAFE Vehicles Rule can be distributed among different household income groups. We allocate the savings across income quintiles based on each quintile's share of aggregate spending on new vehicles as reported in the Consumer Expenditure Survey. Figure 6 depicts the savings as a percentage of the post-tax income of each group. The savings from the SAFE Vehicles Rule disproportionately benefit lower income consumers, with the savings in the lowest income quintile exceeding those of the highest quintile by 66 percent. This is because a larger share of the post-tax income of lower income consumers goes towards the purchase of new vehicles.

[28] In a similar manner, credit prices should also capture the private value of a vehicle's safety attributes to the extent that more fuel efficient vehicles have different safety attributes than less efficient vehicles. That is, if greater fuel efficiency is associated with less safety, it will reduce consumer willingness to pay for such vehicles, thereby affecting the supply and demand of credits. Damages inflicted upon others in an accident may also be captured if liability insurance premiums (paid by the vehicle owner) are correlated with the expected damages that a vehicle model would inflict on others in an accident. We also exclude energy security benefits from reduced fuel consumption. With the United States now exporting as much oil and petroleum products as it imports, the benefits of marginal reductions in domestic oil consumption are unclear.

Figure 6. Consumer Savings from the SAFE Vehicles Rule as a Percent of Income, by Household Income Group



Sources: Consumer Expenditure Survey; CEA calculations.

Conclusion

This Report concludes that the SAFE Vehicles Rule will lead to $26 billion in consumer savings while appropriately balancing the costs and benefits of vehicle fuel economy and greenhouse gas.

Nearly $700 million in GHG credit transactions reveal the price that automakers were willing to pay for permission to produce and sell one vehicle with lifetime emissions one ton in excess of the standard. These transactions give an average price of $86 per ton for the period 2012-2016. The price indicates that the 2012-2021 standards cost automakers and consumers far more than the environmental benefits that would result from burning less fuel. This cost is 70 percent higher than even the estimated worldwide damages from a ton of carbon emissions and ten times higher than the domestic damages from a ton of carbon emissions. The Trump Administration's SAFE Vehicles Rule will strike a better balance between total costs and benefits than did prior policy.

Using this valuation, we estimate that the more gradual increase in the standards under the SAFE Vehicle Rule will reduce prices for consumers by almost $2,200 per vehicle by 2026. Over the 2021-2029 period, the Rule will increase GDP and the real incomes of Americans by $53 billion per year, making it one of the single most impactful deregulatory actions finalized by the Trump Administration thus far.

References

Allcott, H., and N. Wozny. 2014. "Gasoline Prices, Fuel Economy, and the Energy Paradox." *Review of Economics and Statistics* 96, no. 5: 779–95

Anderson, S., and J. Sallee. 2011. "Using Loopholes to Reveal the Marginal Cost of Regulation: The Case of Fuel-Economy Standards." *American Economic Review* 101, no. 4: 1375-1409.

Bento, A., K. Gillingham, M. Jacobsen, C. Knittel, B. Leard, J. Linn, V. McConnell, D. Rapson, J. Sallee, A. van Benthem, and K. Whitefoot. 2018. "Flawed Analyses of U.S. Auto Fuel Economy Standards." *Science* 362, no. 6419: 1119-21.

Berry, S., J. Levinsohn, and A. Pakes. 2004. "Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Car Market." *Journal of Political Economy* 112, no. 1: 68-105.

Busse, M., C. Knittel, and F. Zettelmeyer. 2013. "Are Consumers Myopic? Evidence from New and Used Car Purchases." *American Economic Review* 103, no. 1: 220–56.

CEA (Council of Economic Advisers). 2019. "The Economic Effects of Federal Deregulation since January 2017: An Interim Report." https://www.whitehouse.gov/wp-content/uploads/2019/06/The-Economic-Effects-of-Federal-Deregulation-Interim-Report.pdf.

Dahlby, B. 2008. *The Marginal Cost of Public Funds: Theory and Applications*. Cambridge, MA: MIT Press.

EPA (Environmental Protection Agency). 2013. "Greenhouse Gas Emission Standards for Light-Duty Automobiles: Status of Early Credit Program for Model Years 2009-2011." https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100G858.txt.

---. 2016. "Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation: Technical Support Document." https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100Q3L4.pdf.

---. 2017. "Final Determination on the Appropriateness of the Model Year 2022-2025 Light-duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation." https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100QQ91.pdf.

---. 2019. "The 2018 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975." https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YVK3.pdf.

EPA/DOT (Environmental Protection Agency and Department of Transportation). 2012. "Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards." https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EZI1.PDF?Dockey=P100EZI1.pdf.

---. 2018. "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks. Preliminary Regulatory Impact Analysis." https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/ld_cafe_my2021-26_pria_0.pdf.

---. 2020. "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks. Final Regulatory Impact Analysis."

https://www.epa.gov/regulations-emissions-vehicles-and-engines/safer-affordable-fuel-efficient-safe-vehicles-final-rule.

Gillingham, K., and J. Stock. 2018. "The Cost of Reducing Greenhouse Gas Emissions." *Journal of Economic Perspectives* 32, no. 4:53-72.

Goldberg, P.K. 1998. The Effects of the Corporate Average Fuel Efficiency Standards in the US. *The Journal of Industrial Economics* 46, no. 1:1-33.

Haveman, R., and B. Weisbrod. 1975. "Defining Benefits of Public Programs: Some Guidance for Policy Analysts." *Policy Analysis* 1, no. 1: 169–96.

International Council of Clean Transportation. 2014. *The State of Clean Transport Policy*. https://theicct.org/sites/default/files/publications/ICCT_StateOfCleanTransportPolicy_2014.pdf.

Jaffe, S., R. Minton, C. Mulligan, and K. Murphy. 2019. *Chicago Price Theory*. Princeton: Princeton University Press.

Jacobsen, M. 2013. "Evaluating US Fuel Economy Standards in a Model with Producer and Household Heterogeneity." *American Economic Journal: Economic Policy* 5, no. 2: 148-87.

Leard, B., and V. McConnell. 2017. "New Markets for Credit Trading under US Automobile Greenhouse Gas and Fuel Economy Standards." *Review of Environmental Economics and Policy* 11, no. 2: 207-26.

Leard, B., and V. McConnell. 2020. *Interpreting Tradable Credit Prices in Overlapping Vehicle Regulations.* Resources for the Future Working Paper 20-07. https://www.rff.org/documents/2419/WP_Leard_McConnell_4-20.pdf.

OMB (Office of Management and Budget). 2003. "Circular A-4, Regulatory Analysis." https://www.federalregister.gov/documents/2003/10/09/03-25606/circular-a-4-regulatory-analysis.

Sallee, J., S. West, and W. Fan. 2016. "Do Consumers Recognize the Value of Fuel Economy? Evidence from Used Car Prices and Gasoline Price Fluctuations." *Journal of Public Economics* 135: 61–73.

Appendix

Credit prices should reflect the value that consumers place on fuel savings, with greater preferences for fuel savings leading to lower credit prices. This is because a shift towards buying fuel efficient vehicles reduces the demand for credits by increasing average fleet performance.

Formally, let q denote a vector of market quantities of vehicle models, which differ in many characteristics including fuel consumption. The GHG and CAFE standards affect quantities, including setting some of to zero as vehicle models leave the market and moving others off of zero as new models enter. Let p, c, and g denote the corresponding vectors of retail prices, marginal production costs, and GHG emissions, respectively. The one-for-one pass through assumption relates retail prices to marginal costs:

$$p = \mu + c + (g - G)\lambda$$

where G and λ are scalars denoting the emissions standard and the equilibrium price of a GHG credit and μ is a vector of markups that, by the pass-through assumption, are independent of the GHG standard. The market price λ of a GHG credit and the retail prices p of vehicles are related but are conceptually distinct: the costs of acquiring GHG credits to bring a model into compliance are passed through to consumers in the form of higher retail prices.

If the GHG standard is binding and dot indicates vector dot product, then $g \cdot q = Gq$, which means that specific vehicles can deviate from the standard but the market sales-weighted average emissions does not. The standard G has a retail price effect that varies across vehicles:

$$\frac{dp}{dG} = -\lambda + (g - G)\frac{d\lambda}{dG}$$

Observe that the first term is a scalar that is common across vehicles. The sales-weighted retail price impact is simply that scalar:

$$\frac{q \cdot \frac{dp}{dG}}{q \cdot 1} = -\lambda + q \cdot (g - G)\frac{\frac{d\lambda}{dG}}{q \cdot 1} = -\lambda$$

where $q \cdot 1$ denotes the total quantity summed across vehicles. We have therefore found the average retail price effect of marginal changes in the standard without assuming anything about the features of consumer demand for vehicles. Moreover, the average price effect of a stricter standard (lower G) is exactly the credit price λ.

Of course, consumers care not only about the retail prices p but also fuel economy f (also a vector). But the GHG and CAFE standards have no effect on f, rather they affect the quantities associated with f. So we have:

$$\frac{q \cdot \frac{d(p + f)}{dG}}{q \cdot 1} = -\lambda$$

In words, the sales-weighted average marginal effect of the standard on full prices (purchase plus fuel) is given by the credit price λ.

These results can also be described in terms of price indexes: the purchase price index and the full price index for vehicles each falls by λ when the GHG standard is relaxed. This is exactly what is required by the usual (and theoretically grounded) national accounting standards, with no additional fuel-cost term, for calculating real GDP effects and private net benefits.

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