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Raising automotive fuel efficiency

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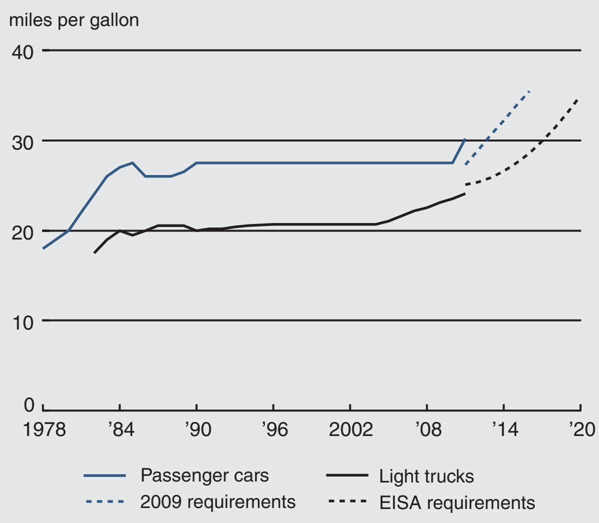
The Obama administration recently moved up the schedule for achieving the fuel efficiency standards set forth by Congress in the 2007 Energy Independence and Security Act. The deadline for meeting these standards is now vehicle model year 2016 instead of 2020.

Stricter fuel efficiency standards, establishing a 35 miles per gallon (mpg) target for the corporate average fuel economy (CAFE) of new vehicle sales by model year (MY) 2020, were part of the 2007 Energy Independence and Security Act (EISA). These requirements will be phased in beginning with MY2011 vehicles. The National Highway Traffic Safety Administration (NHTSA), which is part of the U.S. Department of Transportation, is the government agency authorized to regulate fuel economy. The NHTSA therefore issues the detailed rules required to implement fuel economy standards. During spring of this year, the Obama administration moved up the deadline by which the new requirements have to be met from MY2020 to MY2016. In addition, it instructed the U.S. Environmental Protection Agency (EPA) to regulate automobile emissions of greenhouse gases (GHG). Assuming the requirements for carbon emissions will be met entirely through fuel efficiency improvements equates to achieving a fleet average level of 35.5 mpg by MY2016 (see figure 1).

1. Historical and future CAFE standards



NOTES: CAFE means corporate average fuel economy. EISA means Energy Independence and Security Act of 2007. The 2009 requirements indicate the Obama administration's accelerated plan; see the text for further details. The dashed lines apply to both passenger cars and light trucks.

SOURCE: Brent Yacobucci, 2009, "Regulating fuel efficiency—The CAFE standards and beyond," presentation at the sixteenth annual Automotive Outlook Symposium, Federal Reserve Bank of Chicago–Detroit Branch, June 4.

On June 4, 2009, the Federal Reserve Bank of Chicago held a workshop at its Detroit branch to discuss the challenges of meeting these stricter fuel efficiency requirements.[1] Thomas H. Klier, senior economist, Federal Reserve Bank of Chicago, provided lessons from past experience with regulating fuel efficiency in the auto sector. Brent Yacobucci, specialist in energy and environmental policy, Congressional Research Service, shared his inside-the-Beltway perspective on the new regulations. The session concluded with two views from the frontline: Eric Fedewa, vice president of global powertrain forecasts, CSM Worldwide (an industry consultancy), shared his thoughts on the likely sources of improvements in fuel economy; and Roger Wood, executive vice president and general manager of turbo and emissions systems, Borg Warner, provided the perspective of a supplier of technology that improves fuel efficiency. This *Chicago Fed Letter* summarizes the day's discussions.

From CAFE 1 to CAFE 2

Requirements for corporate average fuel economy in the motor vehicle sector were first proposed in the wake of the 1973 Arab oil embargo. The Energy Policy and Conservation Act of 1975 established CAFE standards for passenger cars to be phased in starting in MY1978.

It authorized the NHTSA to administer the fuel efficiency requirements as well as to set standards for other vehicle classes (such as light trucks, which include minivans, sport utility vehicles, and pickup trucks). The NHTSA exercised the authority to set fuel efficiency standards for light trucks starting in MY1979. Collectively, these standards are referred to as CAFE 1 in this article.

In 2007, the Energy Independence and Security Act included stricter standards, which we refer to as CAFE 2; they require fuel efficiency to rise to 35 mpg by MY2020, representing a 40% increase from CAFE 1. As mentioned before, this spring, the Obama Administration moved up the deadline to meet the new requirement to MY2016; in addition, it established authority for the EPA to regulate GHG emissions from motor vehicles.

CAFE 2 also prescribes a different way of implementing the fuel efficiency standard. Under CAFE 1, a specific mileage standard applied to passenger cars and a different standard applied to light trucks. Each manufacturer had to meet the standard as averaged across the sales of individual models within each vehicle class.[2]

CAFE 2 authorizes "attribute-based" fuel efficiency standards. The underlying rationale was to provide incentives for vehicles of the same size to become more fuel-efficient, instead of possibly compromising safety by achieving fuel efficiency gains primarily through reductions in vehicle size and weight. The attribute chosen is a vehicle's footprint, which is defined as the rectangle created by a vehicle's four wheels. As a consequence, the attribute-based standard will lead to different fuel efficiency targets for different manufacturers, depending on the size mix of the vehicles they sell. As fuel efficiency needs to improve by 30% to 40% across vehicle classes, the cost of complying with the new requirements will be higher for larger vehicles.

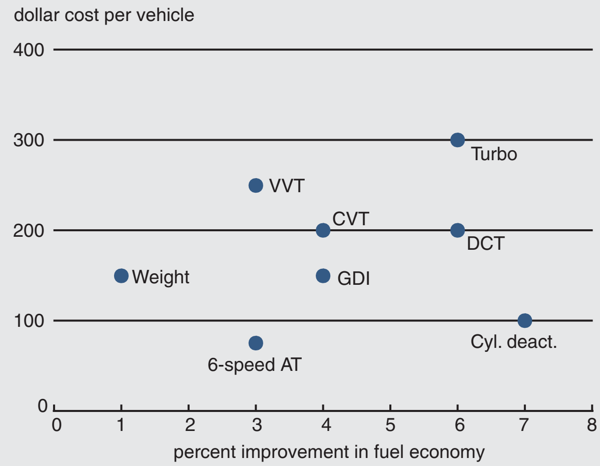
The fact that both the EPA and NHTSA have been charged with regulating automobiles (the former agency addressing emissions and the latter fuel economy) will complicate matters somewhat, because a reduction of GHG emissions through the use of more efficient air conditioning systems in vehicles would also have implications for a vehicle's fuel efficiency. The widely stated fuel efficiency target of 35.5 mpg by MY2016 assumes that all required GHG emission reductions will result from fuel efficiency improvements. To the extent that that is not the case, e.g., if reductions can be achieved by other means such as improved air conditioning systems (which would reduce HFC-134a, another greenhouse gas), the overall mpg target could be somewhat lower. It is widely expected that automakers will apply improvements to their vehicles' air conditioning systems in order to reduce GHG emissions.

How will the industry meet the requirements?

Over 87% of the energy represented by the fuel put into a vehicle's tank is "lost," the vast majority through friction and heat loss in the engine itself as well as through engine idling.[3] Those losses represent a large potential for fuel efficiency improvements within the realm of internal combustion engines. In fact, there was consensus at the workshop that the new standards can be met with existing technologies. Yet compliance will be expensive, representing additional costs of up to several thousand dollars per vehicle.

In order to meet the new fuel economy and GHG emissions targets, automakers will be looking to technologies available at the lowest cost per fuel economy improvement (see figure 2). Most likely, we will see a focus on improvements to the internal combustion engine itself, as well as increased use of more advanced transmissions, such as six-speed automatic transmissions and dual clutch transmissions. Reduction of a vehicle's weight and engine size are also in the mix. For example, a four-cylinder engine in combination with turbocharging can provide power similar to that of a six-cylinder engine.[4] Further, there are several advanced engine management options, such as cylinder deactivation, variable valve timing, and gasoline direct injection, which individually would improve fuel economy between 3% and 7%, at a relatively low cost of up to $250 each. In addition, increased use of biofuels promises significant benefits to automakers in terms of achieving CAFE compliance.[5] However, application of diesel technology, although popular and proven successful in Europe, will be challenging in the U.S. because of the relatively stricter emission regulations. Potential next-generation technologies, such as hybrid powertrains and fuel cells, were characterized by workshop participants as not yet cost competitive.

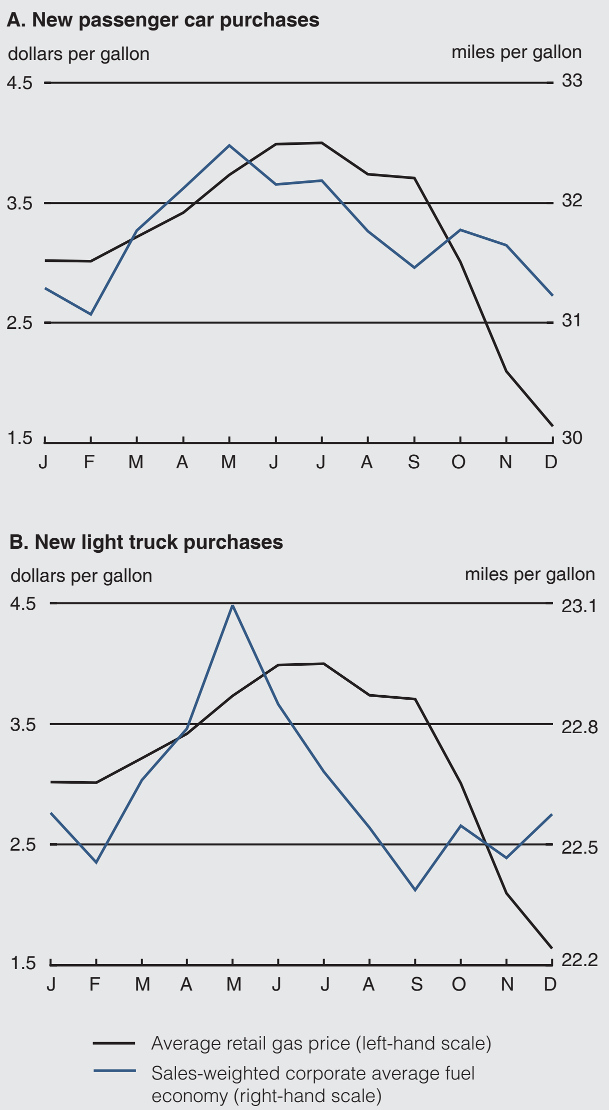
2. Cost–benefit of some fuel efficiency improving technologies



Weight—Weight reduction
6-speed AT—Six-speed automatic transmission
VVT—Variable valve timing
GDI—Gasoline direct injection
CVT—Continuously variable transmission
DCT—Dual clutch transmission
Turbo—Turbocharger
Cyl. deact.—Cylinder deactivation

Source: Fedewa (2009).

3. Consumer response to gas price changes, 2008



Notes: In panel A, the passenger car corporate average fuel economy (CAFE) fleet requirement for model year 2008 was at 27.5 miles per gallon. Light trucks include vehicles such as minivans, sport utility vehicles, and pickup trucks. In panel B, the light truck CAFE fleet requirement for model year 2008 was at 22.5 miles per gallon.

Sources: Authors' calculations based on data from Ward's AutoInfoBank, www.fueleconomy.gov, and U.S. Department of Energy from Haver Analytics.

Past experience with fuel efficiency regulation

How did vehicle manufacturers respond to CAFE 1? Producers adjusted by making vehicles shorter and lighter and, in the process, reducing the size of engines. For example, between 1975 and 1983, when the fuel economy of passenger cars increased by over 40%, the weight of passenger cars fell by over 30% and engine power (as measured in horsepower) fell by 30%.[6] Yet the reduction in engine power was quickly reversed, as the price of gasoline fell to below 1975 levels (in real terms) by 1985 and remained there for about 15 years.[7] By the mid-1980s, the fuel efficiency levels required by CAFE 1 had been met, and in light of the low price of gasoline at the time, fuel efficiency quickly faded in the consumer's mind. By the same token, political efforts to raise fuel efficiency standards were not successful. Subsequently, automakers on balance directed their engineering efforts toward building more powerful engines.

Regulation such as CAFE, which is directed at the producers of vehicles, can and did force the implementation of new technologies, as was observed during the late 1970s and early 1980s. However, the demand for vehicle characteristics such as fuel efficiency depends on their cost-effectiveness. Consumers have preferences for both performance (e.g., speed and acceleration) and fuel efficiency. Yet they show a strong response to fuel economy concerns only when the price of gasoline is high, as seen between 1978 and 1983 and again, more recently, between 2002 and 2009.[8] This is best illustrated by the consumer response to the rollercoaster ride of gasoline prices experienced throughout 2008 (see figure 3). During the first six months of last year, as the price of gasoline inexorably moved toward $4 per gallon, consumers not only switched from light trucks to passenger cars in their purchases of new vehicles, they also tended to buy more fuel-efficient products within each vehicle class. That tendency quickly reversed itself during the second half of the year, as the price of gasoline plunged to below $2 per gallon in less than six months. Figure 3 maps on a monthly basis the fuel efficiency of new passenger cars (panel A) and new light trucks (panel B) purchased last year. For both types of vehicles, the alignment in consumer purchasing behavior and the signal sent by the price of gasoline is evident.

During the discussion at the workshop it was suggested that, looking forward, we need to recognize that regulating fuel efficiency in this country mostly by placing constraints on producers bears certain risks. For example, the tighter fuel efficiency requirements of CAFE 2 could become quite onerous for vehicle manufacturers were the price of gasoline to stay low. (That is because in that scenario, consumers will likely continue to demand large vehicles and engines.) While there is little talk of raising the tax on gasoline, the price of gasoline would probably be affected by the implementation of a carbon emissions cap-and-trade program (via substitute fuels), albeit in a relatively minor way.[9]

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Conclusion

The recent regulatory response to last year's high gasoline prices resembles the policy response observed during the mid-1970s. And so again a race is on for the auto industry to implement state-of-the-art technology in order to improve vehicle fuel efficiency. By all accounts, the new requirements on fuel consumption can be met with existing technologies. Yet, in drawing parallels between the two periods, we are reminded of the importance of consumer preferences. With respect to fuel economy, the price of gasoline can be a powerful tool to direct consumers to more fuel-efficient vehicles, as is amply illustrated by evidence from 2008, a year that saw unprecedented volatility in the price of gasoline.

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[1] This workshop was part of the Chicago Fed's sixteenth annual Automotive Outlook Symposium, held on June 4–5, 2009; the agenda and presentations are available at www.chicagofed.org/news_and_conferences/conferences_and_events/2009_aos.cfm. The June 5 presentations are summarized in William A. Strauss and Emily A. Engel, 2009, "Economy to turn the corner in 2010," *Chicago Fed Letter*, Federal Reserve Bank of Chicago, No. 265a, August, available at www.chicagofed.org/publications/fedletter/cflaugust2009_265a.pdf.

[2] In fact, the CAFE 1 standard for passenger cars had to be met separately for domestically produced cars and for imported cars (this was referred to as the two-fleet rule). A passenger car was considered "domestic" if at least 75% of its content was of either U.S. or Canadian origin. In the case of light trucks, the domestic versus import distinction was in effect only from MY1980 to MY1996. See www.nhtsa.dot.gov/cars/rules/cafe/overview.htm.

[3] Eric Fedewa, 2009, "Drivers for future technology deployment: The role of the consumer, government, and industry to achieve the optimal fuel economy model," presentation at the sixteenth annual Automotive Outlook Symposium, Federal Reserve Bank of Chicago–Detroit Branch, June 4.

[4] A turbocharger effectively reduces vacuum in the engine, allowing cylinders to fill more easily and fully. The result is a larger air volume, which allows the engine to use more fuel.

[5] CAFE rules provide special treatment for dedicated alternative fuel vehicles and dual fuel vehicles in calculating fuel economy. See www.nhtsa.dot.gov/cars/rules/cafe/overview.htm.

[6] U.S. Environmental Protection Agency, 2007, "Light-duty automotive technology and fuel economy trends: 1975 through 2007," report, Washington, DC, No. EPA420-R-07-008, September, available at www.epa.gov/oms/cert/mpg/fetrends/420r07008.pdf.

[7] Ibid.

[8] For recent empirical work on this issue, see Thomas H. Klier and Joshua Linn, 2008, "The price of gasoline and the demand for fuel efficiency: Evidence from monthly new vehicles sales data," University of Illinois at Chicago, mimeo, September, available at http://tigger.uic.edu/~jlinn/gas.pdf; and Meghan R. Busse, Christopher R. Knittel, and Florian Zettelmeyer, 2009, "Pain at the pump: How gasoline prices affect automobile purchasing in new and used markets," Northwestern University, University of California, Davis, and National Bureau of Economic Research, mimeo, February, available at www.econ.ucdavis.edu/faculty/knittel/papers/gaspaper_latest.pdf. Klier and Linn (2008) find the increase in the price of gasoline between 2002 and 2007 can explain nearly half the decrease in market share of U.S. automakers.

[9] On June 26, 2009, the House of Representatives passed the American Clean Energy and Security Act, also known as the Waxman–Markey Bill. It includes provisions to reduce carbon emissions by implementing a cap-and-trade system. Such a program would create a market for permits for carbon emissions. The idea is to harness market forces to reduce emissions at the lowest marginal cost. The Congressional Research Service estimates that at a price of $25 per ton of carbon, the price of gasoline would rise by $0.23. See Jonathan L. Ramseur and Larry Parker, 2009, "Carbon tax and greenhouse gas control: Options and considerations for Congress," CRS Report for Congress, Congressional Research Service, No. R40242, March 10, p. 47, available at http://ncseonline.org/NLE/CRSreports/09Mar/R40242.pdf.