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JULY 2016

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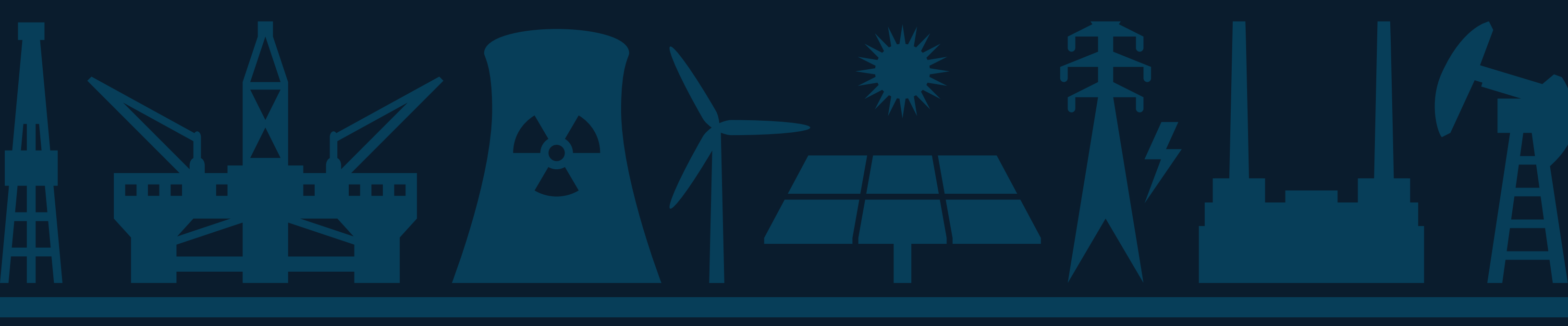

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This policy paper represents the research and views of the authors. It does not necessarily represent the views of the Center on Global Energy Policy. The paper may be subject to further revision. This paper is also available on the Resources for the Future website, www.rff.org.

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EXECUTIVE SUMMARY

Fuel economy standards lie at the center of US efforts to reduce oil consumption and greenhouse-gas emissions. In 2010, the Environmental Protection Agency (EPA) and Department of Transportation (DOT) set standards for model years 2012 through 2016. The fuel economy requirement that manufacturers have to achieve depends on the size of the vehicles they sell, whereas previous standards set uniform requirements for cars and light trucks. Because of the new structure, the level of fuel economy required by the standards depends on the proportion of cars to light trucks sold, as well as the size of those vehicles. If sales shift from smaller to larger vehicles, the required level of fuel economy decreases. In addition, because manufacturers achieve an average level of fuel economy across their fleet, the fuel economy of a specific vehicle can differ from its standard. Changes in sales mix can, therefore, affect the level of fuel economy required from the standards differently from the level of fuel economy that consumers choose.

While fuel prices remained relatively high and stable between 2012 and mid-2014, they began declining sharply in the summer of 2014. This paper examines the effect of lower fuel prices between June 2014 and August 2015 on consumer purchases of new vehicles. Accounting for changes in sales within the car and light truck classes and across classes, we estimate the effects of the decline in fuel prices on the level of fuel economy required by the standards as well as on the level of fuel economy that consumers choose.

Over the study period, low fuel prices had only a modest effect on the required level of fuel economy. If that finding continues past the study period, then low fuel prices will not substantially undermine the fuel consumption goals of the regulating agencies. However, low fuel prices cause the level of fuel economy chosen by consumers to decline more than the fuel economy requirement. Automakers have to make up the difference, which raises the cost of complying with the regulations.

Gasoline prices have continued to decline since the end of the study period, and in the future we intend to extend our analysis by analyzing this decline. Also, we did not examine the extent to which fuel economy standards were achieving the fuel consumption and emissions goals that policymakers stated when the rules were first finalized. This is a separate but important question because of the standards' role in meeting the US commitment to reduce greenhouse gas emissions and reduce the costs of climate change.

INTRODUCTION

Passenger vehicles account for almost half of domestic oil consumption and a large share of US greenhouse gas emissions, and the United States has pledged to reduce its greenhouse gas emissions by about one quarter between 2005 and 2025. The Environmental Protection Agency (EPA) and Department of Transportation (DOT) jointly administer new vehicle fuel economy and greenhouse gas standards, which are designed to roughly double new vehicle fuel economy and cut transportation sector greenhouse gas emissions by 20 percent by 2025.

By April 2018, the regulatory agencies will review and finalize the regulations through 2025, and they could raise or lower the standards in addition to making other changes to the program. Prior to this review, in the second half of 2014, crude oil prices decreased suddenly and sharply. Petroleum product prices follow crude oil prices closely, and between June 2014 and June 2015, the average US price of gasoline declined by almost 25 percent, from $3.77 to $2.89 per gallon; by April 2016, the price had fallen to $2 per gallon.

The fuel economy standards have been politically fraught, and the recent drop in oil and gasoline prices has only added to the controversy. On one hand, lower gasoline prices could undermine the fuel savings from the standards. This is because the overall stringency of the standards depends on the composition of vehicle sales; fuel economy requirements for smaller vehicles are higher (i.e., stricter) than for larger vehicles. Because lower gasoline prices may cause consumers to shift to larger vehicles (which are subject to weaker standards) and drive more (because lower gasoline prices reduce the cost of driving), tighter standards would be needed to help the United States meet international climate pledges. On the other hand, low gasoline prices will make it costlier for manufacturers to meet the current standards because consumers will be less willing to pay for higher fuel economy. As a result, manufacturers will have to adopt additional fuel-saving technologies or further reduce prices of high fuel economy vehicles to meet the standards, reducing short-term profits. Automakers have argued that the standards should be relaxed because of the higher costs of meeting them.[1]

The recent decrease in gasoline prices raises two questions. First, have lower prices reduced the overall level of fuel economy that the manufacturers must attain? Lower gasoline prices have caused consumers to shift from cars to light trucks and toward larger vehicles within these classes, and some observers have claimed that low gasoline prices have undermined, by as much as one-third, the fuel economy gains that manufacturers were initially expected to attain through tighter fuel economy requirements. The second question is: Have lower gasoline prices caused the level of fuel economy consumers choose to fall (perhaps temporarily) below the level manufacturers must attain? This could happen if consumers shift across vehicles subject to the same standard but with lower actual fuel economy, for example, if they opt for the version of a vehicle with a six-cylinder engine rather than a four-cylinder engine. The six-cylinder version has lower fuel economy, but because the two vehicles are the same size, they are subject to the same fuel economy requirement. If consumers shift to vehicles with lower fuel economy but the same size they would have chosen otherwise, the costs to manufacturers and eventually to consumers of meeting the standards would be higher because manufacturers have to add fuel-saving technology or adjust relative vehicle prices.

As a result of our analysis of the new vehicles market, we observed two effects. First, the decline in fuel prices between June 2014 and August 2015 reduced the average fuel economy of new vehicles sold by about 0.3 miles per gallon (mpg) relative to what fuel economy would have been if gasoline prices had remained at 2014 levels, which offsets about 14 percent of the fuel economy increase that occurred between 2011 and 2014.[2] Second, low fuel prices over the same period induced consumers to shift toward larger vehicles that are subject to lower fuel economy requirements. Although fuel economy requirements increase steadily over time, this shift in consumer purchases toward larger vehicles reduced by 0.1 mpg the level of fuel economy that manufacturers must attain. The fact that the decrease was relatively small mitigates concerns that low fuel prices will substantially undermine the fuel economy gains of the standards, at least in the short run.

The fuel economy that consumers chose between mid-2014 and mid-2015 fell by more than did the level of fuel economy manufacturers had to attain over that same period because consumers had a fair amount of choice across vehicles with similar footprint. Consequently, they could respond to low fuel prices partly by choosing vehicles with lower fuel economy but similar footprint compared with the vehicles they would have chosen if fuel prices had remained high; in the preceding example, the four-cylinder and six-cylinder vehicles are subject to the same fuel economy requirement, but the six-cylinder has lower fuel economy. This substitution causes average fuel economy to decline by more than the fuel economy standards that manufacturers must attain, which imposes a cost on manufacturers because they have to make up the difference. We estimate that this effect raises the costs of meeting the standards by $35 per vehicle in 2015, or $555 million for the entire market. Note that this effect is independent of the fact that lower fuel prices reduce consumer benefits of higher fuel economy.

OVERVIEW OF US FUEL ECONOMY STANDARDS

After phasing in during the late 1970s and early 1980s, new vehicle fuel economy standards changed very little for about two decades. The first standards were applied in 1978, and from the mid-1980s until 2012, the fuel economy standard for cars was about 27.5 mpg. From the mid-1980s through 2004, the fuel economy standard for light trucks was about 20 mpg and then began increasing by about 0.5 mpg per year until 2011. Since 2011, fuel economy standards for both cars and light trucks have been increasing and will continue to increase through 2025. The EPA projects that by 2025, the average fuel economy of new vehicles will be double the average fuel economy in 2005. (The doubling does not account for EPA crediting provisions, such as for plug-in electric vehicles or air-conditioning improvements, which effectively reduce actual fuel economy requirements.)

To place the current standards in historical context, Figure 1 plots the car and light-truck standards since the inception of the fuel economy program. The EPA standards are denominated in emissions of carbon dioxide (CO2) per mile traveled, whereas the DOT standards are in mpg. Vehicles with high fuel economy have low CO2 emissions rates, and the agencies have attempted to harmonize the standards so they require roughly similar but not necessarily identical levels of fuel economy. To illustrate the relationship between the EPA and DOT standards, we convert the DOT standards from mpg (i.e., fuel economy) to gallons per one hundred miles (fuel consumption rate), so that higher fuel economy implies lower fuel consumption rates. The figure shows that the standards for both cars and trucks were essentially flat from the 1980s through the mid-2000s, after which the standards for both types of vehicles have become more stringent (i.e., lower). Consistent with the harmonization of the standards, the EPA emissions rates and the DOT fuel consumption rates fall at about the same pace from 2012 to 2025.

Figure 1: Fuel economy and carbon dioxide emissions rate standards since 1978

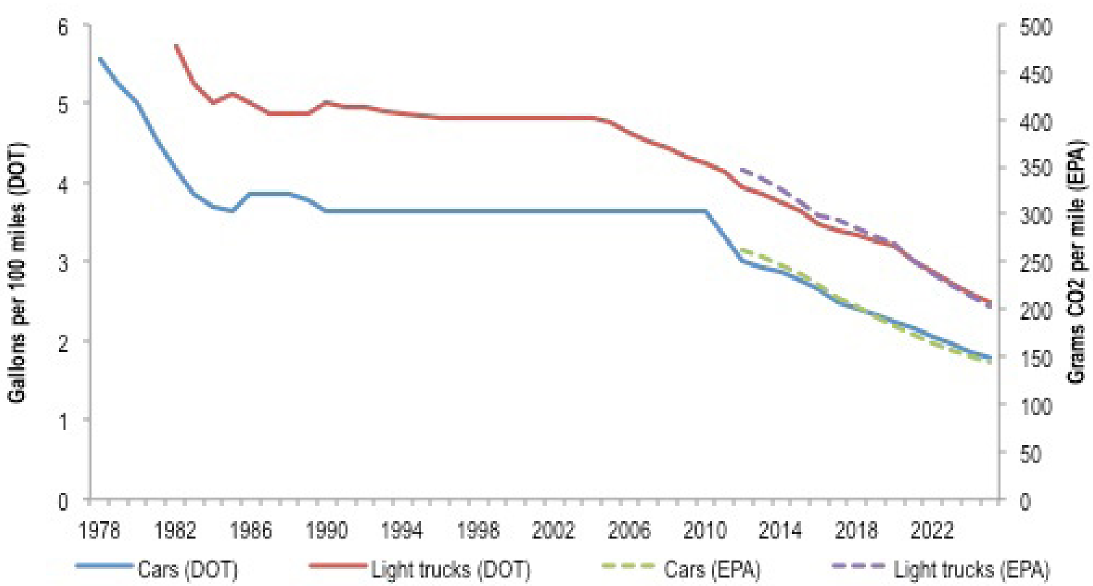

Figure 1: The chart plots Department of Transportation (DOT) and Environmental Protection Agency (EPA) standards for fuel economy and carbon-dioxide(CO2) emissions rates. The DOT standards are expressed in gallons per hundred miles, which is inversely proportional to fuel economy in miles per gallon. The CO2 standards are expressed in grams of CO2 per mile.

From the inception of the fuel economy standards until about 2011, there was one standard for cars and another for light trucks. Each manufacturer had to meet the standard on average for its fleet of cars and light trucks. (Previously, there was also a distinction between imports and domestic production.) The standards changed with the 2012 regulations, and the stringency now varies with a vehicle's size or footprint, where the footprint is roughly the area defined by the vehicle's four wheels. Vehicles with a smaller footprint have stricter fuel economy requirements. For example, the Toyota Camry has a footprint of about 47 square feet and its 2016 fuel economy requirement is about 36 mpg. The Nissan Altima is slightly smaller, with a footprint of 45 square feet, and its fuel economy requirement is higher, at 38 mpg. Light trucks also are subject to a footprint standard, but the requirements are less stringent than for cars. Each manufacturer has to achieve a level of fuel economy that is the sales-weighted harmonic average of the fuel economy requirements for its individual vehicles.[3] Manufacturers may accumulate credits for overcompliance and bank them for use in future years or sell them to other manufacturers that undercomply. Footprint-based standards may serve two purposes. First, they can reduce the distributional effects of the standards on different manufacturers. Second, they can prevent adverse safety consequences if manufacturers would otherwise reduce vehicle size and weight to meet the standard or if consumers would shift to smaller vehicles.

Figure 2 plots each vehicle's 2016 fuel economy requirement (red) and actual 2011 fuel economy (blue) against its footprint. Of course, vehicles in 2011 were not subject to the 2016 fuel economy requirements, but the figure indicates how much pressure the standards placed on the manufacturers to increase fuel economy between 2011 and 2016. The red boxes show that, in the middle of the footprint range, the fuel economy requirement decreases with footprint, but at the extremes, the fuel economy requirement is independent of fuel economy. The blue boxes show that the actual fuel economy of nearly all vehicles was well below the 2016 requirement.

Figure 2: 2011 fuel economy and 2016 standard vs. footprint

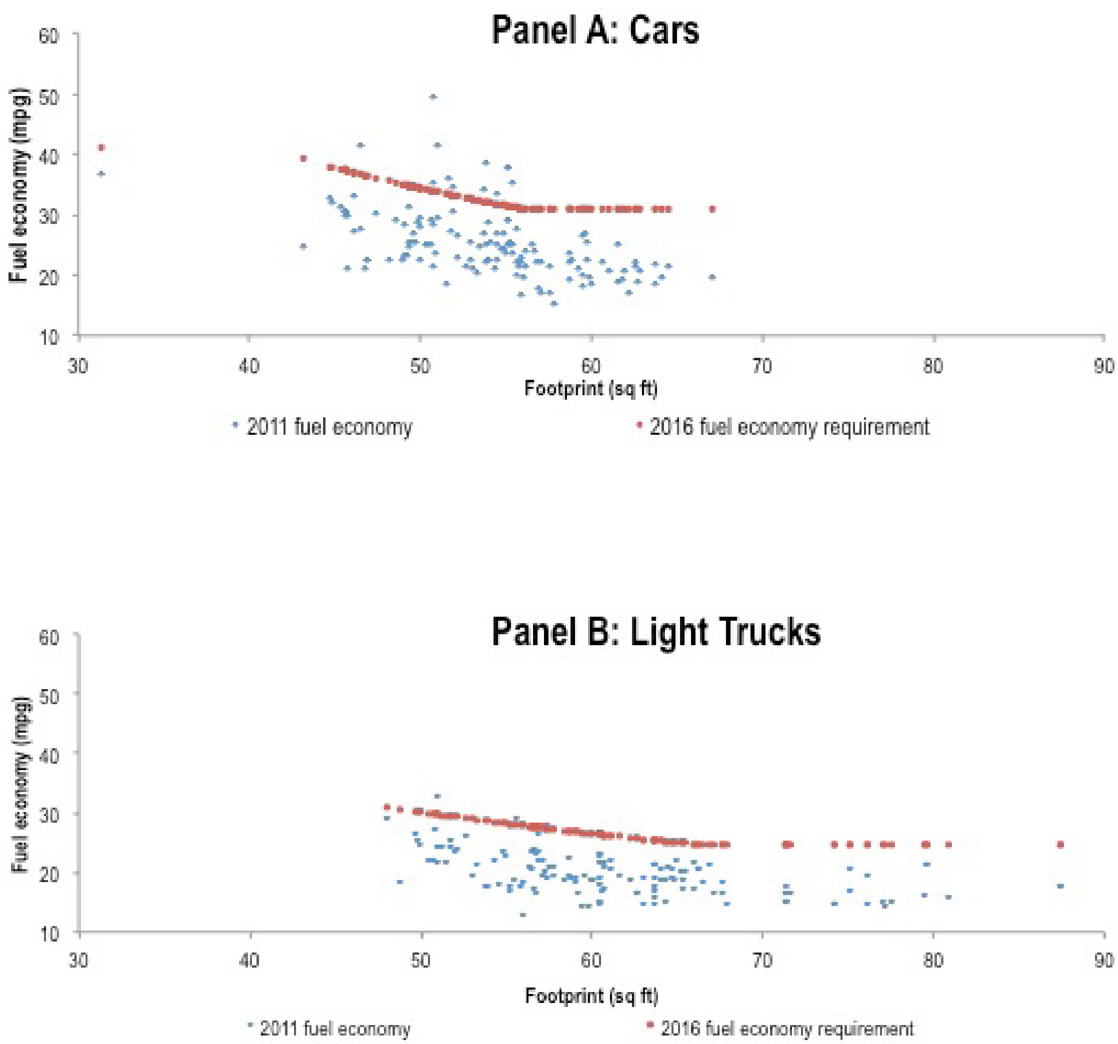

Figure 2: Panel A includes all car models and power types, and panel B includes all light-truck models and power types, both for the 2011 model year. For each model and power type, the figure plots its actual fuel economy (blue) and the 2016 fuel economy requirement (red) in miles per gallon (mpg) against the corresponding footprint in square feet (sq. ft.).

A fuel price decline can affect both the average fuel economy of vehicles sold and the average level of the fuel economy requirement that manufacturers must attain. When a consumer obtains a new vehicle, one of the vehicle's attributes is the future fuel costs that the consumer will have to pay. Fuel costs depend not only on the vehicle's fuel economy, but also on fuel prices, and low fuel prices reduce the future fuel costs of all vehicles. For example, consider someone who drives 10,000 miles per year in a vehicle that achieves 40 mpg. If gasoline prices fall by $1 per gallon that person would save $250 per year. But the savings would be even higher for a vehicle with low fuel economy. If the person drives 10,000 miles in a vehicle that achieves 20 mpg, the same $1 per gallon price decrease would save that person $500, twice as much.

This example shows that low fuel prices reduce the relative cost of owning the 20-mpg vehicle compared with the cost of the 40-mpg vehicle, raising consumer demand for the 20-mpg vehicle. That is, when fuel prices are low, consumers are likely to shift to low fuel economy vehicles because there is less of a fuel-cost penalty from driving the low fuel economy vehicles. Conversely, when fuel prices are high and are expected to remain high, consumers are more likely to favor high-fuel economy vehicles over low fuel economy vehicles.

This suggests that the recent drop in fuel prices should shift sales from high to low fuel economy vehicles, reducing the overall harmonic average fuel economy of new vehicles sold. Further, because vehicles with lower fuel economy are often relatively large, the shift in consumer demand toward low fuel economy vehicles may raise the average size of vehicles sold. Larger vehicles are subject to lower fuel economy requirements than smaller vehicles, and this shift toward larger vehicles reduces the level of fuel economy that the standards require manufacturers to attain.

In principle, a large change in vehicle demand toward bigger vehicles with lower fuel economy requirements could substantially compromise the energy savings expected from the regulation. If, hypothetically, the fuel economy of all vehicles exactly equals their footprint-based fuel economy requirement, any consumer substitution caused by fuel prices would have the exact same effect on the overall level of fuel economy as on the fuel economy requirement—in this example, the two quantities are always the same. In contrast to the hypothetical, figure 2 shows that, in the US market, fuel economy varies a fair bit across vehicles with the same (or very similar) footprints. In that case, lower fuel prices could induce consumers to choose vehicles with lower fuel economy without changing footprint, as in the four-cylinder/six-cylinder example earlier. The lower fuel prices would reduce the level of fuel economy consumers choose by more than the level of fuel economy that manufacturers must attain. If the average fuel economy consumers choose falls by more than the fuel economy requirement that manufacturers must attain, manufacturers will have to make up the difference across their fleets by adjusting their sales mix, adding fuel-saving technology or using credits they may have accumulated from past overcompliance. Any of these responses represents a cost to manufacturers that they may pass along, at least partially, to consumers.

RECENT FUEL PRICE DECREASES APPEAR TO HAVE SMALL EFFECTS ON NEW VEHICLE FUEL ECONOMY

Economic theory suggests a link between fuel prices and vehicle sales as we describe above, but one must analyze data to determine the strength of this link. We begin by looking at aggregate quarterly sales and fuel prices over two time periods. During the first period, which spans 2003 through 2007, fuel prices rose steadily, and during the second period, from 2012 through 2015, fuel prices were high but relatively stable and then decreased. Figure 3 shows the share of passenger cars in total vehicle sales. Because cars have higher fuel economy than light trucks, we expect periods of rising fuel prices to increase the share of cars as consumers shift from light trucks to cars. Likewise, we expect falling fuel prices to decrease the share of cars, and, in fact, we observe just these relationships. From 2003 to 2007, the car share tended to increase in quarters of rising fuel prices, and the car share tended to decrease in quarters of falling fuel prices.

Figure 3: Market share of cars and fuel prices

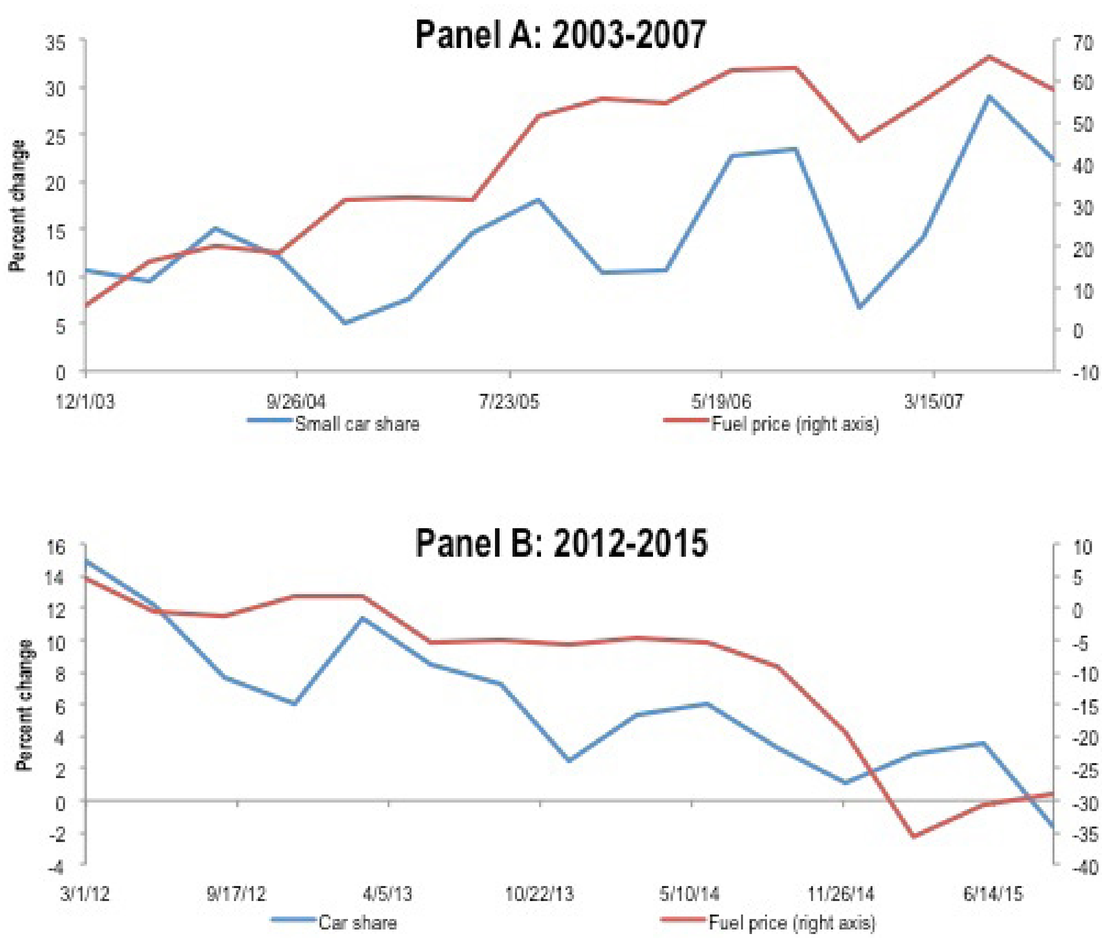

Figure 3: The quarterly average share of cars in total sales and quarterly sales-weighted average fuel price are calculated for model years 2003–2007 (Panel A) and 2012–2015 (Panel B). The figure plots the percent change of the car share and fuel price since the first quarter of model year 2003 (Panel A) and model year 2012 (Panel B).

Figure 4 shows a similarly strong connection between fuel prices and shares of small versus large cars within the passenger car segment (according to our definition, small cars have fuel economy about 4 mpg higher than large cars). High fuel prices induce a shift from large to small cars, which tend to have higher fuel economy, and vice versa when fuel prices fall. The decrease in the market share of small cars between 2014 and 2015 implies an overall decline of about 0.3 mpg for cars.

Figure 4: Market share of small cars and fuel prices

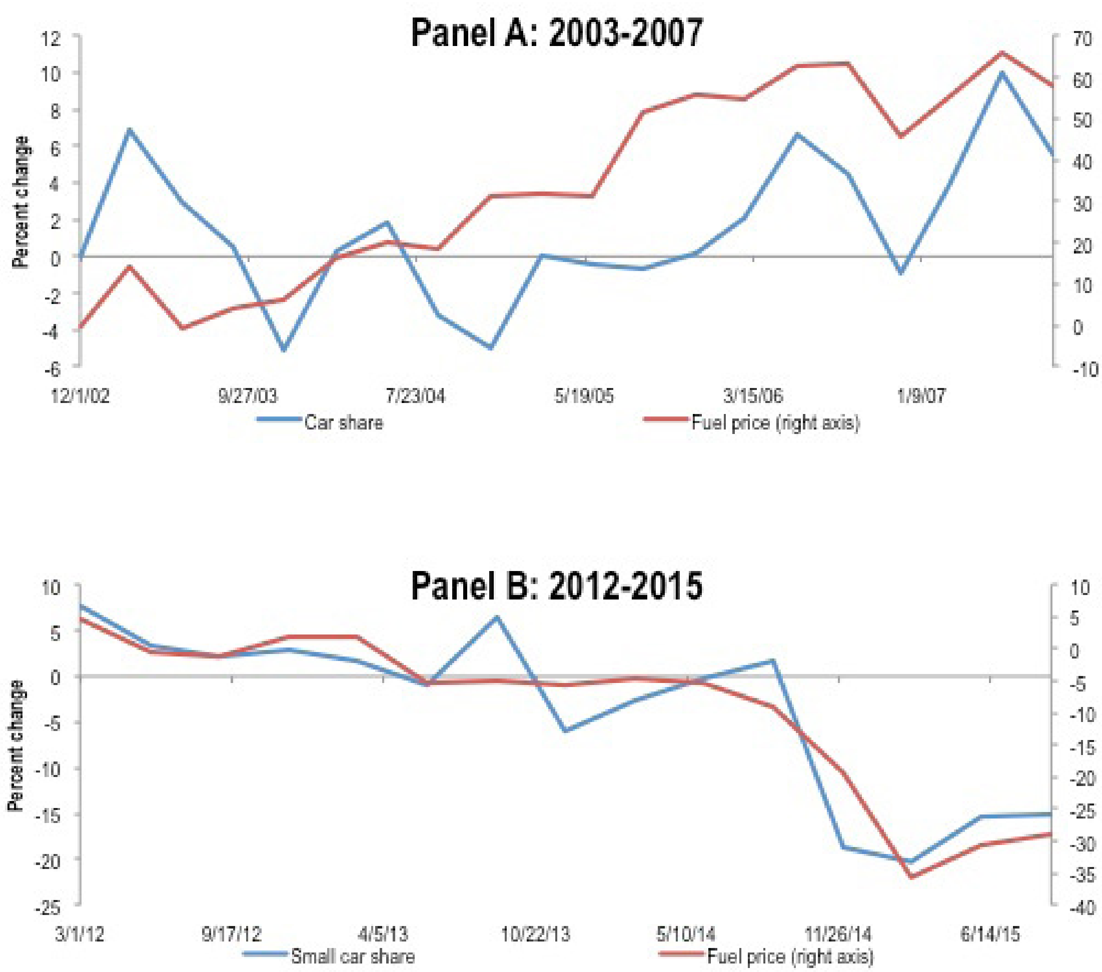

Figure 4: A small car is defined as having a footprint below the thirty-third percentile of the footprint distribution for the corresponding model year. The figure is constructed similarly to figure 3 except using the share of small car sales in total car sales rather than the car share of sales in total sales.

While the preceding trends indicate a strong correlation between fuel prices and market shares of certain types of vehicles, other factors may confound this relationship at times. For example, high fuel prices sometimes precede an economic recession. If the recession reduces income and causes consumers to buy less expensive vehicles (which tend to have higher fuel economy), there could be a spurious relationship between fuel prices and fuel economy. Another concern is that fuel economy is correlated with other vehicle attributes, such as size and weight. Consumer preferences for these attributes could change for reasons other than fuel prices. These changes could coincide with changes in fuel prices by chance, which would similarly create a spurious correlation between fuel prices and fuel economy.

Our statistical analysis controls for these potentially confounding influences on vehicle sales. We focus on short-term effects of fuel prices using monthly data on fuel prices and new vehicle sales. The monthly data allow us to control for other attributes, such as horsepower, that are fixed within a model year—for example, a 2007 Ford Focus sold in January 2007 has the same horsepower as a 2007 Focus sold in February 2007. Focusing on the short term also allows us to control for shifts in preferences for vehicle attributes that tend to occur more gradually than the sudden fuel price changes we observe in the data. Finally, we control for economic conditions, such as the last recession. This approach tells us about the short-term effect of fuel prices on sales—what happens to relative shares of vehicle purchases within a year when fuel prices change. The analysis accounts for short-term manufacturer responses, such as adjusting vehicle prices in response to fuel price changes, but not for long-term changes in technology.

The main conclusion is that the drop in fuel prices between June 2014 and August 2015 reduced the average fuel economy of newly purchased vehicles by 0.3 mpg and the fuel economy requirements that manufacturers must attain by 0.1 mpg. For context, the fuel economy decrease of 0.3 mpg offsets 14 percent of the fuel economy increase that occurred between 2011 and 2014 (i.e., including the first three years of the standards). We also find that although fuel prices affect new-vehicle market shares substantially between 2008 and 2015 (when fuel prices were high and volatile), the effect is actually about half as large as it was in the mid-2000s (when fuel prices were rising).

IMPLICATIONS FOR FUEL ECONOMY STANDARDS

The recent unexpected and large fuel price decline has sharpened the debate over future fuel economy standards. Real fuel prices have fallen dramatically since mid-2014, and the average fuel economy of new vehicles sold, which had been rising for several years, has stopped rising. As the EPA and DOT review the standards, this leveling off has generated calls for tightening current fuel economy standards. On the other hand, lower fuel prices may widen the gap between the fuel economy that consumers would choose and the level of fuel economy manufacturers must attain, making it more difficult for manufacturers to achieve any level of the standards. The manufacturers argue that the higher costs to them and consumers support the weakening standards.

Our analysis suggests that fuel prices had a modest short-term effect on the average level of fuel economy to be attained by the standards during the study period, which ended in August 2015. The decrease in fuel prices over that time period reduced the fuel economy required by the standards, raising the fuel consumption of vehicles sold in 2015 by just 1 percent. Fuel prices continued to decline after the study period, and unless consumers or manufacturers respond much more in the long term than they have in the short term, lower fuel prices should not substantially undermine the fuel economy increases that are expected under the standards.

Although lower fuel prices over the study period did not substantially affect the level of fuel economy manufacturers had to attain, lower fuel prices did increase manufacturers' costs by increasing the gap between market-based fuel economy and the level of fuel economy manufacturers required. Because lower fuel prices reduced the fuel economy that consumers chose by more than they reduced the level of fuel economy that manufacturers must attain, manufacturers will have to make up the difference. We estimate the cost to manufacturers assuming that they increase fuel economy by adding fuel-saving technology to gasoline-powered vehicles. Using DOT estimates of the costs and effectiveness of increasing fleet-wide fuel economy and our own estimates of the effects of fuel prices on model-level sales, we find that costs would be $35 per vehicle higher in 2015, or a total of an additional $555 million in 2015 to attain the standards.[4] This estimate represents a 5 percent increase in costs compared with the agency's estimates for 2015. These costs, like our other estimates, are based on a short-term analysis using a relatively short period of falling fuel prices in 2014 and 2015; the long-term effects are not well understood.

This analysis has focused on the short-term effects of fuel prices on market shares between June 2014 and August 2015, and the implications of fuel prices for average fuel economy and the level of fuel economy that manufacturers must attain. We have not considered the increase in driving caused by lower fuel prices (recent research suggests that a 10 percent fuel economy decrease causes driving to increase by 2 percent), or the broader effects of fuel prices on costs and benefits. We also did not examine the extent to which the standards were meeting the initial fuel consumption and emissions goals of the standards. Finally, we note that the public debate over gasoline prices and the standards has largely ignored the possibility of raising fuel taxes, despite the economic efficiency of this approach.

NOTES

1 For example see Vlasic, Bill. "Low Gas Prices Create a detour on the Road to Greater Fuel Economy." The New York Times, March 22, 2016. http://www.nytimes.com/2016/03/23/business/energy-environment/low-gas-prices-create-a-detour-on-the-road-to-greater-fuel-economy.html.

2 Further details on this research can be found in Leard, Benjamin, Linn, Joshua, and McConnell, Virginia. "Fuel Prices, New Vehicle Fuel Economy, and Implications for Attribute-Based Standards." RFF Discussion Paper (2016):16-04. http://www.rff.org/research/publications/fuel-prices-new-vehicle-fuel-economy-and-implications-attribute-based.

3 The harmonic average of fuel economy for a manufacturer is computed as the ratio of the manufacturer's total sales to the sum across its vehicles of sales divided by fuel economy.

4 The calculation combines the statistical estimates of the effect of falling gasoline prices on the market shares of individual models (described in Leard et al., 2016) with manufacturer cost and effectiveness estimates reported in the DOT analysis of the costs and benefits of the 2012–2016 fuel economy standards (http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/Model+Years+2012-2016:+Final+Rule). For each manufacturer and vehicle class (cars and light trucks), we estimate the change in fuel economy resulting from the decrease in fuel prices between 2014 and 2015. According to these estimates, across manufacturers and classes, the fuel-price decrease reduces sales-weighted fuel economy by 0.3 mpg and reduces the sales-weighted fuel economy manufacturers must attain by 0.1 mpg. DOT reports the cost and effectiveness by manufacturer and vehicle class of meeting alternative levels of fuel economy standards. We interpolate these cost estimates to arrive at an estimated cost per mpg improvement for each manufacturer and class. We multiply the needed change in mpg (on average 0.2 [0.3 – 0.1]) to meet the standard by the cost per mpg, and sum costs across manufacturers and classes.

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