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Climate-Change Policy and CO_2 Emissions from Passenger Vehicles

Summary

Human activities are producing increasingly large quantities of greenhouse gases, particularly carbon dioxide (CO_2), and their accumulation in the atmosphere is expected to affect the climate throughout the world. This Congressional Budget Office issue brief examines the role of passenger vehicles (cars and light trucks) in the U.S. effort to curb those emissions. In particular, the brief looks at how putting a price on CO_2 emissions—for example, through a cap-and-trade system—would affect gasoline prices and, as a consequence, vehicle emissions.

Charging a price for CO_2 emissions would raise the price of gasoline, but that increase—and the resulting decrease in vehicle emissions—would be relatively small. Most of the reduction in CO_2 emissions would occur in other sectors.

The initial impact on vehicle emissions would be particularly small: People could drive less and at slower speeds, and some could switch to public transit, but in the short run they would have few other alternatives. Over time, consumers could respond to higher gasoline prices by buying more fuel-efficient vehicles and reducing their commuting distance when an opportunity arises. Substantial increases in gasoline prices in recent years have triggered measurable responses of both types. But a CO_2 price high enough to induce sizable reductions from other sources of emissions would have only a small effect on vehicle emissions of CO_2. Recent changes to the automobile fuel economy standards—greatly increasing their stringency—will result in a substantial decline in vehicle emissions whether gasoline prices increase or not.

Global climate change is among the most serious long-term challenges facing the nation. The accumulation of greenhouse gases in the atmosphere could have serious and costly effects throughout the world. Although the magnitude of those effects remains highly uncertain, there is growing recognition of the risk that it may be extensive and perhaps catastrophic.

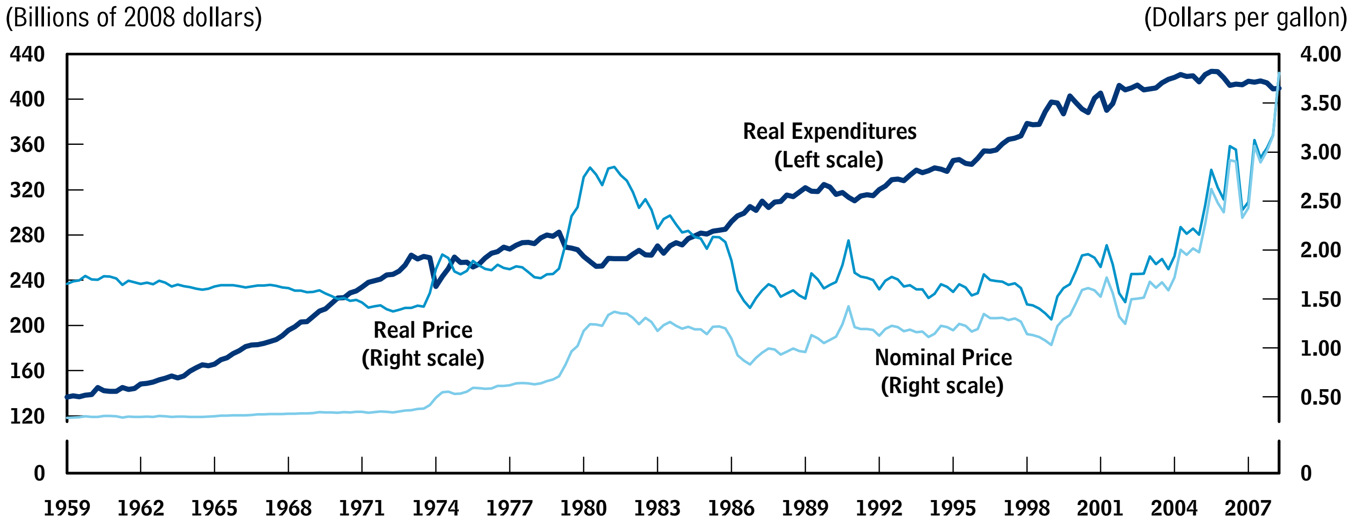
Reducing greenhouse-gas emissions would lower the economic and human health risks associated with a changing climate. The primary greenhouse gas is carbon dioxide (CO_2), and according to the Environmental Protection Agency (EPA), about 20 percent of total U.S. emissions of CO_2 are from passenger vehicles (cars and light trucks). Those emissions are directly related to the amount of gasoline a vehicle uses, which in turn depends on the number of miles the vehicle is driven and on its fuel economy.

For many households, the choices of which car to drive and how much to drive it are among the most visible ways in which individuals contribute to climate change. Yet research suggests that policies to reduce greenhouse-gas emissions by setting a price on them (through a cap-and-trade system or a carbon tax, for example) would have relatively little effect on vehicle emissions. Instead, most of the reductions would come from other sources—particularly electric power generators—from which emissions might be reduced at lower cost.

A cap-and-trade system or a carbon tax would raise the price of gasoline, encouraging consumers to drive less and to buy vehicles that are more fuel efficient, but the effects on the price of gasoline and on consumers' choice of vehicles and driving behavior would be modest under most policy proposals. For example, despite the recent dra-

Figure 1.

Personal Expenditures for Gasoline and the Average Price of Gasoline in the United States



Source: Congressional Budget Office based on data from the Bureau of Economic Analysis and the Energy Information Administration.

Note: Consumer expenditures are for gasoline and motor oil through June 2008 (motor oil is about 1.5 percent of the total).

Consumer expenditures were adjusted for inflation by CBO using the Bureau of Economic Analysis's (BEA's) chained price index for gasoline and other motor fuel. Changes in expenditures therefore reflect changes in gallons consumed. Real (inflation-adjusted) gasoline prices were calculated by CBO using BEA's consumer price index for all urban consumers.

matic rise in gasoline prices—substantially more than would occur under the types of climate policy being discussed—the decline in gasoline consumption and, correspondingly, in vehicle emissions has been relatively small.

A study by the Congressional Budget Office (CBO) found that the rise in gasoline prices between 2003 and 2007 (from $1.50 to more than $3.00 per gallon) caused only a small decline in the amount of driving; a slight reduction in vehicle speeds on uncongested freeways; a moderate increase in the purchase of cars relative to light trucks, such as sport–utility vehicles (SUVs) and minivans; and somewhat better average fuel economy for new cars and light trucks.[1]

Furthermore, imposing a price on CO_2 emissions is unlikely to cause the passenger-vehicle fleet to become more fuel efficient because the recently revised corporate average fuel economy (CAFE) standards already require greater improvements in fuel economy than a CO_2 price would achieve.[2] Those standards will result in a decline in CO_2 emissions irrespective of whether those emissions are priced. Thus, reductions in vehicle emissions would constitute only a small fraction of the total reduction in CO_2—probably less than 5 percent—that would occur under a policy of pricing CO_2 emissions.

This issue brief updates the findings from CBO's earlier study, describing how consumers responded as gasoline prices continued to climb, to more than $4 per gallon by May 2008, where they remained for much of the summer.[3] The brief then looks at how pricing CO_2 emissions would affect passenger vehicles and driving behavior, and it assesses the potential reductions in vehicles' CO_2 emissions that would result from such a pricing policy.

Gasoline Prices, Driving Behavior, and Choice of Vehicle

In response to increases in the price of gasoline, individuals can reduce their gasoline consumption by changing their driving behavior, the type of vehicle they drive, and eventually where they choose to live and work. In the short run, most of their adjustment is in the form of changed behavior, with only a modest effect on gasoline consumption. In the longer run, consumption becomes more sensitive to higher prices because motorists are able to respond in ways they cannot in the short run—

Table 1.

Estimated Effects of a $2 Increase in the Price of Gasoline on Speeds on Uncongested Highways

(Miles per hour)

Speed Percentile	Speed in 2004	Reduction in Speed
15th	65.4	1.4 to 2.4
Median	68.4	1.0 to 1.5
85th	70.8	0.6 to 0.75

Source: Congressional Budget Office based on data from the California Department of Transportation for January 2004 through April 2008.

Note: Sample includes six freeway locations in California: Northbound I-680 in San Ramon, east of Oakland; Northbound I-880 in San Jose; Westbound SR 60 in City of Industry (eastern Los Angeles County); Southbound I-405 in Westminster (Orange County); Eastbound SR 78 in San Marcos (northern San Diego County); Westbound I-8 in San Diego.

particularly by choosing vehicles that get better gasoline mileage. Sustained high prices would eventually alter land-use patterns, as people began to seek homes and job locations that would reduce their commuting distance.

Driving Behavior

Although some important aspects of driving behavior—particularly the length of the commute to work—cannot be adjusted quickly in response to changes in the price of gasoline, motorists can quickly make other changes to save gasoline (and they can revert just as quickly if prices go down). They can drive more slowly, accelerate more gradually, take fewer discretionary trips, use shopping or recreation sites that are closer to home, or switch to other modes of transportation where possible.

In response to higher gasoline prices beginning in 2003, gasoline consumption began to grow more slowly in the United States and, eventually, to decline (see Figure 1).[4] With sharply higher prices in 2008, total miles of vehicle travel have been lower each month than in the corresponding month in 2007—a phenomenon not seen in the United States since 1979. Through June, motorists drove 2.8 percent fewer miles than in the first six months of 2007.[5] Moreover, the higher prices in 2008 have reinforced the decline in driving speeds on uncongested freeways that was identified in CBO's January 2008 study, as well as the increase in ridership on public transit.

For this issue brief, CBO updated and expanded its analysis of driving speeds on uncongested freeways, using data from 2004 through April 2008 for six California freeway locations. Over that time, as the price of gasoline increased by $2—to nearly $4 per gallon—the median speed of freeway travel in uncongested conditions declined between 1.0 mile per hour (mph) and 1.5 mph (see Table 1). The resulting fuel savings are consistent with estimates of how prices affect gasoline consumption in the short run. According to those estimates, consumption tends to decline by about 0.6 percent for every 10 percent increase in the price of gasoline.[6] The decline in speed was somewhat greater for vehicles traveling at slower speeds, and it was smaller for vehicles moving at faster speeds.[7] That result is consistent with the notion that motorists' responses depend on how they value their time: If motorists who place a higher value on their time tend to drive faster than the median driver, they will also be less likely to slow down in response to higher gasoline prices, because they value saving time more than saving on fuel costs.[8] Similar logic could explain why the response is greater for vehicles traveling at below-median speeds.

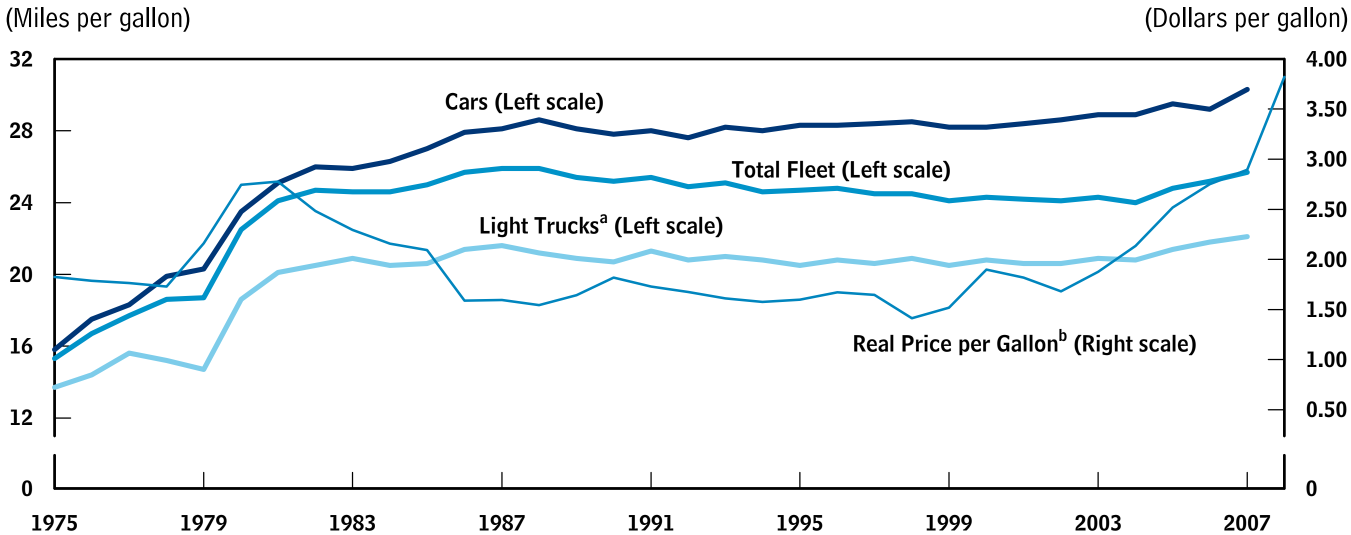
Choices of New and Used Vehicles

In the long run, the response to higher gasoline prices is estimated to be about seven times greater than in the short run: A sustained increase in the price of gasoline would ultimately reduce consumption by about 4 percent for every 10 percent increase in price.[9] (Such an estimate may be less applicable to larger price increases, however, because there are practical limits to how much people can reduce their use of gasoline.) The larger response over time reflects consumers' greater ability to use less fuel by eventually making more dramatic changes than simply driving at slower speeds—in particular, by replacing their vehicles with ones that have greater fuel efficiency. With higher gasoline prices over the past few years, demand has shifted toward more fuel-efficient vehicles. If gasoline prices remain high, that shift is likely to continue.

Between 2003 and 2006, the average rated fuel economy of new cars and light trucks sold in the United States increased by about 1 mile per gallon (mpg), from 24.3 mpg to 25.2 mpg, according to EPA's calculations.

Figure 2.

Average Rated Fuel Economy for New U.S. Passenger Vehicles and the Real Price of Gasoline



Source: Congressional Budget Office based on data from the Environmental Protection Agency.

Note: Data are for sales-weighted fuel economy. The Environmental Protection Agency determines a vehicle's fuel economy performance, either through its laboratory results or in test data submitted by the manufacturer, and the National Highway Traffic Safety Administration (NHTSA) determines compliance with corporate average fuel economy (CAFE) standards. NHTSA considers CAFE credits the automaker has earned, including those for hybrid and dual-fuel vehicles. NHTSA's CAFE data are similar to those illustrated here, although the averages are slightly higher because of the credits.

a. Includes sport-utility vehicles and minivans.

b. The real (inflation-adjusted) gasoline price for 2008 is the Energy Information Administration's estimated annual average price as of July 2008. Real (2008) prices were calculated by CBO using the Bureau of Economic Analysis's implicit price deflator.

The average for 2007 was 25.7 mpg.[10] Based on monthly data for the first half of 2008, the average for the year will probably be higher. Those increases follow several decades in which average fuel economy remained steady or gradually declined (see Figure 2).

Factors other than gasoline prices have contributed to the increase in average fuel economy. The CAFE standard for light trucks was raised by 1.5 mpg between 2004 and 2007.[11] Yet the influence of higher gasoline prices is clear because average fuel economy for new cars also increased over that time, even though the CAFE standard for those vehicles did not change.

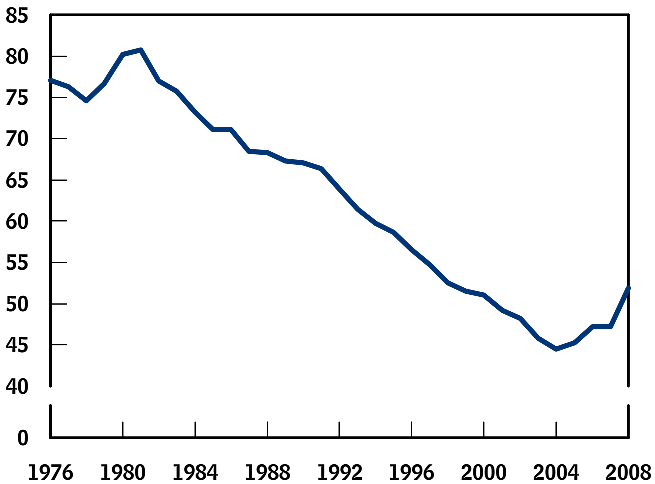
The most important factor in the overall increase in average fuel economy has been the substantial recent growth in the share of cars among all new passenger vehicles. In 1981, more than 80 percent of all new passenger vehicles were cars. Since then, as light trucks—first minivans, then SUVs—became more popular, the share of cars fell every year, bottoming out at less than 45 percent in 2004 (see Figure 3). In response to increases in the price of gasoline over the past several years, the market share for cars has rebounded, reaching a seasonally adjusted annual rate of 56 percent in May, June, and July 2008, while the average price of gasoline was above $4 per gallon.

That turnaround is all the more noteworthy because automakers have been raising prices more quickly for cars than for light trucks, according to CBO's analysis of two years of manufacturer's suggested retail prices (MSRPs).[12] For the nearly 200 vehicle models in that analysis, the average increase in MSRP for the identical model of car was 1.2 percent between the 2005 and 2006 model years, compared with only 0.3 percent for SUVs and minivans. That pricing pattern reflects the shift in consumer preferences toward smaller, more fuel-efficient vehicles as the price of gasoline first exceeded $3 and then remained there for an extended time. Furthermore, within each

Figure 3.

Share of Cars Among Sales of New Passenger Vehicles

(Percentage of sales)



Source: Congressional Budget Office based on data from the Bureau of Economic Analysis.

Note: Market share for 2008 reflects the seasonally adjusted rate through July.

category of vehicle, MSRPs have been rising more quickly for models with better fuel economy ratings.[13]

Implications of Higher Gasoline Prices for Vehicle Emissions

The adjustments that people have made in how (and how much) they drive and in the types of vehicles they are buying have been in response to larger increases in gasoline prices than would be likely to occur under any of the current proposals for pricing CO_2 emissions. The findings of this analysis, along with CBO's previous work and that of others to estimate the costs of proposed policies for dealing with climate change, provide a basis for estimating how gasoline prices and vehicles' CO_2 emissions would be affected by such policies.

CBO has estimated that a price in 2012 of $28 per metric ton of CO_2 (and other equivalent greenhouse gases) would lead to a reduction of about 10 percent in total U.S. emissions for that year compared with what would be expected if emissions were not priced.[14] That price per ton of CO_2 emitted would add about 25 cents to the price of a gallon of gasoline—about a 6 percent increase if gasoline cost $4 per gallon.[15] In the short run, total gasoline consumption (and thus CO_2 emissions from vehicles) would remain essentially the same in response to such a small increase in price.[16] Over time, CO_2 emissions from vehicles would decline by around 2.5 percent, all else being equal—much less than from other sources given that the average reduction in emissions would be 10 percent—as consumers took the increase in the price of gasoline into account when replacing existing vehicles and revisiting decisions about where to live or work.

Several factors account for the relatively small influence that a price on CO_2 emissions would have on passenger vehicles and driving behavior. They include:

- The much smaller effect an emissions price would have on gasoline prices relative to the recent increase in those prices;[17] and
- The extent to which Americans have become dependent on automobile travel.

Furthermore, the volume of emissions in coming years will be heavily influenced by new, more stringent CAFE standards that will result in substantial gains in fuel economy over the next dozen years (see Box 1).[18] Correspondingly, pricing CO_2 emissions would not have any additional effect on fuel economy beyond what the CAFE standards already require, unless gasoline prices were much higher than they currently are.

A comparison of average vehicle fuel economy and gasoline prices in the United States with those in the European Union supports the conclusion that a very high CO_2 price would be necessary to significantly reduce vehicle emissions. In 2006, the average fuel economy for new passenger vehicles in the European Union was about 38 mpg.[19] Europe's higher fuel economy is due primarily to its much higher fuel taxes; the European Union has no mandatory standards for fuel economy.[20] Taxes on gasoline in Europe, levied by each country individually, vary between €0.51 and €0.57 per liter, or about $2.40 to $3.10 per gallon, depending on the exchange rate. Those taxes are about five to six times higher than the U.S. average of $0.47 per gallon.[21]

Tax differences are not the entire story, however. Cultural, historical, geographic, and infrastructural differences between the United States and Europe have also contrib-

Box 1.

CAFE Standards and Vehicles' CO_2 Emissions

Beginning in 2011, corporate average fuel economy (CAFE) standards will become more stringent and will vary for vehicles of different sizes. By law, 2020 model-year passenger vehicles (cars and light trucks) must average at least 35 miles per gallon (mpg) of gasoline, an increase of almost 10 mpg above the average for 2007 model-year vehicles.[1] The National Highway Transportation Safety Administration has the discretion to raise the standards above 35 mpg by 2020. Even at the statutory standard, new passenger vehicles will emit about 28 percent less carbon dioxide (CO_2) per mile. By 2035, when most pre-2020 passenger vehicles will have been retired, the new CAFE standards could be reducing total U.S. emissions of CO_2 by about 5 percent or more, depending on the number of registered vehicles, the price of gasoline, the rate of growth in CO_2 emissions elsewhere in the economy, and whether the CAFE standards are further tightened after 2020.

A number of factors could help minimize the cost of meeting tighter standards. Technological advances could expand the opportunities for saving fuel. Also, higher gasoline prices could encourage increased demand for fuel-efficient vehicles, which would make it easier for automakers to sell enough of those vehicles to comply with the standards.

The new fuel-economy standards could result in lower relative prices for vehicles that are more fuel efficient than other vehicles of similar size. Automakers have previously used such pricing practices as part of an overall strategy for complying with CAFE standards.[2] In influencing automakers' strategies for pricing vehicles, the standards may not only affect how vehicles are designed but may also provide consumers with financial incentives to buy vehicles that are more fuel efficient and disincentives to buy vehicles that have more power and better performance—attributes that are necessarily traded off against improved fuel economy.

1. Section 102 of the Energy Independence and Security Act of 2007, 49 U.S.C. § 32902(b)(2)(A), 121 Stat. 1499.
2. See Congressional Budget Office, *The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax* (December 2003).

Although a price on CO_2 emissions would increase demand for fuel economy, in the presence of a stringent CAFE standard that price would probably have little or no effect on average fuel economy. The CO_2 price, together with existing gasoline taxes, would strengthen the incentive for consumers to buy vehicles that are more fuel efficient, up to the point at which their additional cost per gallon of fuel saved—their expenditure on fuel-saving technologies (reflected in the vehicle's price) and the value of their forgone gains in performance—would equal the CO_2 price. (The location of that point depends on the amount of driving each consumer expects to do.) But on the margin, only one of the policies would actually boost fuel economy. Either the price of the CO_2 permit would be high enough to stimulate demand for fuel economy in excess of what the CAFE standard would require, or the standard would require fuel economy in excess of that demand.[3]

Although a cap-and-trade system would probably have little effect on fuel economy with stringent CAFE standards in place, as long as vehicles continued to run on gasoline (or on coal-generated electric power) a cap-and-trade system would further reduce vehicle emissions by raising automotive fuel prices and thus encouraging motorists to drive less and at slower speeds. In doing so, it would also address other social costs associated with driving, including those from other polluting emissions, accidents, noise, and congestion. The CAFE standards would have the opposite effect—they would encourage driving by reducing fuel costs. However, that "rebound" effect may be small.[4]

3. Because the new CAFE standards keep the distinction between cars and light trucks (automakers must meet each type of standard separately), under some circumstances a CO_2 price could affect the average fuel economy of new vehicles even with relatively stringent standards in place. If a high CO_2 price caused enough consumers seeking better fuel economy to switch from buying a new truck to buying a new car, the combined average fuel economy would go up.
4. See Kenneth A. Small and Kurt Van Dender, "Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect," *Energy Journal,* vol. 28, no. 1 (2007), pp. 25–51.

uted to Europe's greater average fuel economy. The wide adoption of fuel-efficient diesel-powered cars in Europe may also have played a small role.[22] Thus, if gasoline prices in the United States equaled those in Europe, average fuel economy in the United States would probably approach the average for the European Union but would remain somewhat lower.

That comparison suggests that gasoline prices might have to rise above $6.50 per gallon—for example, from a CO_2 price that added $2.00 or $2.50 per gallon to gasoline prices—for the average fuel economy of new vehicles in the United States to approach the 35 mpg that the new CAFE standards will require. But the CO_2 prices contemplated in current U.S. climate legislation and in prominent international policy analyses would add much less than $2.00 to the price of gasoline. Thus, such pricing, by itself, would probably not increase average fuel economy beyond what the CAFE standards will require.

CBO has estimated that under S. 2191, the America's Climate Security Act of 2007, the price of a CO_2 emissions permit would rise from about $23 per metric ton in 2009 to about $44 in 2018 as the stringency of the bill's cap on greenhouse-gas emissions was gradually increased.[23] Such permit prices would raise gasoline prices by about 20 cents per gallon in 2009 and 40 cents per gallon in 2018.[24] A recent report by the Intergovernmental Panel on Climate Change (IPCC) suggests that a permit price of as much as $80 per ton of CO_2 might be necessary by 2030 to reduce emissions enough to achieve a stabilized climate by 2100. That pricing policy would add about 70 cents per gallon to the price of gasoline in 2030.[25] Even the much greater and much earlier reductions called for in the *Stern Review on the Economics of Climate Change* (requiring a current estimated permit price of $95 per ton of CO_2, rising to $191 per ton by 2050 and higher after that) would not cause gasoline prices in the United States to be as high as they already are in Europe.[26] The permit prices in the Stern report would add roughly $0.85 to $1.70 per gallon to gasoline prices over the next four decades.

The rising demand for more fuel-efficient vehicles is a trend that is likely to be reinforced as automakers gradually redesign more of their vehicles to better satisfy that demand. Over time, they will offer improved fuel economy for a wider array of vehicles appealing to a broader spectrum of consumer tastes.[27] Although a CO_2 emissions price would have relatively little effect on vehicle emissions, it would stimulate additional research and development of technologies for improving fuel efficiency, an effect that the new fuel economy standards will also have. New fuel-efficiency technologies will, in turn, create additional opportunities for reducing atmospheric CO_2 concentrations and stabilizing Earth's climate.

1. Congressional Budget Office, *Effects of Gasoline Prices on Driving Behavior and Vehicle Markets* (January 2008).
2. CAFE standards specify the minimum average level of fuel economy that each automaker must achieve for the passenger vehicles it sells in the United States in a given model year.
3. Energy Information Administration, http://tonto.eia.doe.gov/dnav/pet/pet_pri_gnd_a_epmr_pte_cpgal_w.htm.
4. The Department of Transportation estimates that for the first quarter of 2008, U.S. motorists used about 1.3 percent less gasoline and 7 percent less diesel fuel than during the same period in 2007. See www.fhwa.dot.gov/pressroom/fhwa0817.htm.
5. Department of Transportation, www.fhwa.dot.gov/ohim/tvtw/08juntvt/08juntvt.pdf.
6. Estimates range from 0.3 percent to 0.8 percent, averaging about 0.6 percent. See Jonathan E. Hughes, Christopher R. Knittel, and Daniel Sperling, *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand*, Research Report UCD-ITS-RR-06-16 (University of California, Davis, Institute of Transportation Studies, 2006); and Kenneth A. Small and Kurt Van Dender, "Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect," *Energy Journal*, vol. 28, no. 1 (2007), pp. 25–51.
7. For faster traffic, CBO examined 85th percentile speeds because, according to the Federal Highway Administration, all states and most local agencies use the 85th percentile as a primary criterion in establishing their speed limits. For symmetry, CBO used 15th percentile speeds for slower traffic.
8. Since the beginning of 2008, several major trucking companies have announced that, as a matter of company policy, they would reduce their trucks' top-end cruising speeds by about 3 mph, on average, by adjusting the trucks' speed-governing devices.
9. See Department of Energy, *Policies and Measures for Reducing Energy Related Greenhouse Gas Emissions: Lessons from Recent Literature,* DOE/PO-0047 (July 1996); and Small and Van Dender, "Fuel Efficiency and Motor Vehicle Travel."
10. See Environmental Protection Agency, *Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2007*, EPA420-R-08-015 (September 2008), Table 1, p. 9, www.epa.gov/oms/fetrends.htm.
11. See National Highway Traffic Safety Administration, www.nhtsa.dot.gov.

12. MSRPs may differ from the actual purchase prices negotiated between consumers and automobile dealers, including rebates and incentives. CBO did not have such data for this analysis, however.

13. See Congressional Budget Office, *Effects of Gasoline Prices on Driving Behavior and Vehicle Markets*, Box 2-2, pp. 21–22. The prices of used vehicles have been changing in the same way, and for some larger vehicles the drop in price has been particularly dramatic. For example, the wholesale prices of some 2005 model-year SUVs and pickup trucks fell by more than 20 percent over the first half of 2008, according to *Automotive News* (June 23, 2008).

14. That includes a 7 percent reduction in emissions by entities subject to S. 2191, America's Climate Security Act of 2007 (see CBO's April 10, 2008, cost estimate at www.cbo.gov/ftpdocs/91xx/doc9120/s2191.pdf), plus additional and proportionately greater reductions from other, lower-cost sources—primarily via carbon sequestration and reduced emissions from landfills.

15. CBO calculated the increase of 25 cents in the price of gasoline on the basis of about 20 pounds of CO_2 released per gallon of gasoline consumed. In theory, consumers and producers of gasoline would share that cost. But because gasoline consumption is relatively unresponsive to price in the short run, in practice consumers of gasoline would pay almost all of the CO_2 price.

16. On the basis of the recent demand-response estimates cited in note 6, a 6 percent increase in gasoline prices would reduce consumption by only around 0.4 percent in the short run.

17. A CO_2 price would have a much greater effect on the price of coal (a primary fuel in electricity generation) than on the price of gasoline, simply because a dollar's worth of coal contains more carbon than a dollar's worth of gasoline. Moreover, the marginal costs of reducing CO_2 emissions may also be lower for coal-powered electricity generation and other sources than for vehicles.

18. See CBO (January 2008), pp. xxi. Some analysts believe that consumers underestimate the value of fuel savings from improved fuel economy. If so, pricing CO_2 would be less than ideally effective against vehicle emissions—and a higher CO_2 price would be required to achieve a given reduction in vehicle emissions than if consumers valued fuel savings correctly.

19. In terms of the European Union's voluntary de facto fuel-consumption standard, the 2006 average fuel economy in Europe was 160 grams of CO_2 per kilometer (km)—about 7 liters of gasoline, or 6 liters of diesel fuel, per 100 km. The CO_2 rate converts to about 34 mpg. The 38-mpg value—an estimate of what the European average would be if measured using the U.S. test cycle—is used for comparison with the United States. For fuel economy averages, test-cycle differences, and conversion factors, see International Council on Clean Transportation, *Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update* (July 2007), www.lowcvp.org.uk/assets/reports/ICCT_GlobalStandards_2007.pdf.

20. In 1998, when average fuel economy in Europe was about 180 g CO_2 /km, the European Union adopted a voluntary standard of 140 g CO_2 by 2008, which has not been achieved. It is now debating the adoption of either a mandatory fuel economy standard of 130 g CO_2 by 2012 or of 125 g CO_2 by 2015.

21. European gasoline taxes are averages for 2002 and 2008 among the 15 countries that joined the European Union before 2004. See, respectively, *Fuel Taxation* (August 17, 2004; updated November 6, 2006), www.euractiv.com/en/taxation/fuel-taxation/article-117495; and European Commission, *Excise Duty Tables* (July 2008), ec.europa.eu/taxation_customs/resources/documents/taxation/excise_duties/energy_products/rates/excise_duties-part_II_energy_products-en.pdf. U.S. gasoline taxes vary by state. For the average U.S. fuel tax (as of January 2008), see American Petroleum Institute, www.api.org/policy/tax/stateexcise/upload/December_2007_notes.pdf.

22. See Lee Schipper, *Automobile Fuel-Economy and CO2 Emissions in Industrialized Countries: Troubling Trends Through 2005/6*, World Resources Institute (2008), pdf.wri.org/automobile-fuel-economy-co2-industrialized-countries.pdf. For environmental reasons, automakers have not been able to sell many diesel-powered vehicles in the United States, although that is set to change with the development of low-sulfur diesel fuels that can satisfy the more stringent U.S. standards for particulate emissions.

23. See CBO's cost estimate for S. 2191, America's Climate Security Act of 2007 (April 10, 2008), www.cbo.gov/ftpdocs/91xx/doc9120/s2191.pdf.

24. EPA has also analyzed S. 2191 and estimates CO_2 prices that would add about \$0.53 per gallon in 2030 and \$1.40 per gallon in 2050. See www.epa.gov/climatechange/downloads/s2191_EPA_Analysis.pdf.

25. See International Panel on Climate Change, *Climate Change 2007: Synthesis Report*, p. 59, www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

26. See www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm.

27. For example, hybrid technology is being introduced on larger vehicles, including the Chevrolet Tahoe and Cadillac Escalade—big SUVs with combined fuel economy ratings of 21 mpg and 20 mpg, respectively.

This brief was prepared by David Austin. It and other CBO publications are available at the agency's Web site (www.cbo.gov).

Peter R. Orszag
Director