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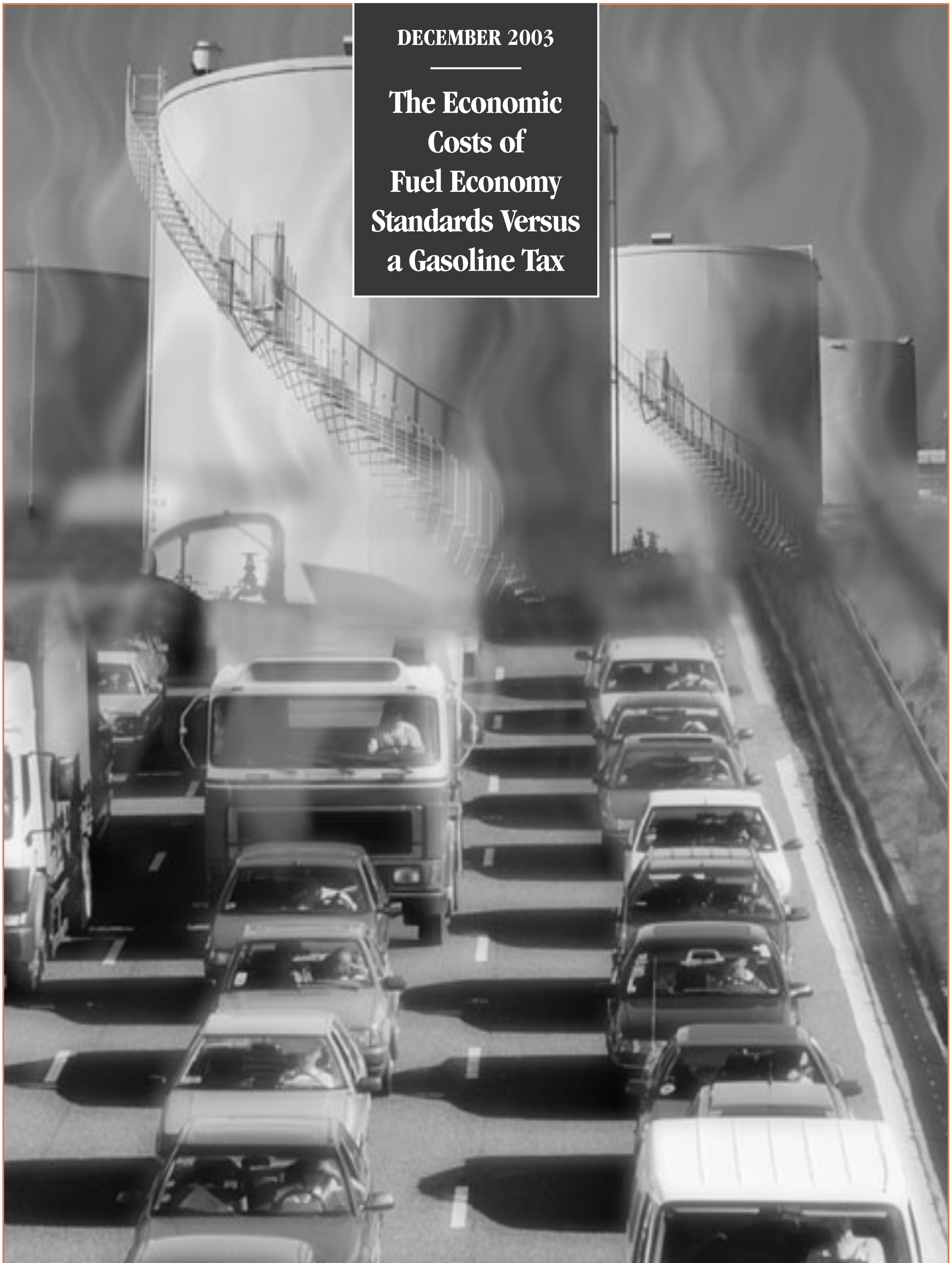
A CBO STUDY

DECEMBER 2003

The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax



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The Congress of the United States ■ Congressional Budget Office

Preface

In recent years, there has been renewed interest in the Congress in policies that would reduce gasoline consumption in the United States. That interest has been motivated primarily by concerns about the nation's energy security and about the risk that carbon emissions, 20 percent of which come from gasoline consumption, may affect the Earth's climate. This Congressional Budget Office (CBO) study—prepared at the request of the Senate Committee on Environment and Public Works—compares the economic costs of two methods for reducing gasoline consumption: raising the corporate average fuel economy (CAFE) standards for passenger vehicles and increasing the federal tax on gasoline. In analyzing CAFE standards, the study also estimates the potential cost savings from allowing automakers to trade fuel economy credits with one another as a way of complying.

The study breaks down the costs that each of the alternative policies would impose on both producers and consumers. Further, it discusses the prospects for CAFE standards to improve social welfare given that the existing gasoline tax also provides consumers an incentive to buy more-fuel-efficient vehicles. In keeping with CBO's mandate to provide objective, impartial analysis, this study makes no recommendations.

David Austin and Terry Dinan of CBO's Microeconomic and Financial Studies Division wrote the study, under the supervision of Roger Hitchner. CBO's Robert Dennis, Richard Farmer, Arlene Holen, Deborah Lucas, and Tom Woodward provided valuable comments, as did Robert Carroll (formerly of CBO); Andrew Kleit of Pennsylvania State University; Kenneth Small of the University of California, Irvine; and Ian Parry of Resources for the Future.

John Skeen edited the study, and Juyne Linger proofread it. Cecil McPherson provided research assistance. Angela Z. McCollough typed the tables in the draft. Maureen Costantino designed the cover and prepared the study for publication, and Annette Kalicki prepared the electronic versions for CBO's Web site (www.cbo.gov).

Douglas Holtz-Eakin
Director

December 2003

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Summary

Some Members of Congress and public interest groups have recently proposed raising the corporate average fuel economy (CAFE) standards for automobiles. Proponents of CAFE standards see them as a way to decrease the United States' dependence on oil and its emissions of carbon dioxide (the predominant greenhouse gas). In this study, the Congressional Budget Office (CBO) estimates the costs that raising CAFE standards would impose on automobile producers and consumers. This study also extends previous research by examining the potential cost savings from instituting a system in which producers could trade "fuel economy credits." Under that system, producers with high costs of complying with CAFE standards could meet the new standards by applying credits bought from producers that exceeded the standards. CBO also compares the costs of CAFE standards with those of a higher gasoline tax, an alternative policy for reducing gasoline consumption. Finally, CBO examines the available evidence on whether changing CAFE standards or the gasoline tax could improve social welfare, a general measure of society's well-being that includes not only the value derived from the goods and services that people consume but also factors that diminish the quality of life, such as pollution and traffic congestion.

CAFE standards are currently set at 27.5 miles per gallon (mpg) for cars and 20.7 mpg for light trucks. The standard for cars has not changed since 1990; the truck standard, fixed since 1996, is due to increase to 22.2 mpg by 2007. The federal gasoline tax, which dates from 1932 and is earmarked for mass transit and the construction and maintenance of highways, is currently 18.4 cents per gallon. The average tax on gasoline—including federal, state, and local taxes—is 41 cents per gallon.

The Costs of Alternative Policies

CBO estimates the costs borne by producers and consumers resulting from various increases in CAFE standards and various increases in the tax on gasoline—which effect different levels of reduction in gasoline consumption. A 10 percent reduction in gasoline consumption is used as a benchmark for the purpose of comparing the costs of the alternative policies.

According to CBO's estimates, CAFE standards designed to meet the benchmark 10 percent reduction—about 31.3 mpg for cars and 24.5 mpg for light trucks—would impose costs on producers and consumers of new vehicles totaling approximately $3.6 billion per year, over and above the value of fuel savings (*see Summary Table 1*). Those costs average about $228 per new vehicle sold. The costs are measured in the long run—that is, once the vehicles currently on the road are retired.

Instituting fuel economy credit trading along with the higher standards would reduce the costs of raising the CAFE standards by shifting the adoption of fuel economy measures away from higher-cost firms to lower-cost firms. CBO estimates that trading would cut the costs of achieving the benchmark target by 16 percent, to about $3.0 billion per year, or $184 per vehicle.

The gasoline tax would achieve the 10 percent reduction at the lowest cost of the three policy alternatives examined. Under the demand and supply responses that CBO assumed, a 46-cent-per-gallon tax increase would achieve the targeted reduction and would impose a welfare cost of $2.9 billion per year—3 percent less than the cost of CAFE standards with trading and 19 percent less than the cost of the standards without trading.

Summary Table 1.

Total Long-Run Annual Costs to Achieve a 10 Percent Reduction in Gasoline Consumption Under Alternative Policies

(Billions of dollars)

	CAFE Standards		
	Without Trading	With Trading	Gasoline Tax
Policy Modeled	31.3 mpg for cars 24.5 mpg for light trucks		46-cent-per-gallon increase
Total Welfare Costs[a]	3.6	3.0	2.9
Producers' costs	1.2	0.8	0.5
Consumers' costs	2.4	2.2	2.4

Source: Congressional Budget Office.

Note: CAFE = corporate average fuel economy; mpg = miles per gallon.

a. For producers, costs are measured as reductions in total profits, while for consumers, they are measured as reductions in the amount that consumers value their new vehicle over and above the purchase price.

The advantage of a gasoline tax over CAFE standards is much greater in the short run. Neither the higher tax nor higher CAFE standards would achieve full effectiveness until all existing vehicles were replaced, or after about 14 years in CBO's analysis. But over the initial 14 years, the tax would save 42 percent more gasoline than would CAFE standards with trading, while costing 27 percent less (*see Summary Figure 1*). The gasoline tax would outperform the CAFE standards because, while both policies would improve the fuel economy of new vehicles, the tax would produce greater immediate gasoline savings by inducing owners of both new and existing vehicles to drive less. In contrast, by making new vehicles cheaper to operate, higher CAFE standards would encourage owners of new vehicles to drive more (and would not affect the driving incentives of existing-vehicle owners at all).

Consumers would bear the brunt of the costs under all of the policies considered, according to CBO's estimates. Achieving the 10 percent reduction through higher CAFE standards would cost new-vehicle buyers about $2.4 billion per year if automakers were not allowed to trade fuel economy credits, or $2.2 billion if they were allowed. In either case, consumers would bear more than two-thirds of the total long-run costs. Consumers' costs would vary across vehicle types. In some cases, buyers of vehicles with poor fuel economy would be subsidizing the purchase of fuel-efficient vehicles. Finally, if policymakers chose to achieve the 10 percent reduction through a 46-cent increase in the tax on gasoline, gasoline consumers would bear nearly 85 percent of the total long-run costs, or $2.4 billion per year, CBO estimates.

Fuel economy credit trading would significantly reduce producers' costs of complying with CAFE standards, from roughly $1.2 billion per year to $0.8 billion per year. Credit trading would reduce compliance costs for firms that bought credits (projected to be primarily the "Big Three" domestic automakers), while boosting revenue for firms that sold credits.

Some Key Assumptions and Limitations

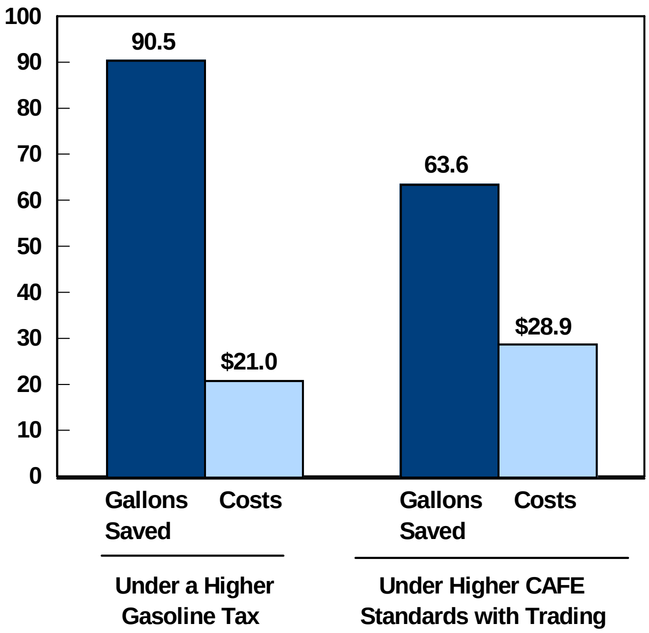
To study the effects of alternative policies, CBO developed a detailed simulation model of the U.S. passenger vehicle market. That model extends previous research by capturing firms' competition on both price and fuel economy and by measuring the potential savings due to instituting fuel economy credit trading. In CBO's model, firms' responses to policy changes are motivated by the desire to maximize profits given the costs of improving fuel economy[1] and the response of consumers to changes in vehicles' prices and fuel economy.

1. Cost estimates come from National Research Council, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards* (Washington, D.C.: National Academy of Sciences, 2002).

Summary Figure 1.

The Effects of CAFE Standards with Trading Versus a Gasoline Tax Over the First 14 Years

(Billions)



Source: Congressional Budget Office.

Notes: CAFE = corporate average fuel economy.

The figure depicts effects over the first 14 years (after which all current vehicles are assumed to be retired) from policy changes that would bring about a 10 percent reduction in gasoline consumption.

A key assumption is that firms will not voluntarily use future new technologies to produce fuel savings. CBO made that assumption because consumers' preferences over the past 15 years have induced automakers to increase vehicles' size and weight (for safety or other reasons) and horsepower, while holding gasoline mileage ratings steady. Given that pattern, CBO believes that regulatory intervention would be required to raise average mileage ratings and that any increase in the standards would reduce the welfare of automobile producers and consumers.

One of the main contributions of this study is its comparison of CAFE standards and the gasoline tax on the basis of a consistent set of assumptions. For instance, in calculating how demand responds to an increase in the price of gasoline resulting from a tax hike, CBO uses the same assumptions about consumers' behavior and technology costs as in its analysis of higher CAFE standards.

Several factors that could reduce the direct costs of increases in CAFE standards or the gasoline tax are not considered in this study. The costs that CAFE standards would impose on producers and consumers could be considerably lower if the real price of gasoline rose—making fuel economy a more desirable attribute for vehicles. Further, the costs imposed by higher CAFE standards or by a higher gasoline tax would be reduced if future fuel-saving technologies were significantly less costly than the ones anticipated or if consumers' preferences shifted to smaller, less powerful vehicles.

On the other hand, other factors could result in costs that are higher than those estimated in this study. For example, this study estimates only costs that CAFE and gasoline tax policies might impose on the sellers and buyers of vehicles and gasoline, although both policies have the potential to impose costs in other parts of the economy. Including those additional costs could significantly boost CBO's estimates of the costs of all of the policies considered.

Given those limitations, the costs reported in this study should not be viewed as precise estimates. Nonetheless, CBO believes that its conclusions about the relative cost-effectiveness of the alternative policies discussed are sound.

Could Increases in CAFE Standards or the Gasoline Tax Improve Social Welfare?

Increasing CAFE standards or the gasoline tax would impose costs on both producers and consumers of, respectively, vehicles and gasoline—direct costs that are estimated by CBO's modeling. An important question, therefore, is whether those costs would be worthwhile—that is, would they be justified by the accompanying benefits? The primary benefit from reducing gasoline consumption would be the decrease in the external costs that such consumption creates—in particular, the costs stemming from the United States' dependence on oil and the carbon dioxide emitted during gasoline combustion. In its recent report, the National Research Council suggested that a reasonable, albeit uncertain, estimate of those external costs would be 26 cents per gallon.[2]

Determining whether the costs of higher CAFE standards would be justified requires accounting for the effect that existing taxes have on gasoline consumption. The existing state, local, and federal taxes on gasoline already provide an incentive for consumers to reduce their consumption of gasoline: consumers will buy more-fuel-efficient cars and drive less as long as the costs of doing so are less than the tax-induced increase in the price of gasoline.

If the existing tax was equal to the external costs associated with consuming a gallon of gasoline—that is, if it reflected the total costs that gasoline consumption imposes on society—then consumers would have an incentive to reduce their consumption by an amount that took those external costs fully into account. In that case, there would be no need to increase CAFE standards.

Given that the existing tax on gasoline currently averages 41 cents per gallon, consumers have an incentive to buy fuel-efficient vehicles and to reduce driving up to a cost of 41 cents per gallon saved.[3] If the National Research Council's 26-cent estimate for the external costs of consuming a gallon of gasoline is correct, then the existing tax on gasoline already provides new-car buyers with an incentive to pursue fuel economy up to a cost that exceeds the benefits of reducing gasoline consumption by 15 cents. In that case, raising the CAFE standards would impose unwarranted costs on automakers and buyers of new vehicles and would reduce social welfare.

Estimating the external costs associated with consuming gasoline is not part of this study, and CBO does not endorse the National Research Council's estimate—indeed, that organization itself considers its estimate to be tentative. However, given the magnitude of the existing tax on gasoline, higher CAFE standards would have the potential to improve social welfare only if the external costs associated with consuming a gallon of gasoline exceeded 41 cents, a figure that is significantly higher than the National Research Council's estimate.

Higher CAFE standards could further reduce social welfare by worsening traffic congestion and increasing the number of traffic accidents. That undesirable outcome could occur because higher CAFE standards would lower the per-mile cost of driving, providing new-vehicle owners with an incentive to drive more. While the increase in driving associated with higher CAFE standards may be relatively small, some studies suggest that the resulting costs of the increased congestion and traffic accidents may nevertheless be large.

Although the existing tax on gasoline exceeds the NRC's estimate of the external costs associated with consuming gasoline, the tax is not necessarily too high. The gasoline tax serves purposes other than encouraging gasoline buyers to take the external costs of gasoline consumption into account. It also discourages driving. Determining the "optimal" tax on gasoline is beyond the scope of this study, but such a determination could take into account the external costs associated with driving—beyond those specifically associated with consuming gasoline (the costs of increased dependence on oil and higher carbon emissions)—such as traffic congestion and accidents. Depending on the outcome of such an assessment, increases in the existing tax on gasoline could improve social welfare.

2. See National Research Council, *Effectiveness and Impact of CAFE Standards*. Also, note that improving fuel efficiency would not necessarily reduce other pollutants emitted by passenger vehicles—such as carbon monoxide, nitrogen oxides, and hydrocarbons—because the Environmental Protection Agency's maximum emission rates for those pollutants are defined in terms of grams per mile rather than per gallon. Thus, those pollutants are, in principle, independent of gasoline mileage. (In practice, though, cars with better mileage ratings may pollute less than the agency's standards allow.)

3. Producers of gasoline might bear part of the tax. In that case, the price of gasoline would increase by less than the amount of the tax. In either case, however, the incremental cost of the tax (borne by producers and consumers) would be 41 cents.

CHAPTER

1

Introduction

Recently, there has been much discussion, in the Congress, in the press, and among public interest groups, about fuel economy standards for cars and light trucks. The average fuel economy of new vehicles has been declining for more than a decade, as consumers have increasingly switched from cars to trucks or more powerful cars. At the same time, there has been increasing concern about the energy security of the U.S. economy and about the role of carbon dioxide emissions in global climate change.[1] Proponents of higher fuel economy standards hope that reducing gasoline consumption will help address those concerns.

A recent Congressional Budget Office (CBO) study provided a qualitative comparison of the effects of three policies that could decrease gasoline consumption: an increase in the corporate average fuel economy (CAFE) standards that govern passenger vehicles, an increase in the federal tax on gasoline, and a "cap-and-trade" program for the carbon dioxide emissions that result when gasoline is burned.[2] That study weighed those policies against four major criteria: whether they would minimize costs to producers and consumers; how reliably they would achieve a given reduction in gasoline use; what implications they would have for the safety of driving; and what effects they would have on factors such as traffic congestion, requirements for highway construction, and emissions of air pollutants other than carbon dioxide.

This study extends CBO's previous work by providing a quantitative comparison of the costs that producers and consumers would bear as a result of two of the policies: an increase in CAFE standards and an increase in the federal tax on gasoline. A significant feature of this study is that it compares the costs of those policy options on the basis of a consistent set of assumptions—in particular, assumptions about consumers' preferences concerning fuel economy and about the costs of technologies for improving fuel economy. Higher CAFE standards would reduce gasoline consumption by raising vehicles' fuel economy, while an increase in the federal gasoline tax would discourage consumption by raising the price of gasoline.

The study considers two alternative designs for the CAFE program. The first, based on the existing design, would require each manufacturer individually to meet the standards. Under the second design, manufacturers could trade "fuel economy credits"; that is, firms exceeding the standards could sell credits to firms that would otherwise fall short of the standards. The trading of fuel economy credits would lower the costs of raising the CAFE standards; this study estimates the resulting savings.

The Rationale for Decreasing Gasoline Consumption

Proponents of higher CAFE standards point out that the standards are a way of improving energy security and reducing climate change. The energy-security cost of gaso-

1. For a discussion of the scientific consensus and economic issues related to climate change, see Congressional Budget Office, *The Economics of Climate Change: A Primer* (April 2003).

2. See Congressional Budget Office, *Reducing Gasoline Consumption: Three Policy Options* (November 2002).

Burning a gallon of gasoline releases 8.9 kilograms of carbon dioxide into the atmosphere. See National Research Council, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards* (Washington, D.C.: National Academy of Sciences, 2002), p. 85.

line consumption can be measured as the risk of macroeconomic losses from higher oil prices due to disruptions in the world oil supply. Some analysts argue that the United States would be less vulnerable to such disruptions if it used less oil.[3] The use of motor gasoline (which is derived from oil) accounts for about 43 percent of U.S. petroleum use and about 11 percent of world petroleum use.

Gasoline consumption can contribute to climate change because it produces emissions of carbon dioxide, the predominant "greenhouse gas." Although climate change might benefit some regions, it could ultimately cause extensive physical and economic damage in others. That damage is uncertain, but it could include higher sea levels; wider ranges for tropical diseases; disruptions to farming, forestry, and natural ecosystems; and greater variability and extremes of regional weather. Carbon emissions make up about 84 percent of U.S. greenhouse gas emissions, with motor vehicles accounting for approximately 20 percent of U.S. carbon emissions.

Reducing gasoline consumption could cut the amount of oil that the United States consumes and the greenhouse gases that it emits. But, as this study discusses, determining whether or not increases in CAFE standards would have the potential to improve social welfare—that is, including not only the value derived from the goods and services that people consume but also factors that diminish the quality of life, such as pollution—requires considering the role that the existing tax on gasoline plays in reducing gasoline consumption. Further, one must consider the increase in driving that could result from higher CAFE standards (as people enjoyed the lower operating costs of higher-mileage vehicles) and the resulting social costs—such as greater traffic congestion and an increased risk of accidents.

3. Because oil prices are determined in the world market, vulnerability does not depend on where the oil is produced. Foreign disruptions would cause price shocks in the United States, even if the country produced all of its oil domestically.

The Existing CAFE Standards and Gasoline Taxes

The Energy Policy and Conservation Act of 1975 mandated CAFE standards. Currently, those standards are 27.5 miles per gallon (mpg) for cars and 20.7 mpg for light trucks (which is due to increase to 22.2 mpg by 2007). All manufacturers that sell more than 10,000 passenger vehicles per year in the United States must comply with the standards.

Firms must comply by ensuring that the average fuel economy of the vehicles that they sell each year meets or exceeds the applicable CAFE standard. Compliance is determined separately for each firm's domestic and imported car fleets (a distinction no longer made for light trucks). Producers that fail to meet a CAFE standard must eventually pay a penalty of $5.50 per vehicle for every tenth of a mile per gallon that their fleet average falls short. Firms have some leeway in complying over time, as they can undercomply in one year provided that they overcomplied by an equivalent amount during the three preceding years or that they overcomply within the next three years. Actual compliance, then, depends on firms' fleet averages over several years.

The federal government began levying a tax on gasoline in 1932. Historically, the tax has supported the Highway Trust Fund, providing a dependable source of funding for the Interstate highway system. Today, gasoline tax receipts are also earmarked for mass transit projects. The federal tax has increased gradually over the years, from an initial rate of 1 cent per gallon to today's 18.4 cents per gallon. Including state and local taxes on gasoline, which average 22.6 cents per gallon, the average tax in the United States is about 41 cents per gallon.

Three Policy Alternatives

Increase CAFE Standards

CBO has modeled the effects of raising the car and light-truck CAFE standards in half-mpg increments up to 38 mpg and 31.2 mpg, respectively. This study estimates the resulting reductions in gasoline consumption, estimates the overall costs of raising the standards and breaks out those costs for producers and consumers, and explores the concomitant changes in the composition of the new-vehicle fleet.

An increase in CAFE standards would directly affect automobile producers and indirectly affect automobile consumers. Producers would face higher manufacturing costs from adopting new fuel-saving technologies in their vehicles and a reduction in profits if they adjusted their pricing to increase the sales of their higher-mileage vehicles. While consumers with a relatively strong preference for fuel economy could come out ahead, on average consumers would face higher vehicle prices and, in effect, share compliance costs with the manufacturers.

The CAFE program analyzed in this study differs from the actual program in several ways. First, while in theory manufacturers are free to pay a penalty in lieu of complying with CAFE standards, in fact, U.S. manufacturers invariably choose to comply. They do so, according to an automobile industry representative, to avoid or reduce the possibility of legal or public relations ramifications. As a result, this study presumes compliance annually. Second, because relevant data are unavailable, this analysis does not distinguish between domestic and imported automobiles. Thus, CBO considers compliance based on the fuel economy of each firm's domestic and imported vehicles combined. Finally, in CBO's analysis, firms' compliance is defined in terms of their production in a single year. The actual CAFE program's flexibility in allowing firms to comply on a multiyear basis is largely a response to the uncertainty inherent in sales forecasts and related production decisions and thus need not be a focus of CBO's analysis.

Increase CAFE Standards and Introduce Credit Trading

Allowing firms to trade fuel economy credits would lower the costs of improving fuel economy for any given increase in CAFE standards. Under a credit-trading system, firms that exceeded one of the CAFE standards would generate credits that they could sell to firms that fell below that standard. The selling and buying of credits would be voluntary. A credit would be denominated in gallons of gasoline saved,[4] and its price determined by the dynamics of demand and supply. Each firm's compliance would be based on the average fuel economy of the vehicles that it sold plus the fuel economy credits that it held.

Aggregate cost savings would result when automakers with lower marginal compliance costs (the additional costs of achieving incremental increases in average fuel economy) exceeded the CAFE standards and sold the resulting credits to firms with higher marginal compliance costs. A firm would buy a credit as long as the price was less than the cost of an equivalent increase in the firm's average fuel economy. Essentially, firms would choose the means of complying that was least expensive for them.

Increase the Federal Gasoline Tax

The gasoline tax could also be used as a policy tool for reducing gasoline consumption. By raising the price of gasoline, a tax increase would give drivers an incentive to undertake a broad range of gas-saving activities—including purchasing more-fuel-efficient vehicles; retiring gas-guzzlers earlier than they otherwise would have; driving less; driving more slowly; and maintaining their vehicles better.

The costs of increasing the gasoline tax would be borne by both consumers and producers, the former by reducing the amounts they purchased as prices increased at the pump, and the latter by diminishing their net revenues. Indirectly, an increase in the gasoline tax would also affect automobile manufacturers by raising the demand for fuel economy in new vehicles. The size of those effects, and thus the costs of achieving a given reduction in gasoline consumption via a tax increase, would depend crucially on how responsive consumers were to changes in the price of gasoline and on the share of the tax that was borne by gasoline producers.

4. Savings would be calculated relative to the CAFE standard, per hundred miles of driving. For example, if the standard was 30 mpg, a car with a mileage rating of 31 mpg would save 0.1 gallons per hundred miles relative to a car rated at 30 mpg and would therefore generate one-tenth of a credit.

CHAPTER

2

Methods and Data

To properly estimate the costs of raising corporate average fuel economy standards, it is necessary not only to have information on the expected technology costs, but also to anticipate how automakers and consumers would respond to the new standards. Similarly, to estimate the costs of an increase in the gasoline tax, it is necessary to have information about how consumers and producers would respond to that tax.

For this study, the Congressional Budget Office has developed an economic simulation model to predict how automakers would respond to increases in fuel economy standards. Firms' responses are governed by their motivation to maximize profits, which depend on the fuel economy of their vehicles, the prices that they charge, and in turn the consumer demand for those vehicles; the technology costs of increasing fuel economy; and the actions of other firms. CBO also uses this simulation model to predict changes in consumer demand for fuel economy as gasoline prices rise, an important component in analyzing the costs of a higher gasoline tax.

Analyzing CAFE Standards

Methods

CBO's simulation model for the automobile market describes activity in the U.S. passenger vehicle market, relying on information about current production and pricing, estimated technology costs for raising fuel economy, and estimated consumer demand for different types of vehicles. The model distinguishes vehicles by type and manufacturer, price, and fuel economy.

In such a setting with differentiated products, firms set prices and fuel economy levels so as to maximize their profits, subject to complying with CAFE standards. (By contrast, in a perfectly competitive market, each individual firm represents such a small share of the market that its actions have no influence on the product's price.) The firms' behavior in setting prices is disciplined by consumers' freedom to switch from one type of vehicle to another and from one firm to another. So while a firm could increase its profit per vehicle by raising its prices, it would sell fewer cars and may reduce its overall profits. The firm must also respond to its rivals' pricing decisions, as consumers' choices are determined by relative as well as absolute prices.

In its model, CBO simulates the effects of higher CAFE standards by imposing new fuel economy constraints on the firms and letting them optimize their prices and fuel economy levels again. In an iterative fashion, each firm in turn makes those adjustments, given the values the other firms have chosen, until a unique equilibrium is reached. At that point, every firm has maximized its profits, and none wishes to make further adjustments. Vehicle supply and demand are by definition equal at that point.

In CBO's analysis, all firms face identical costs of technology for increasing vehicles' fuel economy, with costs differing for each vehicle type. Boosting a vehicle's fuel economy increases its production costs because the vehicle must be redesigned. This analysis assumes that new CAFE standards would allow manufacturers sufficient lead time to incorporate new technologies into their products.[1] Firms' final technology costs depend on the actual increases in fuel economy that they adopt. Differ-

1. According to the recent study of the CAFE program by the National Research Council, achieving widespread use of even existing technologies would probably require five to 10 years. See National Research Council, *Effectiveness and Impact of CAFE Standards*, p. 4.

ences in the mix of vehicles that firms sell, in the baseline fuel economy of those vehicles, and in firms' manufacturing costs and profits ensure that their responses to new standards will be diverse.

Given the complexity of the interactions between firms and consumers, firms have several ways to comply with new fuel economy standards. The most direct way, of course, is to increase the fuel economy of their vehicles. Firms could also alter their pricing to draw consumers toward their more-fuel-efficient vehicles, lowering the prices of those vehicles while raising the prices of their less-fuel-efficient ones, a strategy called mix-shifting.

In CBO's analysis, raising a vehicle's mileage rating lowers its effective price, as consumers take into account the present discounted value of the fuel savings when they make their purchase decisions.[2] In CBO's model, the effects of price changes depend on the elasticities of demand across six vehicle makes and 10 types, that is, consumers' propensity to change their choice of vehicle because of a change in price.[3] The model includes elasticities for every possible pairing among 60 different vehicles (including pairings of each vehicle with itself), providing the percentage change in the quantity demanded of one vehicle due to a 1 percent increase in the price of the other. Thus, the analysis requires a 60-by-60 elasticity matrix describing how consumers would respond to an incremental change in any price.

Data

The simulation model that CBO has created for this analysis is a detailed but stylized version of the market, incorporating pricing and production data for General Motors, Ford, DaimlerChrysler, Toyota, and Honda, including all divisions and wholly owned subsidiaries with vehicle sales in this market. Those are the five largest firms in the U.S. passenger vehicle market in terms of unit sales.[4] The model also includes data on a composite sixth firm representing most of the remainder of the industry.[5] Consequently, the model covers about 95 percent of the U.S. market.

Each firm produces both cars and light trucks. In CBO's analysis, they are classified as follows:

Types of Cars:

- Subcompact (including sports cars),
- Compact (including sedans and wagons),
- Midsize (including sedans and wagons),
- Large (including sedans and wagons),
- Luxury small (subcompacts and compacts with a price above $31,000), and
- Luxury large (midsize and large cars with a price above $35,000).[6]

Types of Light Trucks:

- Minivan,
- Small sport utility vehicle (SUV) (with six or fewer cylinders),
- Large SUV (with eight cylinders), and
- Pickup (including small and standard sizes).

The baseline data used in this analysis reflect the prices, unit sales, and fuel economy ratings of vehicles sold in the United States in 2001.[7] Information on sales came from *Automotive News*; wholesale and suggested retail prices for the available configurations of every vehicle came from

2. CBO calculates the present value of fuel savings relative to a vehicle's baseline fuel economy, with savings accumulating over time as the vehicle is driven.

3. An elasticity gives the percentage change in one variable in response to a 1 percent change in another. For example, a price elasticity of demand of -1.5 means that a 1 percent price increase leads to a 1.5 percent decrease in the quantity demanded.

4. Their subsidiaries include Saab (owned by General Motors), Jaguar and Volvo (owned by Ford), and Mercedes-Benz (owned by DaimlerChrysler).

5. The sixth firm includes BMW, Daewoo, Hyundai, Isuzu, Kia, Mazda, Mitsubishi, Nissan, Subaru, and Volkswagen.

6. The particular dollar thresholds used to define small and large luxury cars separate traditional luxury brands (for example, BMW, Cadillac, Jaguar, Lincoln, Mercedes) from other brands.

7. Total U.S. sales were 16.6 million in 2001, which is 4 to 5 percent less than occurred in 2000 or 2002. See *Automotive News* data center, at www.autonews.com. CBO's estimates of welfare losses would be slightly higher if data from those years were used instead.

Edmunds.com; and fuel economy data, for multiple configurations of engine size, transmission type, and drive wheels, came from the Environmental Protection Agency.[8]

Each vehicle is identified by its type and manufacturer. For example, CBO has combined the data for Ford's two nonluxury midsize models in 2001, the Taurus and the Mercury Sable, into information on a vehicle called the "Ford midsize car," with a quantity sold equal to total U.S. sales of the Taurus and the Sable, and a price and fuel economy equal to the median price and median fuel economy rating for Taurus and Sable's available configurations of engine size, type of transmission, and other attributes not included in CBO's analysis.

The Cost of Fuel Economy. The findings of this analysis depend critically on the estimated direct cost of improvements in fuel economy. CBO uses cost estimates developed in the recent National Research Council (NRC) study. The NRC considered fuel-saving technologies that are either already available or are anticipated within 10 to 15 years,[9] ordering them from lowest to highest cost. The NRC estimated the incremental costs of reducing gasoline consumption for each of 10 different types of vehicles.[10]

Consumers' preferences over the past 15 or 20 years have led automakers to increase vehicles' size and weight (for safety and other reasons) and horsepower, while holding gasoline mileage more or less constant. Consequently, in its model, CBO assumes that firms will not voluntarily use the fuel-saving technologies identified by the NRC to increase their average fuel economy. That is, to reduce gasoline consumption, regulatory intervention would be required. Thus, because some firms are currently just complying with the CAFE standards, CBO assumes that any increase in the standards would reduce the welfare of vehicle producers and consumers.[11] CBO implemented that assumption by first running the model with all of the new technologies available, but with no increase in CAFE standards. CBO then eliminated the technologies that the model predicted firms would use, implicitly assuming that firms would prefer to offset the resulting mileage gains by increasing their vehicles' power or weight (which are held constant in the model). The remaining technologies are those that the automakers would not use voluntarily, meaning that using them to comply with higher CAFE standards would impose costs on them or on their customers (*see Box 2-1*).

CBO's calibration method thus implies that increases in CAFE standards would impose costs on producers and consumers. One recent study goes further and assumes that the *current* CAFE standards are binding—implying that average fuel economy would fall if the standards were

8. For model-year prices, see "New Car Pricing" at www.edmunds.com. For quantities sold, see "Sales, U.S. Car—2001" and "Sales, U.S. Light Truck—2001" at www.autonews.com. For model-year fuel economy, see "Fuel Economy Guide Data" for the 2001 model year at www.epa.gov/otaq/fedata.htm. Data on prices and fuel economy are reported by model year, which begins in October; data on sales are by calendar year. Thus, the overlap of the information is nine months.

9. See National Research Council, *Effectiveness and Impact of CAFE Standards*. This recent, publicly funded study was produced by an independent panel of engineers, physical scientists, and economists, in consultation with the U.S. Department of Transportation. The final report reflects the panel's consideration of public comments from representatives of the automobile industry, environmental advocacy groups, and other interested parties.

10. The NRC assumes that firms would not reduce the weight of their vehicles to improve fuel economy, in fact, that weight will increase 5 percent because of additional requirements for emissions and safety equipment. The NRC holds vehicles' performance (for example, horsepower) constant and adjusts for interactions between fuel-saving technologies that could otherwise result in the double counting of some savings. The 10 vehicle types included in the analysis are subcompact, compact, midsize and large cars; small, midsize, and large SUVs; minivans; and small and large pickup trucks. CBO uses slightly different vehicle types in some cases for consistency with the demand elasticity estimates that it uses. CBO uses the NRC's cost estimates for "compact" and "large" cars in its "luxury small" and "luxury large" categories, respectively; it uses the average of the NRC's estimated costs for midsize and large SUVs in its "large SUV" category; and it averages the NRC's estimated costs for small and large pickups.

11. If producers satisfied new CAFE standards by reducing vehicles' performance or weight, consumers' costs would be in the form of reduced satisfaction from owning a new vehicle.

Box 2-1.

Can Higher CAFE Standards Be "Free"?

In 2002, the National Research Council (NRC) published a study of the corporate average fuel economy (CAFE) program and of fuel-saving technologies for light-duty passenger vehicles.[1] It found that the value of the fuel savings from installing the lowest-cost technologies would exceed the costs by between 12 and 27 percent for new cars, depending on the vehicle's size, and between 25 and 42 percent for light trucks.[2]

The Congressional Budget Office's (CBO's) analysis extends the NRC study by estimating losses in producers' profits and consumers' welfare from tightened CAFE standards, given the NRC's estimates of technology costs. The NRC analysis could be misinterpreted as suggesting that employing the new technologies to boost fuel economy would improve welfare as long as the resulting fuel savings exceeded the cost of the technologies. If that were so, there might be no need to raise the CAFE standards.

However, without regulatory intervention, the new technologies may not be used for fuel economy. As the NRC report notes, "given the choice, consumers might well spend their money on other amenities … rather than on … fuel economy…." Indeed, between 1981 and 2003, according to the Environmental Protection Agency's calculations, average fuel economy changed very little (increasing from 20.5 to 20.8 mpg),[3] yet average horsepower nearly doubled (from 102 to 197), weight increased by almost 25 percent (from 3,201 to 3,974 lbs), and the time for acceleration from 0 to 60 mph fell by nearly 30 percent.[4] Further technological advances, such as those described in the NRC report, could be used to continue that trend. Therefore, increases in CAFE standards or in the gasoline tax may be necessary if policymakers want average fuel economy to rise.

Forcing manufacturers to use new technologies to improve fuel economy would reduce carbon emissions and decrease the United States' oil dependency but would not necessarily make automobile (or fuel) producers or consumers better off. Those groups would be better off only if consumers have been incorrectly valuing fuel economy by overly discounting savings at the pump or if consumers have been receiving inadequate information about the fuel savings offered by different cars. CBO does not think that either of those conditions holds.[5]

Given that consumers have not demonstrated a preference for fuel economy at current prices, the average fuel economy of the U.S. new passenger vehicle fleet should not be expected to rise unless forced to through government action. Absent that, gasoline consumption may fall only if future technologies lower the price of improvements in fuel economy, the real price of gasoline rises significantly,

1. See National Research Council, *Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards* (Washington, D.C.: National Academy of Sciences, 2002).
2. The NRC compared the cost of improvements in fuel economy with the projected fuel savings over an expected vehicle life of 14 years, assuming 15,600 miles of driving in the first year, declining by 4.5 percent per year thereafter. The NRC assumed a real (inflation-adjusted) price of gasoline of $1.50 per gallon and a discount rate of 12 percent for consumers. Finally, the NRC assumed that fuel economy would be 15 percent less than indicated by the Environmental Protection Agency's test results and that future safety and emissions standards would reduce gasoline savings by 3.5 percent.
3. These are adjusted ratings that reflect actual driving conditions.
4. See Environmental Protection Agency: "Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2003," EPA420-R-03-006 (April 2003). In the report, EPA asserts that "based on accepted engineering relationships, … had the new 2003 light vehicle fleet had the same average performance and same distribution of weight as in 1981, it could have achieved about 33 percent higher fuel economy."
5. See Congressional Budget Office, "Reducing Gasoline Consumption: Three Policy Options," (November 2002).

Box 2-1.

Continued

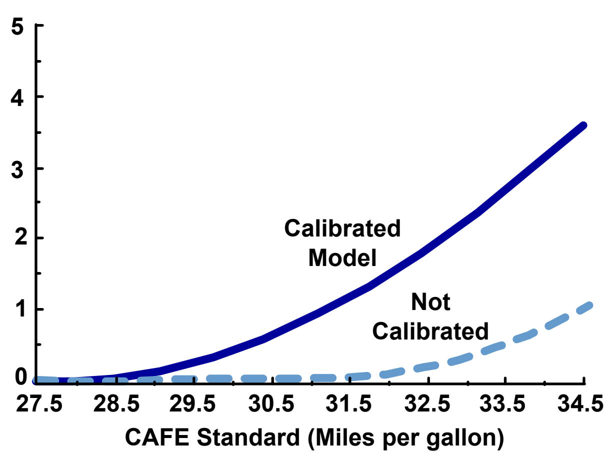
or consumers place a higher value on fuel economy at any price of gasoline. Because the technologies described in the NRC study do not lower the costs of improving fuel economy (they merely extend the scope of current fuel-saving technologies to offer further savings at greater costs)[6] and because CBO's analysis assumes that consumers' preferences remain the same and that gasoline prices are constant, increasing the CAFE standards or the gasoline tax in the simulation model imposes costs on producers and consumers of new vehicles (or of gasoline); that is, their welfare (producers' profits and the value consumers receive from their purchases of new vehicles or gasoline) falls.

The figure shows the effect of including in CBO's model a realistic assumption about the adoption of fuel-saving technologies. The dashed curve shows the results of the simulation model run with all of the new technologies available. Those results show an average voluntary (that is, "free") fuel economy increase of approximately 3.2 mpg for cars, which would bring the least fuel-efficient firm's fleet average up to 30.7 mpg. The corresponding "free" increase for the light truck CAFE standard is 3.7 mpg. Raising the standards by those amounts would raise the industry average fuel economy levels to 32 mpg for cars and 24.4 mpg for light trucks, meaning that CAFE standards would not be necessary unless even higher average fuel economy was desired.[7]

But CBO regards those unconstrained results as unrealistic. They do not account for automakers and their customers' demonstrated preferences over the past 15 years. They fail to acknowledge that the gains from cost-effective fuel-saving technologies have been offset by other design changes and have not translated into fuel savings. Therefore, CBO has calibrated its model to incorporate those facts; the model eliminates the technologies that provide those "free" increases in fuel economy. In the calibrated model, which is the source of the results presented in this report, any increase in CAFE standards would, by assumption, yield welfare losses for producers and consumers. As indicated by the solid curve in the figure, a car standard of 32 mpg in the calibrated model would result in losses to producers and consumers of nearly $2 billion per year; an increase in the light-truck standard would impose additional costs.

The Effects of Calibration in CBO's Model on the Welfare Loss from a Higher CAFE Standard for Cars

(Welfare loss in billions of dollars)



Source: Congressional Budget Office.

Note: As described in the text of this box, CBO calibrated its model to include what it believes is a realistic assumption about the adoption of fuel-saving technologies.

6. Personal communication with K.G. Duleep, who served on the National Research Council panel on CAFE, 2003.

7. The industry average fuel economy would be above the CAFE standard as long as some firms overcomplied (as Toyota and Honda currently do). In recent years, the annual industry averages have exceeded current CAFE standards by an average of about one mile per gallon for cars and a third of a mile per gallon for light trucks.

relaxed.[12] If CBO had made a similar assumption, its estimates of the costs of raising CAFE standards would have been greater than those presented in this study; however, CBO does not feel that sufficient data exist for estimating the extent to which the existing standards constrain producers' and consumers' choices.

The Discount Rate and Valuation of Future Fuel Cost Savings. The value that consumers place on reductions in gasoline consumption can also affect the costs of CAFE standards. Higher fuel economy translates directly into dollars saved at the gas pump. Consumers' valuation of fuel economy depends, however, on how much they expect to drive and on how heavily they discount future savings. Dollars saved in the future are worth less than dollars saved today because current savings can be invested to grow in value over time.

CBO discounts consumers' fuel savings at a rate of 12 percent per year. That rate, used in other recent studies of CAFE standards, including the NRC report, is slightly higher than the interest rate that consumers reported for used-car purchases in the most recent Consumer Expenditure Survey.[13] For further comparability with the NRC report, CBO assumes the same values for gasoline price ($1.50 per gallon); vehicle-miles driven (15,600 in the first year); and average years of operation (14).[14]

The particular discount rate that CBO assumes has less influence on predictions of costs than it would in the uncalibrated model. The lower the discount rate in the uncalibrated model, the more consumers would value improvements in fuel economy, and thus the more firms would use technologies to increase fuel economy. But because CBO's calibration method eliminates freely chosen technologies, a lower discount rate would also make it more costly for firms to achieve additional improvements. As explained above, CBO's decision to calibrate the model in that way was based on the observation that firms have used available technologies to increase power and weight rather than fuel economy.

Demand Elasticities. The costs that new CAFE standards would impose on producers and consumers would depend on how responsive consumers are to changes in vehicle prices. Consumers' CAFE costs are measured as reductions in the net value of their new-vehicle purchases, that is, the value that consumers attach to their vehicles over and above the price they pay for them. Welfare would fall after a price increase, not only for consumers that purchased a vehicle but also for those who would have bought a new vehicle except for the rise in price. Producers also bear CAFE costs in two ways: reduced profit margins on the cars that they sell and forgone profits from reduced sales.

The less that a price increase would affect consumers' purchasing decisions—that is, the more inelastic the demand for cars—the better able producers would be to pass along the costs of complying with CAFE standards, in the form of higher vehicle prices. If demand is relatively inelastic, consumers would bear most of the economic costs of higher CAFE standards.

12. See Andrew N. Kleit, *Impacts of Long-Range Increases in the Corporate Average Fuel Economy Standards*, AEI-Brookings Joint Center for Regulatory Studies, Working Paper 02-10 (October 2002). Kleit estimates that in the absence of CAFE standards, the average fuel economy ratings of General Motors, Ford, and DaimlerChrysler would be 1.05, 1.42, and 0.55 mpg lower, respectively, for their cars and 0.59, 0.5, and 0.4 mpg lower for their light trucks. He estimates the cost of the existing standard at $1,652 per mpg per vehicle, meaning, for example, that the existing CAFE standard for cars costs General Motors $1,734 per car, or (1.05)*($1,652). Further, he finds that the cost of a 3 mpg increase in the CAFE standards would be 33 percent higher if the existing CAFE standards are binding.

    CBO's analysis assumes that current standards are just short of binding, so there would be an economic cost to any increase in the standards, but a small increase would come at a small cost. (Note that consumption-reducing policies that impose no costs on producers and consumers also do not save any gasoline.)

13. Consumers can be expected to discount the value of future fuel savings at a rate at least as high as their cost of borrowing funds. At a 12 percent discount rate, consumers would be unwilling to spend an extra dollar on fuel economy improvements that would lower their fuel costs by, say, 10 cents per year because the cost savings would be less than the annual interest on that dollar.

14. The NRC assumes that the vehicle-miles driven decline at a rate of 4.5 percent annually. In CBO's analysis, the decline is slightly more gradual, corresponding better to the National Household Travel Survey's vehicle usage data, available at http://nhts.ornl.gov/2001/index.shtml.

In this study, CBO uses estimated demand elasticities that originate from a consumer survey developed by General Motors.[15] From industry-level elasticities and estimates of manufacturers' markups of wholesale prices over cost, CBO developed firm-level elasticities that preserved what the survey data implied about the overall market elasticity and the elasticities indicating consumers' propensity to switch vehicle types in response to price changes. The firm-level elasticities further describe consumers' propensity to respond to changes in vehicle prices by switching firms and reflect firms' ability to maintain prices above their marginal costs.[16]

Analyzing the Gasoline Tax

In contrast to the market for automobiles, the gasoline market features substantially undifferentiated products. Retail firms distinguish themselves primarily by mixing proprietary additives with essentially identical gasoline. Each firm's products come in several grades (octane ratings) that may vary in price by 5 to 10 percent, though consumers' choices are governed largely by the fuel requirements of their particular vehicles.

In a market with undifferentiated products, producers have little flexibility in setting retail prices. CBO's analysis therefore does not need to account for strategic pricing by firms and can gauge the effects of a gasoline tax directly from the aggregate supply and demand for gasoline, that is, from the respective price elasticities.

The more inelastic the demand for gasoline—that is, the more that consumers sustain the quantities they purchase when the price rises—the bigger a tax increase would have to be to achieve a given reduction in gasoline consumption, and the greater the associated welfare losses to gasoline producers and consumers.[17] Similarly, the more inelastic the supply—that is, the smaller the increase in the quantities supplied by producers when the market price goes up—the smaller the share of the gasoline tax consumers would pay. Because producers would be absorbing more of the cost in that case, the tax increase would be less effective at reducing consumption.[18]

CBO assumes that the price elasticity of the gasoline supply is 2. That is, a 1 percent increase in the price that producers receive for gasoline would lead to a 2 percent increase in the quantity produced. That value comes from comparing the effects of changes in gasoline prices on the quantities supplied, according to the Energy Information Administration's 2010 forecast.[19]

15. See Kleit, *Impacts of Long-Range Increases in the Corporate Average Fuel Economy Standards*.

16. *Edmunds.com* reports manufacturers' invoice prices to dealers and the manufacturers' suggested retail prices—the difference between which CBO takes as the dealer markup. On the basis of research by Pinelopi Goldberg, CBO assumes that manufacturers' markups are twice as large as dealers'. See Pinelopi K. Goldberg, "Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry," *Econometrica*, vol. 63, no. 4 (July 1995), pp. 891-951. That assumption yields estimates of firms' manufacturing costs and suggests the elasticities indicating consumers' propensity to switch firms. CBO assumes that firms' costs rise with the number of vehicles they produce. Thus, a change in a vehicle's price affects unit costs because it affects the quantity sold.

17. For taxes, welfare losses comprise forgone profits for producers and, for consumers, lost surplus due to a reduction in the amount of gasoline sold. That lost surplus reflects the difference between the price that consumers would have been willing to pay for the gallon that they purchased and the price that they actually paid. Note that for the gasoline actually sold, the higher prices paid by consumers due to a tax, and the lower prices received by producers, are not counted in the measure of welfare loss. The difference between the price paid and the price received, that is, the tax, constitutes a transfer to the public sector and is not considered a cost to the economy. Thus, producers' and consumers' welfare losses under a tax arise solely from decreased sales.

18. According to the Energy Information Administration's projections and CBO's analysis, the cost of producing gasoline would rise somewhat as the quantities supplied increased.

19. See Energy Information Administration, *Annual Energy Outlook*, (January 2003), Appendix B, Tables B11 and B12, available at www.eia.doe.gov/oiaf/archive/ae003/pdf/appb.pdf. CBO found little published information on the supply elasticity of gasoline. Some analyses of gasoline taxes assume a perfectly elastic supply curve—with the costs of supplying gasoline independent of the quantities supplied. If CBO had made a similar assumption, then the gasoline tax would appear to be less costly.

In the short run, consumers respond to a change in the price of gasoline primarily by adjusting their driving behavior. A tax increase would achieve its full effect only in the long run, as consumers replaced their vehicles and fully adapted to the gasoline tax. Specifically, after an increase in the tax, consumers would value fuel economy more, and the average fuel economy of new vehicles could rise.

Those two effects divide the price elasticity of demand into distinct components. One indicates the percentage change in vehicle-miles traveled due to a 1 percent increase in the price of gasoline. The other component indicates the percentage change in the average fuel economy of the vehicle fleet from a 1 percent increase in the price of gasoline. The overall gasoline price elasticity of demand is the sum of those two effects.[20] In the short run, the elasticity of vehicle-miles traveled predominates. In the long run, the elasticity of fuel economy plays a larger role as more consumers purchase new vehicles.

Increasing the price of gasoline in the model—while holding CAFE standards at their baseline levels—causes consumers to seek better fuel economy and permits a direct calculation of the fuel economy elasticity implicit in the analysis. That elasticity depends on technology costs, the value of fuel savings, the propensity of consumers to change their choice of new vehicle in response to a change in vehicle prices, and other factors relevant to the analysis.

By that method, CBO estimates a fuel economy elasticity of about +0.22, meaning that a 10 percent increase in the price of gasoline would eventually result in improvements in fuel economy that would reduce gasoline consumption by 2.2 percent. On the basis of available data, CBO assumes an elasticity of vehicle-miles traveled of –0.2.[21] Thus, the elasticity value that emerges from CBO's simulation model is –0.39, meaning that a 10 percent increase in the price of gasoline would reduce the quantities sold by 3.9 percent. That estimate allows CBO to compare the effects of a gasoline tax increase and of more stringent CAFE standards on the basis of a consistent set of assumptions. The value is in line with more recent estimates of long-run elasticities, which tend toward the low end of the range between –0.3 and –0.9 in the empirical literature.[22] The estimates vary in part because they are sensitive to the type of econometric model used and to the time period covered.

Limitations

CBO's analysis examines the effects of higher corporate fuel economy standards in a market that is based on actual, current conditions. If new types of vehicles are introduced or if consumers' tastes change significantly, the costs of new standards or of a higher tax could be higher or lower than CBO predicts.

20. The overall price elasticity of gasoline consumption can be written as $\beta_Q = \beta_{VMT}(1-\beta_{FE}) - \beta_{FE}$, where the β_x are price elasticities, Q is demand for gasoline, FE is fuel economy, and VMT is vehicle-miles traveled. Thus, the total decrease in gasoline consumption from a permanent increase in the gasoline tax is due to driving less (β_{VMT}, a direct result of the price increase) and buying more-fuel-efficient vehicles ($-\beta_{FE}$, where the minus sign indicates that fuel economy and consumption move in opposite directions), with an adjustment ($-\beta_{VMT} * \beta_{FE}$) for the increase in driving due to improved gas mileage and thus lower vehicle operating costs. That (small) adjustment is referred to as the take-back, or rebound, effect.

21. On the basis of a review of the literature, David Greene concluded that the elasticity for vehicle miles traveled in the long run is about -0.2. See David Greene, "Why CAFE Worked," Oak Ridge National Laboratory (November 6, 1997), p. 12.

22. The range of –0.3 to –0.9 comes from a 1991 survey of 97 estimates of gasoline price elasticity. See Carol Dahl and Thomas Sterner, "Analyzing Gasoline Demand Elasticities: A Survey," *Energy Economics* (July 1991). More recently, the Department of Energy, on the basis of a review of newer studies, suggested an estimate of long-run elasticity of –0.38. See Department of Energy, Office of Policy and International Affairs, *Policies and Measures for Reducing Energy-Related Greenhouse Gas Emissions: Lessons From Recent Literature*, DOE/PO-0047 (July 1996).

For instance, while recent history suggests that producers have not found it profitable to raise average fuel economy, their conclusion could change if higher gasoline prices caused consumers to place a greater value on fuel savings.[23] A shift in preferences toward smaller vehicles could reduce the costs of complying with CAFE standards below the estimates offered in this study. Or to similar effect, manufacturers could introduce vehicle types not included in CBO's analysis (such as smaller, higher-mileage SUVs that handled more like cars). The assumption that increases in CAFE standards would impose costs on consumers and producers—which is consistent with consumers' preferences and producers' decisions over the past 15 years—is a key determinant of CBO's cost estimates.

CBO's analysis is limited to technologies that would improve the fuel economy of gasoline-powered vehicles. It thus excludes vehicles powered by alternative means, such as fuel cells and gas/electric hybrid engines. Such vehicles as yet constitute an insignificant portion of the market. To the extent that their rate of adoption grows and that firms do not offset the resulting fuel economy gains by boosting the performance of their vehicles, the costs of complying with CAFE standards would shrink.

Furthermore, the analysis considers only compliance strategies that do not involve reductions in vehicle weight or performance (such as acceleration). CBO's predictions of costs pertain to a vehicle fleet resembling that actually existing today. Should consumers become willing to sacrifice some weight or performance in their vehicles in exchange for higher fuel economy, compliance costs as measured in this analysis would be reduced, but the true costs would also include the value of the surrendered attributes. Given consumers' current tastes, however, modeling the effects of CAFE standards holding fixed those vehicle attributes other than fuel economy is not a major limitation.

In addition, this analysis does not account for the effects of existing CAFE standards. To the extent that existing standards currently constrain production decisions and the choices that consumers face, the costs of increases would be higher than CBO estimates. In that case, the existing standards would already be requiring producers to sell more-fuel-efficient vehicles than consumers want: therefore, small increases in the standards would add to that existing distortion, creating larger losses for producers and consumers than if there were no existing constraints.

Accounting for the existing tax on gasoline would also raise the predicted costs that a tax increase would impose on producers and consumers of gasoline. The existing tax does not impose a net cost on society, however, if it is justified by the extent to which it discourages driving (thus lowering the social costs of driving, such as traffic congestion) and gasoline consumption. Some research indicates that the social benefits created by taxing gasoline may justify a tax rate significantly higher than the existing rate.[24]

Assumptions about the price elasticity of vehicle-miles traveled affect CBO's prediction of the relative costs of an increase in the gasoline tax and an increase in CAFE standards. If a lower elasticity value were assumed for vehicle-miles traveled, the implied gasoline price elasticity would also be lower, and a tax would appear to be less effective at reducing gasoline consumption. In contrast, CAFE standards would appear to be relatively more efficient because raising the standards—and reducing vehicles' operating costs—would have a smaller (though still positive) predicted effect on the amount people drive, thus enhancing the standards' ability to reduce gasoline consumption.

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23. CBO assumed a constant real price of gasoline when calculating the value that consumers would attach to improvements in fuel economy. The real price of gasoline spiked in the early 1980s but it hovered between $1.20 and $1.35 (measured in 1996 dollars) in 11 of the 15 years from 1986 to 2000.

24. See Ian W.H. Parry and Kenneth A. Small, "Does Britain or the United States Have the Right Gasoline Tax?" Discussion Paper, Resources for the Future (Washington D.C.: Resources for the Future, 2001).

CHAPTER

3

Results

The biggest firms in the U.S. passenger vehicle market currently achieve average fuel economy ratings about equal to the existing corporate average fuel economy standards for cars and light trucks. Consequently, increasing the standards would force those firms—or, if the increases were large enough, all firms—to raise the average fuel economy of the vehicles they sell, imposing costs on both producers (in the form of reduced profits) and consumers (in the form of higher vehicle prices, net of the value of gasoline savings).

If firms were permitted to trade fuel economy credits, it would lower the incremental cost of reducing gasoline consumption by transferring the adoption of fuel-saving technologies from firms with higher costs of improving fuel efficiency (that is, firms with lower fuel economy ratings) to firms with lower costs. Given the choice of improving average fuel economy or buying credits, firms would pursue the means of complying that was least expensive for them. As a result, every firm would end up with the same marginal cost per gallon saved.

An increase in the gasoline tax would be an even less costly way to reduce gasoline consumption. In fact, a tax increase would have a significant advantage over more stringent CAFE standards in the initial years because, while consumers would only gradually buy new, more-fuel-efficient vehicles, they would reduce their driving immediately in response to the tax. That change would not only reduce gasoline consumption, but it would also lower other social costs of driving, such as traffic congestion and the frequency of accidents. In contrast, higher CAFE standards would tend to encourage driving (by lowering the per-mile cost) and would thus increase those social costs.

Measurement Concepts

The costs that higher CAFE standards would impose on consumers have two components: higher prices paid by purchasers of new vehicles and a loss in the well-being of consumers who would be discouraged from buying a new vehicle because of the higher prices. In measuring the vehicle price increases that would result from mandated improvements in fuel economy, the Congressional Budget Office subtracts the value of the gasoline savings that purchasers would derive over the lifetime of their vehicles, reflecting the assumption that consumers take fuel savings into account in their decisions about purchasing new vehicles.

A tax increase would, similarly, raise gasoline prices and reduce the quantity sold, which would also reduce the welfare of gasoline consumers. They would adjust to a higher tax by driving less as well as by potentially choosing more-fuel-efficient vehicles.

CBO measures producers' lost welfare as the reduction in their net revenues, or profits. With an increase in CAFE standards, average vehicle production costs would rise more than prices would as firms added fuel-saving technologies. Thus, firms' vehicle profit margins would decline, as would total vehicle sales. In the case of a gasoline tax increase, while the retail price of gasoline would rise, the price received by gasoline producers and suppliers would fall—with the tax increase making up the difference.[1]

1. Aggregate welfare losses may not be the sole criterion for favoring one policy over another. Other considerations could include fairness (a policy's effect on different income, demographic, and/or geographic groups) and certainty (the likelihood that a given policy would achieve its target). See Congressional Budget Office, *"Reducing Gasoline Consumption: Three Policy Options."*

The Relationship Between Increases in CAFE Standards and Reductions in Gasoline Consumption

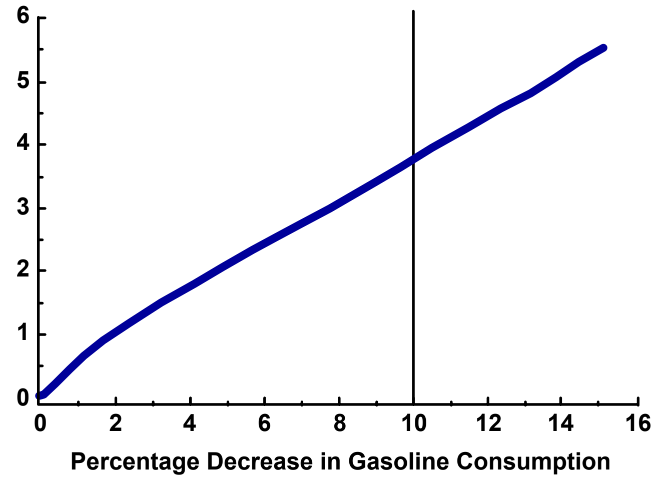
CBO considered various ways that CAFE standards could be raised or restructured. With separate standards for cars and for light trucks, the standards could be raised in equal or unequal increments, in either nominal or percentage terms, of miles per gallon or of gallons per mile (gpm). Here CBO analyzes the effects of raising both standards in equal-mpg increments and of introducing fuel economy credit trading.

Because of the difference in the average fuel economy for cars and light trucks, an equal-mpg increase in the CAFE standards for both would reduce the average rate of fuel consumption (measured in gallons per mile) more for light trucks than for cars. For example, raising both standards by 3.8 mpg (to 31.3 mpg for cars and 24.5 mpg for light trucks) would lower the average rate of gasoline consumption for light trucks by 15 percent, from (1/20.7) gpm to (1/24.5) gpm, while the rate for cars would fall by 12 percent. Because not all firms would have to improve their average fuel economy by this much to comply with the new standards and because the higher fuel economy would encourage additional driving, the overall reduction in gasoline consumption would be 10 percent (*see Figure 3-1*). Small increases in the standards would not require any actions by manufacturers with CAFE ratings above the current standards (thus explaining the initial, steeper portion of the curve).

Figure 3-1.

Gasoline Savings from Raising CAFE Standards by an Equal Number of Miles per Gallon for Both Cars and Light Trucks

(MPG increase in standards)



Source: Congressional Budget Office.

Total Long-Run Costs

CBO measures the total annual private welfare losses (ignoring benefits) of an increase in CAFE standards in the long run—that is, once all of the existing vehicles are retired (or after 14 years, by CBO's assumption). CBO considers any increase in CAFE standards to be binding, meaning that some firms in CBO's simulation model are currently just compliant and that any increase in the standards would therefore force them to raise the average fuel economy of their new-vehicle fleet. Consequently, higher standards would necessarily reduce the welfare of producers and consumers of new vehicles.

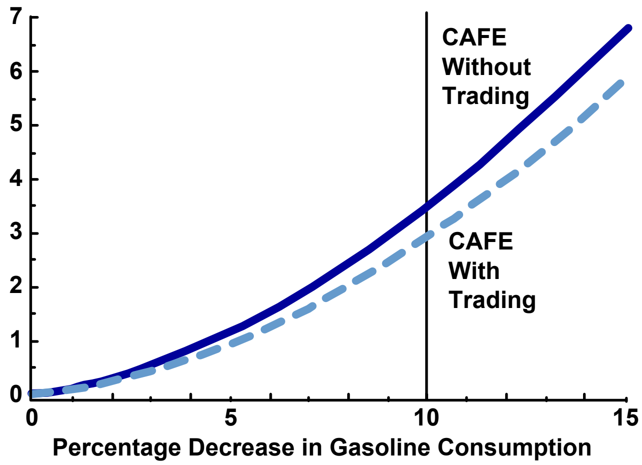
The total costs associated with setting car and truck standards so as to reduce gasoline consumption by the benchmark target of 10 percent would reduce producers' and consumers' welfare by about $3.6 billion per year (*see Figure 3-2 on page 17 and Table 3-1 on page 18*). If firms were allowed to trade fuel economy credits in order to comply, the costs of achieving the benchmark target would fall to about $3.0 billion per year, representing a savings of 16 percent.[2] Greater reductions in gasoline consumption would result in increasingly higher costs.

2. All results in this report, including the costs described here, are annual and are for vehicles produced in a single model year. For this analysis, CBO assumes that the new CAFE standards would allow sufficient lead time for firms to redesign their products as necessary, in particular so that the relevant fuel economy technologies would be available.

Figure 3-2.

Costs of Reducing Gasoline Consumption Through More Stringent CAFE Standards, With and Without Credit Trading

(Billions)



Source: Congressional Budget Office.

As with CAFE standards themselves, a credit-trading program could be structured in various ways. The most important consideration is whether to give credits to firms whose baseline fuel economy would already be above the new standards or to award credits only for further improvements. Rewarding preexisting overcompliance would allow firms to sell some credits based on fuel economy gains made before the standards were raised, so as the CAFE standards were raised, gasoline consumption would not actually drop until those credits were used up. Awarding credits only for improvements made after the standards were raised, though, would effectively penalize firms for voluntarily overcomplying with the existing standards. For that reason, CBO's results are based on awarding credits for preexisting overcompliance.

The costs of achieving a given reduction in gasoline consumption via a tax increase depend on the price elasticities of the demand for and supply of gasoline. The lower the price elasticity of demand is, the less responsive consumers are to price changes, and thus the greater the tax increase (and associated welfare cost) that would be necessary to save a given amount of gasoline. The higher the supply elasticity is, the greater the share of a gasoline tax that would be borne by consumers and thus the more effective the tax and the lower its cost. CBO's assumptions about the demand and supply elasticities in the gasoline market imply that consumers' share of a tax would be about 85 percent. If the supply was perfectly elastic, consumers' share of the tax would be 100 percent. In that case, producers' costs would be unaltered by the change in demand due to the tax—and the full amount of the tax would be passed on to consumers in the form of higher prices.

The long-run annual costs of a gasoline tax increase designed to achieve the benchmark reduction in consumption would be $2.9 billion under CBO's assumptions about the demand and supply elasticities for gasoline (*see Table 3-1 on page 18*). That figure would fall to $2.5 billion if the gasoline supply is perfectly elastic. Importantly, although the long-run annual costs of the tax would be only slightly less than those of higher CAFE standards with credit trading, the tax would have a significant advantage over CAFE standards in the initial years of the policies, before the stock of existing vehicles was replaced (see the upcoming discussion in the section "Cost Savings and Gasoline Savings in the First 14 Years"on page 20).

CBO's analysis considers only the direct effects that increases in CAFE standards or a gasoline tax would have on the vehicle and gasoline markets. Including effects on other markets—such as capital and labor markets—could significantly increase the total welfare losses of each of the policies analyzed (*see Box 3-1 on page 19*).

Consumers' and Producers' Shares of the Total Long-Run Costs

By CBO's estimates, consumers would bear the majority of the costs of higher CAFE standards and, relative to automakers, would share in few of the gains from credit trading. For example, meeting the benchmark target with CAFE standards would impose costs on vehicle producers of about $1.2 billion without trading and about $0.8 billion with trading, or roughly 1.4 percent and 1 percent, respectively, of their total annual net revenues (*see Table 3-1*). But costs to consumers would be roughly $2.4 billion and $2.2 billion, respectively.

Table 3-1.

Total Long-Run Annual Costs to Achieve a 10 Percent Reduction in Gasoline Consumption Under Alternative Policies

(Billions of dollars)

	CAFE Standards		
	Without Trading	With Trading	Gasoline Tax
Policy Modeled	31.3 mpg for cars 24.5 mpg for light trucks		46-cent-per-gallon increase
Total Welfare Costs[a]	3.6	3.0	2.9
Producers' costs	1.2	0.8	0.5
Consumers' costs	2.4	2.2	2.4

Source: Congressional Budget Office.

Note: CAFE = corporate average fuel economy; mpg = miles per gallon.

a. For producers, costs are measured as reductions in total profits, while for consumers, they are measured as reductions in the amount that consumers value their new vehicles over and above the purchase price.

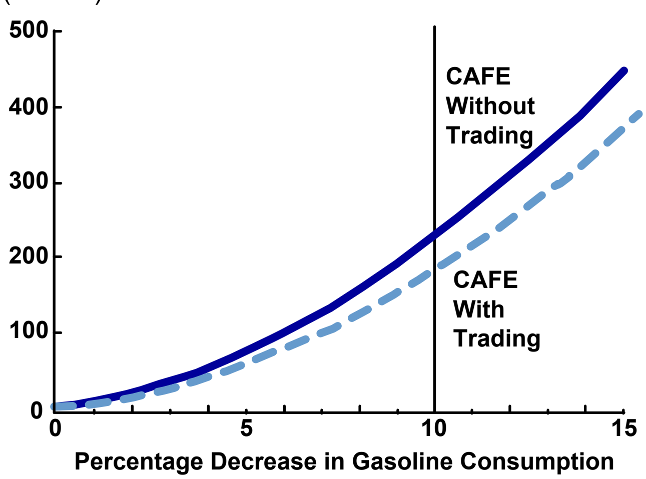
The ratios of consumers' costs to producers' costs—about 2 to 1 without trading and nearly 3 to 1 with trading—depend on the demand for and the supply of new passenger vehicles and on the degree of product differentiation among them. The latter helps producers set prices above marginal costs without losing many sales. On the basis of the empirical evidence described previously, CBO assumes that consumer demand for new passenger vehicles is somewhat elastic at about –1.4 (so a 10 percent price increase for all vehicles would reduce unit sales by 14 percent) and that producers have some market power, allowing them to maintain profit margins that, in CBO's simulation model, range from about 17 percent for compact cars to 26 percent for large SUVs.

On a per-vehicle basis, the simulation model predicts that the average total welfare loss associated with using CAFE standards to reduce gasoline consumption by 10 percent would be about $228, of which roughly $153 would come from consumers. Under the credit-trading system, the average per-vehicle cost is predicted to be $184, with consumers bearing $142 of that amount (*see Figure 3-3*). Producers' costs for that level of gasoline savings would be about $75 per vehicle, or about $42 with credit trading. As mentioned, those costs reflect higher vehicle prices (net of the value of the discounted gasoline savings), lower vehicle sales, and reduced profit margins. Consumers' costs are averages of the lost welfare for consumers who purchase new vehicles under the higher CAFE standards and for those who would have purchased but for the higher new-vehicle prices; the size of the latter group is a small fraction of that of the former.

Figure 3-3.

Costs per Vehicle of More Stringent CAFE Standards, With and Without Credit Trading

(Dollars)



Source: Congressional Budget Office.

Box 3-1.

Effects on Markets Not Included in This Analysis

One limitation of the Congressional Budget Office's (CBO's) study is that it measures the costs that increases in the corporate average fuel economy (CAFE) standards or gasoline taxes would impose on producers and consumers of vehicles and gasoline but does not measure costs in other affected markets. Accounting for effects on, for instance, the labor and capital markets would require using a "general-equilibrium" approach—modeling the entire economy, not just the markets directly affected. Including the effects on other markets could substantially increase estimates of the costs of both policies. However, CBO does not believe that including those effects would alter the basic conclusion that an increase in the tax on gasoline would be a more cost-effective way to reduce gasoline consumption than an increase in CAFE standards would, because it would not change the fact that a gasoline tax would achieve much greater reductions in gasoline consumption—at a much lower cost—in the initial years of the policy. Furthermore, a higher gasoline tax would generate revenues that policymakers could use to offset inefficiencies in other markets, but higher CAFE standards would not offer that possibility.

Many analysts have concluded that pollution-reducing policies could generate significant welfare losses in labor and capital markets by exacerbating the discouraging effect that existing taxes on labor and capital have on economic activity.[1] By raising the prices of new passenger vehicles and of gasoline, an increase in CAFE standards or in the gasoline tax would lower the real (inflation-adjusted) returns to labor and capital. Those effects, in turn, would reduce the incentive of households to work and to save and invest. While the change in the amount of labor or capital supplied as a result of the gasoline-saving policies would be small, the welfare loss could be large because capital and labor markets are already heavily taxed.[2] Small changes in the supply of factors in heavily taxed markets can create relatively large welfare costs—a result referred to as the tax interaction effect.

Increases in the CAFE standards or in the gasoline tax could generate a tax interaction effect. The policies would differ, however, in other ways that they affected the economy. An increase in the CAFE standards would decrease revenue (by reducing gasoline sales and hence the amount of taxes collected at the current rate), while an increase in the gasoline tax would raise additional revenues (outweighing the loss in revenue associated with declining gasoline sales). If they chose to, policymakers could use the additional revenues generated by an increase in the gasoline tax to decrease taxes on labor and/or capital, thereby offsetting some of the tax interaction effect. In contrast, maintaining the level of revenue following an increase in CAFE standards would necessitate increasing taxes.

1. For a survey of the literature, see A. Lans Bovenberg and Lawrence H. Goulder, "Environmental Taxation and Regulation," in Alan Auerbach and Martin Feldstein, eds., *Handbook of Public Economics*, 3rd ed. (Amsterdam: Elsevier, 2002).

2. Researchers have proposed a formula that can determine the increase in the total welfare cost that commodity taxes, such as a gasoline tax, would have if effects on the labor market were considered. See Lawrence H. Goulder and Roberton C. Williams III, "The Substantial Bias from Ignoring General Equilibrium Effects in Estimating Excess Burden, and a Practical Solution," *Journal of Political Economy*, vol. 111, no. 4 (August 2003), pp. 898-927. On that basis, the total welfare cost of a 46-cent increase in the gasoline tax could be more than twice as high as CBO estimates. Unfortunately, no such formula is available for environmental standards, such as CAFE standards, so CBO compares the two policies on a partial-equilibrium basis.

Total Long-Run Costs for Firms Buying Credits and Firms Selling Them

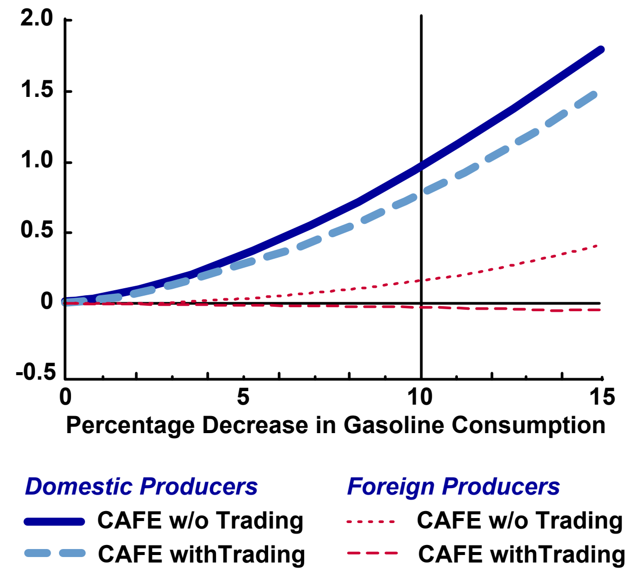
Although most automakers are now multinational entities, the distinction between "domestic" and "foreign" reflects the firms' corporate histories and is useful here in identifying the buyers and sellers of credits. Most of the demand for credits would come from domestic firms, and virtually all of the supply would come from foreign firms.

Both domestic and foreign firms would benefit from trading, according to CBO's analysis. Domestic firms would have reduced welfare losses because buying credits would lower their costs of complying. Foreign firms could be better off than they would have been in the absence of an increase in CAFE standards because, in the aggregate, the extra revenue that they would get from selling the credits they earned by going beyond the new standards could more than cover their costs of doing so (*see Figure 3-4*).[3] The disparity between domestic firms' and foreign firms' total costs partly reflects differences in compliance costs per vehicle but occurs primarily because domestic firms sell more vehicles in the United States than foreign firms do.

Figure 3-4.

Domestic and Foreign Producers' Costs for More Stringent CAFE Standards, With and Without Credit Trading

(Billions of dollars)



Source: Congressional Budget Office.

Cost Savings and Gasoline Savings in the First 14 Years

Depending on consumers' responses to an increase in the price of gasoline, the annual long-run costs of reducing gasoline consumption via higher CAFE standards as opposed to an increase in the gasoline tax may not differ very dramatically. Because both policies would promote fuel economy in new vehicles, they would not reach their full effectiveness until all existing vehicles were replaced with newer ones manufactured after the policies were enacted.

However, until the long run has been reached, that is, until the 14 years constituting the average life of a vehicle have passed, a gasoline tax would save much more gasoline, at a much lower cost, than would an equivalent increase in CAFE standards. Both policies would gradually increase average vehicle fuel economy, as older vehicles were retired. But that changeover would account for only about half of the total effect of a gasoline tax. The other half of the effect would occur immediately, as consumers responded to higher retail gasoline prices by driving less. Because all vehicles, not just new ones, would be driven less, a tax would be initially much more effective than an equivalent increase in CAFE standards. In fact, over the initial 14 years, a tax designed to reduce gasoline consumption by 10 percent would save an additional 27 billion gallons of gasoline, or 42 percent more, and would cost nearly 30 percent less (*see Figure 3-5*).[4] The costs of the CAFE standards would be the same in all 14 years. The costs of the gasoline tax would increase annually, as improvements in fuel efficiency further reduced gasoline consumption, until the steady state was reached.

3. CBO's predicted division of gains from trading between buyers and sellers of fuel economy credits assumes that the credit market would be perfectly competitive, implying a single market-clearing price equal to the cost of supplying the "last" (and most expensive) credit. But with relatively few agents, as in the automobile market, sellers could realize greater gains at the expense of buyers, or vice versa. However, because both parties would have an incentive to continue trading until all possible gains were realized, the number of credits traded and the gains available from trading need not depend on whether the trading market is competitive.

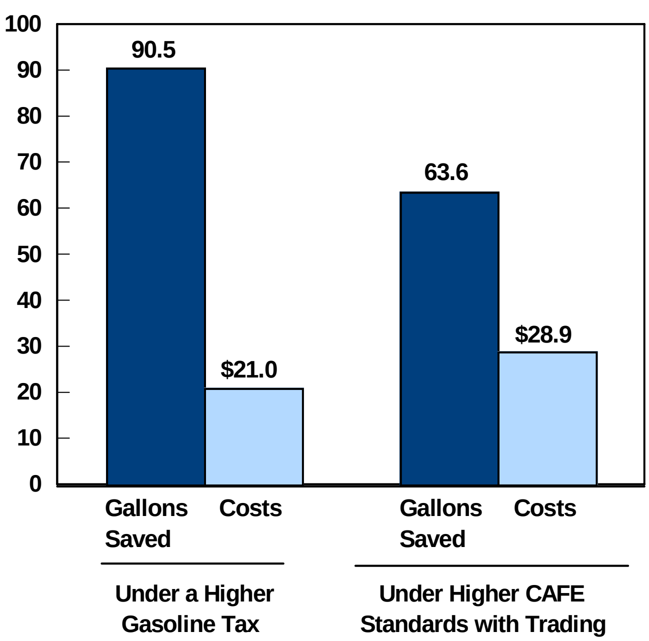
4. The costs and savings have been discounted to present-value terms at an annual rate of 6.2 percent, reflecting the relative price volatility of petroleum.

The advantage of a tax stems from its greater scope for reducing gasoline consumption: only the tax would encourage behaviors such as carpooling, relying on public transportation, or combining trips. By contrast, higher CAFE standards could encourage driving by lowering the operating costs of new vehicles, thus offsetting some of the potential gasoline savings from raising the standards. Under CBO's assumptions, in its first year the tax would save about seven times as much gasoline as the equivalent CAFE standards would. That advantage would decline in each subsequent year, and in the long run, that is, after 14 years, both policies would, by design, save the same amount of gasoline per year.

Figure 3-5.

The Effects of CAFE Standards with Trading Versus a Gasoline Tax Over the First 14 Years

(Billions)



Source: Congressional Budget Office.

Notes: CAFE = corporate average fuel economy.

The figure depicts effects over the first 14 years (after which all current vehicles are assumed to be retired) from policy changes that would bring about a 10 percent reduction in gasoline consumption.

The Long-Run Effects of Increasing CAFE Standards on the Passenger Vehicle Market

The size of the passenger vehicle market could shrink by several percent if CAFE standards were raised significantly (*see Figure 3-6*). On a percentage basis, unit sales of light trucks would ultimately decline about twice as much as would those of cars, primarily reflecting the particular CAFE policies that CBO modeled—that is, car and light-truck standards raised in equal-mpg increments but from different starting points. As noted earlier, because the current standard for light trucks is lower than that for cars, a given mpg increase would require a greater percentage reduction in gasoline consumption by trucks than it would by cars.

Moderate increases in CAFE standards would not have a very large effect. The benchmark increase of 3.8 mpg in the standards would result in a predicted decline of only 1.3 percent in unit sales of light trucks and a 0.2 percent decline in car unit sales (as indicated in Figure 3-6). Those declines result from an increase of approximately 0.5 percent in average vehicle prices, after accounting for the value of the resulting gasoline savings.

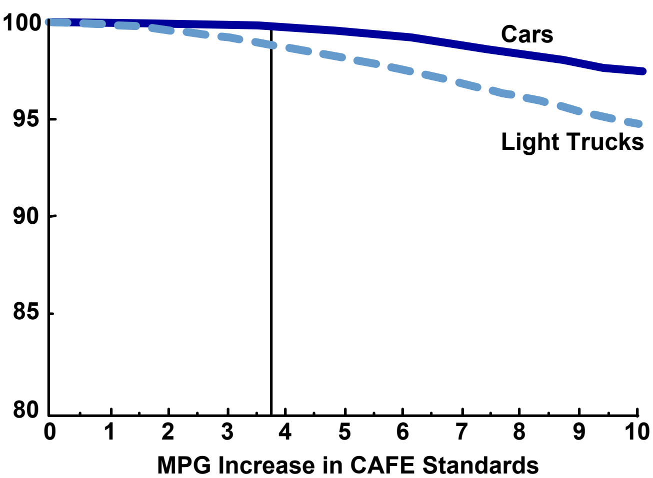
According to CBO's simulation model, the price increases of fuel-efficient cars and light trucks would tend to be less than the costs of the fuel-efficiency technologies installed by the manufacturers. Buyers of those vehicles could enjoy benefits (in terms of better mileage) worth well in excess of the increase in purchase price, while price increases for low-mpg vehicles could exceed the added cost of the new technologies. The difference could occur because higher CAFE standards would give firms an incentive to draw consumers toward more-fuel-efficient vehicles. In effect, buyers of vehicles with poor fuel economy would be subsidizing buyers of fuel-efficient vehicles.

Not all of the decline in the unit sales of cars and light trucks would be permanent. Some of the depicted decline represents delayed purchases: faced with higher vehicle prices, some consumers would simply drive their current vehicles an extra year or two before replacing them. The simulation model captures both delayed and permanently lost sales, and it is not possible to say how much of the decline is due to which effect. It is likely, though, that

Figure 3-6.

The Effect of More Stringent CAFE Standards on Sales of Cars and Light Trucks

(Percent)



Source: Congressional Budget Office.

because some of the "lost" sales are merely delayed, the true long-run effects of higher CAFE standards on unit sales would be slightly lower than predicted by CBO's model.

Could Increases in CAFE Standards or the Gasoline Tax Improve Social Welfare?

Because raising CAFE standards would impose costs on both producers and consumers, an important question is whether those costs would be outweighed by the benefits that they would bring about.

In the absence of existing policies to discourage the use of gasoline (and other complications described below), the optimal increase in CAFE standards could be determined by balancing the costs of tightening the standards against the resulting benefits stemming from the reduction in gasoline consumption. The fact that existing policies—such as federal, state, and local taxes on gasoline—already discourage gasoline consumption complicates the picture.

If the existing per-gallon tax was equal to the existing external costs associated with consuming a gallon of gasoline (or, alternatively, the social benefits associated with reducing consumption by one gallon), then there would be no need to increase the CAFE standards. The tax on gasoline would give buyers just the right incentive to change their behavior to reflect the costs that consuming gasoline imposes on society.

If the tax on a gallon of gasoline was less than the external costs associated with consuming that gallon, then higher CAFE standards could potentially benefit society. In that case, one would need to weigh the additional benefit associated with reducing gasoline consumption—a benefit equal to the external costs less the existing tax—against the costs that the higher standards would impose on producers and consumers of vehicles (costs that are quantified by CBO's model).

Finally, if the existing tax on gasoline was greater than the external costs associated with consuming gasoline, then increasing CAFE standards could make society worse off. Higher CAFE standards would force further reductions in gasoline consumption, even though the existing tax was already causing consumers to reduce their consumption by a greater amount than was justified by the external costs that the consumption imposed on society.[5] In that case, the social "benefit" associated with saving one more gallon of gasoline through higher CAFE standards would be negative.

Two key questions, therefore, are, What is the existing tax on gasoline, and, What are the costs that consuming a gallon of gasoline imposes on society? The first question is easy to answer. The average federal, state, and local tax paid on a gallon of gasoline is 41 cents. The second question, however, is very difficult to answer.

In its recent report, the National Research Council suggested that there are two primary external costs associated with gasoline consumption that could be addressed by increasing the CAFE standards. First, gasoline combustion releases carbon into the atmosphere, and those emissions are thought to lead to a gradual warming of the Earth.

5. Having a gasoline tax that was greater than the external costs associated with consuming a gallon of gasoline could be justified on other grounds. It could be an efficient means of raising revenues, or it could reflect external costs associated with driving—such as traffic congestion or an increased risk of accidents—that would be diminished by a higher gasoline tax but not by higher CAFE standards.

Second, gasoline consumption adds to the United States' dependency on oil and, therefore, increases the country's vulnerability to disruptions in the world supply of oil.

While acknowledging uncertainty, the NRC tentatively suggested an estimate of 12 cents to reflect the cost of carbon emissions resulting from a one gallon decrease in gasoline consumption (which corresponds to a cost of $50 per metric ton of carbon). Further, it suggested an energy-security cost associated with consuming one gallon of gasoline of 12 cents (which corresponds to a cost of $5 per barrel of oil). Finally, the NRC estimated a cost of 2 cents per gallon due to emissions of air pollutants associated with the production and distribution of gasoline, resulting in total external costs of 26 cents per gallon.[6]

If the NRC's estimate of 26 cents for the external costs of consuming a gallon of gasoline is correct, then the existing tax on gasoline of 41 cents already provides buyers of new vehicles with an incentive to pursue fuel economy up to a cost that exceeds by 15 cents the benefits associated with reducing gasoline consumption.[7] In that case, higher CAFE standards would impose unwarranted costs on automakers and new-vehicle buyers—and thereby would reduce social welfare.[8]

Estimating the external costs associated with consuming gasoline is beyond the scope of this study, and CBO does not endorse the NRC's estimate. However, given the existing gasoline tax of 41 cents per gallon, higher CAFE standards would have the potential to improve social welfare only if the external costs associated with consuming gasoline exceeded 41 cents per gallon—a figure significantly higher than the external costs suggested by the NRC.

Higher CAFE standards could further reduce social welfare by worsening traffic congestion and increasing the number of traffic accidents.[9] That undesirable effect could occur because higher CAFE standards would lower the per-mile cost of driving, providing owners of new vehicles with an incentive to drive more. While the increase in driving associated with higher CAFE standards might be relatively small, some studies suggest that the resulting costs of the increased congestion and traffic accidents may nevertheless be large.[10]

A complete determination of the potential for higher CAFE standards to improve social welfare requires accounting for both the effect of the existing gasoline tax as well as the CAFE-induced increase in driving-related costs. Increased CAFE standards have the potential to improve social welfare only if the reduction in the costs of climate change and oil dependency due to higher CAFE

6. See National Research Council, *Effectiveness and Impact of CAFE Standards,* p.8.

7. Producers of gasoline might bear part of the tax. In that case, the price of gasoline would increase by less than the amount of the tax. In either case, however, the incremental cost of the tax (borne by producers and consumers) would be 41 cents.

8. CBO estimates that for CAFE standards with trading, the marginal cost of reaching the benchmark target (that is, the cost of saving the "final" gallon of gasoline) is 33 cents per gallon saved (with the external costs resulting from the increase in driving ignored).

9. In addition to increasing the risk of an accident occurring, according to some analysts, higher CAFE standards could increase the harm that accidents cause by leading to lighter, smaller vehicles. That claim is controversial, however. Some members of the NRC panel argue that the "relationships between vehicle weight and safety are complex and not measurable with any degree of certainty at present." See National Research Council, *Effectiveness and Impact of CAFE Standards*, p.117.

10. For example, one study estimates that the external cost of each additional mile driven is $0.035 from the additional congestion and $0.03 from the additional accident risk. See Parry and Small, "Does Britain or the United States Have the Right Gasoline Tax?"

standards is greater than the existing tax on gasoline plus the CAFE-induced increase in congestion and accident costs.[11]

While the existing tax on gasoline exceeds the NRC's estimate of the external costs associated with consuming gasoline, the tax is not necessarily too high. Gasoline taxes serve other purposes besides encouraging gasoline buyers to take the external costs of gasoline consumption into account. Gasoline taxes also discourage driving. Determining the "optimal" tax on gasoline is beyond the scope of this study, but such a determination might take into account the external costs that are associated with driving—but that are independent of the amount of gasoline consumed—such as traffic congestion and accident risk.[12] Finally, a determination of the optimal tax might include the external costs associated with consuming gasoline (the costs of oil dependency and carbon emissions, discussed above). Such an assessment could conclude that increases in the existing tax on gasoline could improve social welfare.[13]

11. The authors of a forthcoming study have attempted to make this complete assessment. They find that the existing tax on gasoline, as well as the costs associated with CAFE-induced increases in driving, make it appear that increases in CAFE standards could significantly reduce overall welfare. However, the authors cannot agree on whether increases in CAFE standards would be preferable to no gasoline-saving policy. They indicate that higher CAFE standards would have the potential to improve social welfare if the benefits of reduced oil consumption and carbon emissions increased over time, if technologies to improve fuel economy turned out to be less expensive than anticipated, or if the current market fails to provide optimal incentives for fuel economy innovation. See Paul R. Portney et al., "The Economics of Fuel Economy Standards," *Journal of Economic Perspectives* (forthcoming).

12. Some researchers have proposed a gasoline tax as a means of addressing those externalities, provided that other, more direct means are not feasible. More direct methods of addressing such externalities could involve using congestion pricing (tolls that rise with traffic density as a way of controlling highway congestion) or tying insurance premiums to the number of miles driven.

13. One study concludes that the optimal tax on gasoline would be $1.01. See Parry and Small, "Does Britain or the United States Have the Right Gasoline Tax?"