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A
CBO
STUDY

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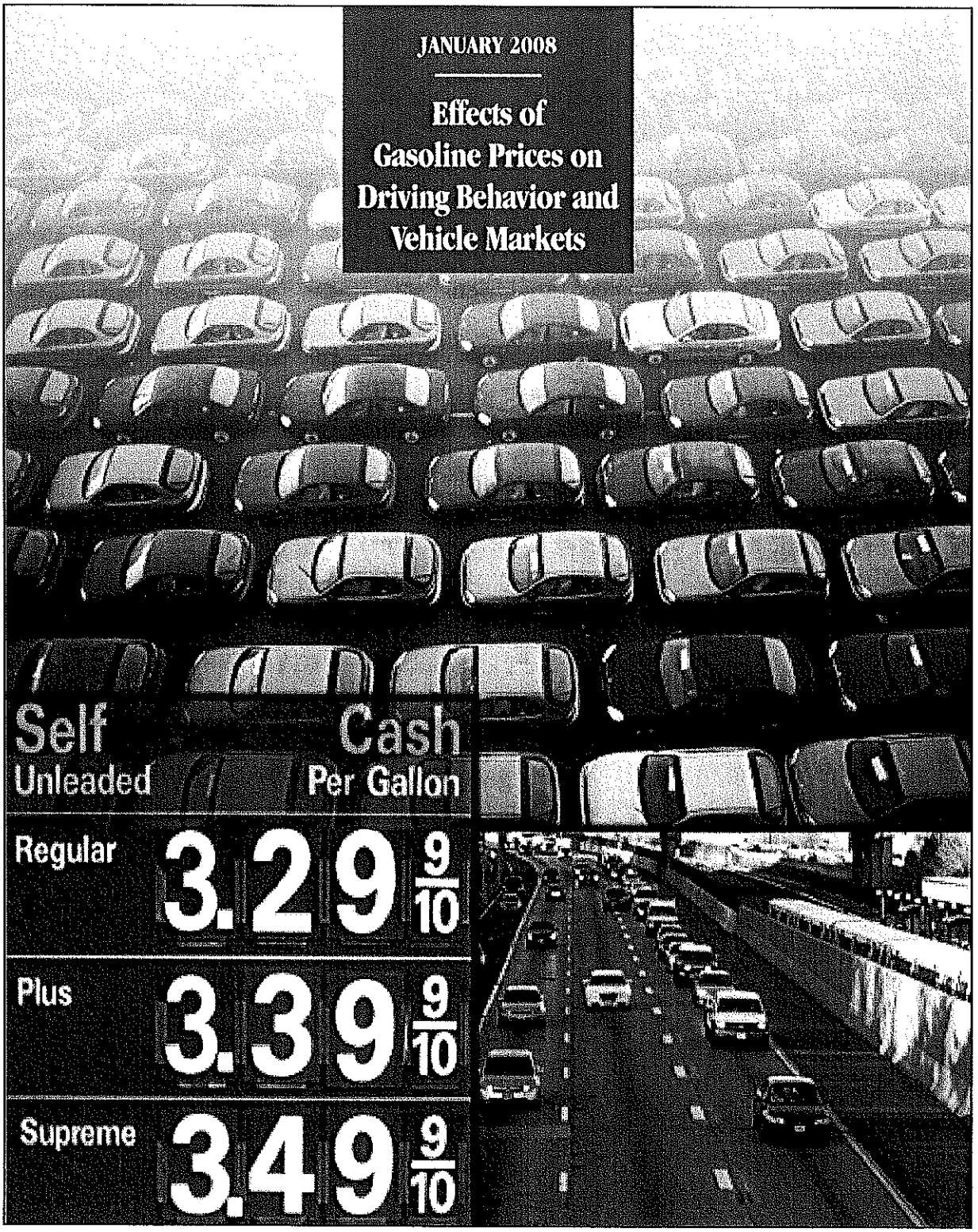
Effects of Gasoline Prices on Driving Behavior and Vehicle Markets



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Summary

In January 2003 the average retail price for a gallon of gasoline in the United States was $1.50—roughly equal to the real (inflation-adjusted) price during much of the preceding half-century. Since then, the price of gasoline has risen sharply. It was last below $2 per gallon in February 2005, and for much of 2007, prices topped $3 per gallon (see Summary Figure 1).

This Congressional Budget Office (CBO) study examines the scope and intensity of consumers' responses to the upward trend in gasoline prices that began in 2003. Those responses have been large enough to interrupt a pattern of steady growth in total gasoline consumption dating back to 1990, the last time U.S. gasoline prices rose substantially.[1] If current high prices—and consumers' responses to them—persist, the effect on overall gasoline consumption will grow stronger as older, less-fuel-efficient vehicles are retired and as consumers consider other, less easily implemented adjustments to their patterns of consumption.

The 100 percent increase in real U.S. gasoline prices since 2003, which is larger even than the record increases of the early 1980s, has induced motorists to adjust their driving habits and the types of vehicles they purchase. Those responses have important implications for the future fuel efficiency of the passenger vehicle fleet, for the way vehicles are driven, and for the use of the nation's highway and mass transit networks should higher gasoline prices persist. The findings of this study are thus relevant in assessing the impact of policies that seek to encourage greater fuel economy and promote more-efficient patterns of driving.

In preparing this study, CBO analyzed data on trip frequencies and speeds on several California highways from 2003 to 2006. CBO also gathered and analyzed data on U.S. sales of new and used vehicles over the same period.

The data show that consumers have responded in a variety of ways to higher gasoline prices. The effect has thus far been small, which is consistent with current estimates of the short-run responsiveness of gasoline consumption to changes in price. That effect would be expected to increase if prices remained high.[2]

CBO has found the following specific effects in its analysis:

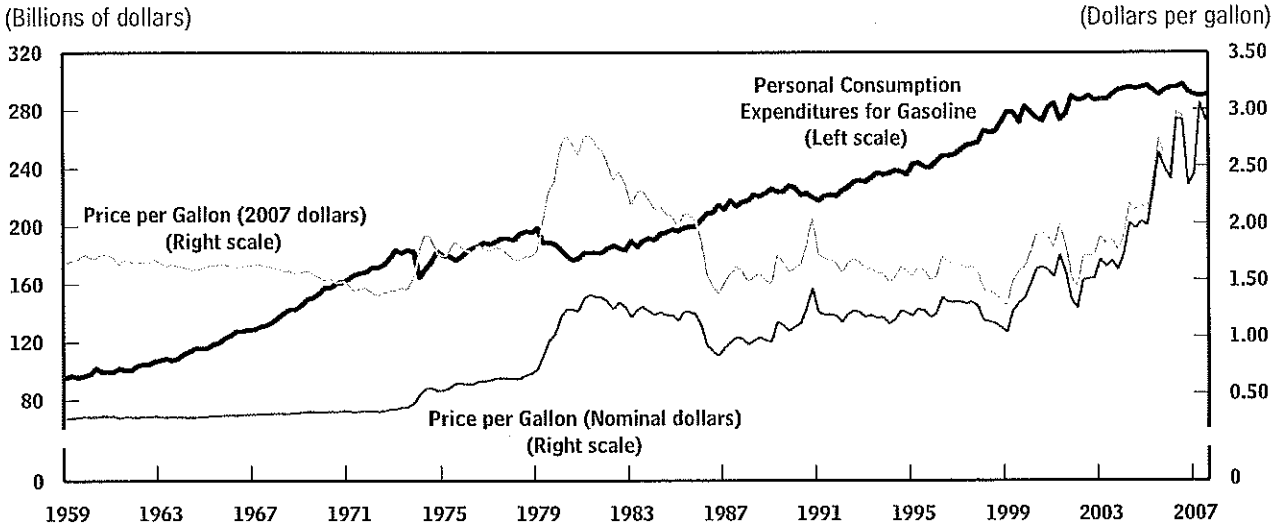
- Freeway motorists have adjusted to higher prices by making fewer trips and by driving more slowly. CBO analyzed data collected at a dozen metropolitan highway locations in California, along with data on gasoline prices in California, to identify changes in driving patterns. On weekdays in the study period, for every 50 cent increase in the price of gasoline, the number of freeway trips declined by about 0.7 percent in areas where rail transit is a nearby substitute for driving; transit ridership on the corresponding rail systems increased by a commensurate amount. Median speeds on uncongested freeways declined by about

1. Similar episodes also occurred in 1974 and 1979 in conjunction with Mideast oil supply interruptions. The current increase has several origins, including higher prices for crude oil caused by increased global demand, higher-than-usual refinery costs, and larger price markups. See, for example, Federal Trade Commission, *Gasoline Price Changes: The Dynamic of Supply, Demand, and Competition* (2005), www.ftc.gov/reports/gasprices05/050705gaspricesrpt.pdf; and *Investigation of Gasoline Price Manipulation and Post-Katrina Gasoline Price Increases* (2006), www.ftc.gov/reports/060518PublicGasolinePricesInvestigationReportFinal.pdf.

2. The short-run responsiveness, or *elasticity*, of consumption to changes in price reflects adjustments that consumers can easily (in some cases, spontaneously) make, without any major investment. By contrast, the long-run elasticity is greater because it reflects the effects of additional choices that arise over a period of years, including vehicle purchases and decisions about where to live in relation to one's place of work.

Summary Figure 1.

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



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

Notes: Consumer expenditures are for gasoline and motor oil through October 2007 (motor oil is about 1.5 percent of the total).

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

three-quarters of a mile per hour for every 50 cents the price of gasoline has increased since 2003.

- After increasing steadily for more than 20 years, the market share of light trucks (including sport–utility vehicles and minivans), relative to all new passenger vehicles, began to decline in 2004. As a result, the average fuel economy of new vehicles has increased by more than half a mile per gallon since 2004 (because light trucks tend to be less fuel efficient than cars).

- Used-vehicle prices have shifted, reflecting changing demand, particularly with respect to fuel economy: The average prices for larger, less-fuel-efficient models have declined over the past five years as average prices for the most-fuel-efficient automobiles have risen.

Consumers' Responses to Higher Gasoline Prices

Recent research suggests that consumers are not very responsive to changes in the price of gasoline, at least in the short run. (Increased expenditures on gasoline have, however, reduced consumers' saving, real income growth, and probably other forms of consumption.)[3] For a variety of reasons, consumers are currently only about one-fifth as responsive to short-run changes in gasoline prices as they were several decades ago. That decline in sensitivity has been attributed to growth in real income, which has rendered gasoline a smaller share of consumers' purchases from disposable income. Price sensitivity also has

3. See Congressional Budget Office, *The Economic Effects of Recent Increases in Energy Prices* (July 2006).

declined because a gallon of gasoline takes a car farther than it did in the past, in part because of fuel economy standards. Finally, the development of distant suburbs also has contributed by making some consumers more reliant on the automobile. The longer commutes are balanced by lower housing costs.[4]

The research suggests that a 10 percent increase in the retail price of gasoline would reduce consumption by about 0.6 percent in the short run.[5] Over a longer period, consumers would be much more responsive to an increase in the price of gasoline (should the higher price persist) because they would have more time to make choices that took longer to put in place, such as buying an automobile that gets better gasoline mileage. Estimates of the long-run elasticity of demand for gasoline indicate that a sustained increase of 10 percent in price eventually would reduce gasoline consumption by about 4 percent.[6] That effect is as much as seven times larger than the estimated short-run response, but it would not be fully realized unless prices remained high long enough for the entire stock of passenger vehicles to be replaced by new vehicles purchased under the effect of higher gasoline prices—or about 15 years. Over that time, consumers also might adjust to higher gasoline prices by moving or by changing jobs to reduce their commutes—actions they might take if the savings in transportation costs were sufficiently compelling. Those long-term effects would be in addition to consumption savings from short-run behavioral adjustments attributable to higher fuel prices.

Driving Behavior

Underlying the market's overall response to higher gasoline prices are some specific short-run adjustments in the way people drive. To estimate the importance of those adjustments and how they contribute to the response to higher gasoline prices, CBO analyzed two sets of data: One consisted of detailed information on traffic flows at multiple freeway locations in California; the other contained measurements of vehicle speeds at some of those locations.

California was chosen because its highway system has an extensive network of automatic data collection devices that have recorded large quantities of traffic data from many locations over long periods. (More information about the data and how they were collected is provided in Appendix A.) Although CBO's analysis is based on data from California, the findings should apply to metropolitan areas in other states to the extent that those areas are similar in terms of drivers' ages and income, the vehicle stock, highway configuration, and enforcement of speed limits.

Many of the freeways CBO studied run parallel to light- or heavy-rail transit systems, so it is possible to discern the effects of gasoline prices on daily vehicle flow in the presence or absence of an accessible rail transit alternative to driving. CBO's study also took into account the time

4. For a discussion of increased reliance on the automobile, see Matthew E. Kahn, "The Environmental Impact of Suburbanization," *Journal of Policy Analysis and Management,* vol. 19, no. 4 (2000), pp. 569–586. For information on the decline in fuel costs' share of disposable income, 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. For information on the decline of fuel costs as a share of total driving expenditures, see Ian W.H. Parry and Kenneth A. Small, "Does Britain or the United States Have the Right Gasoline Tax?" *American Economic Review,* vol. 95, no. 4 (2005), pp. 1276–1289; and Hughes, Knittel, and Sperling, *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand.*

5. See Hughes, Knittel, and Sperling, *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand,* and Small and Van Dender, "Fuel Efficiency and Motor Vehicle Travel." With the relatively small price elasticity, moderate price increases may cause the *growth* in consumption to decline even as total consumption continues to rise, because gasoline consumption depends on factors other than price: Growth in the population and in the number of registered vehicles and drivers, for example, leads to increases in total consumption. A sizable increase in price would be required to completely neutralize those factors and cause total consumption to decline.

6. A 1996 federal report proposed a value of -0.38 for long-run price elasticity. 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). That value was used by the Congressional Budget Office in *Reducing Gasoline Consumption: Three Policy Options* (November 2002) and in *The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax* (December 2003). Kenneth A. Small and Kurt Van Dender, in "Fuel Efficiency and Motor Vehicle Travel," estimate a similar long-run price elasticity value of -0.43. Higher estimates exist, but they come primarily from the 1970s and 1980s and from international studies. For a survey, see Daniel Graham and Stephen Glaister, "The Demand for Automobile Fuel: A Survey of Elasticities," *Journal of Transport Economics and Policy,* vol. 36 (2002), pp. 1–26.

of day, day of the week, season, road characteristics, and other factors that influence the way motorists drive.

CBO's analysis indicates that, since 2003, for every nominal increase of 50 cents per gallon in the price of gasoline, median driving speeds on uncongested urban freeways have declined by about three-quarters of a mile per hour, on average, and the amount of weekday traffic on freeways next to commuter rail systems has declined by about seven-tenths of a percent. Those adjacent commuter rail systems also are affected by higher gasoline prices: The increase in the number of passengers per day on those systems is approximately equal to the decline in the number of vehicles on the adjoining freeways. Those effects, although fairly small, are highly consistent with recent estimates of the short-run elasticity of demand for gasoline.

Purchases of New Vehicles

If sustained, higher gasoline prices would increasingly influence consumers' automobile-buying habits. Consumers typically own a vehicle for several years, during which time little can be done to affect that vehicle's fuel economy. Consumers who are considering replacing a vehicle are more likely to buy a more-fuel-efficient vehicle the higher they expect gasoline prices to be during the time they own their next vehicle.

Thus, with rising gasoline prices, in 2004 the market share of light trucks began to decline relative to that of cars. That year, light trucks constituted about 55 percent of the passenger vehicle market; by 2006, that proportion had slipped below 52 percent. The decline occurred despite slight increases in financial incentives to promote the purchase of light trucks in 2006 and a slower average rate of increase in suggested retail prices compared with those for cars.

Consistent with a shift in the mix of vehicles sold, the higher gasoline prices of the past several years have contributed to an increase of more than half a mile per gallon in the combined average fuel economy ratings of new cars and light trucks since 2004. A primary cause has been the decreased market share of light trucks, which average fewer miles per gallon than cars do. But light trucks also have become more fuel efficient, a trend that began in 2003 and that has been spurred on by the adoption of more-stringent fuel economy standards beginning with the 2005 model year. The average fuel economy of new cars also has increased somewhat in nearly every model year since 2000—the first sustained increase since the mid-1980s. (In 2000, average real gasoline prices also reached levels not seen since the mid-1980s.) That such an increase occurred despite slightly larger annual price increases for more-fuel-efficient vehicles (a pattern that carried over to used-vehicle markets) is a further indication of an increase in consumer demand for fuel economy.

The increase in fuel economy among new vehicles over the past few years has partially offset the 1.9 mile per gallon (mpg) decline that occurred from 1987 through 2004.[7] Should higher gasoline prices persist over the next decade or more, and should consumers continue to respond to those prices as they have done over the past few vehicle model years, the increase in fuel economy eventually will be reflected throughout the fleet rather than, as currently, only in passenger vehicles from the past few model years.

Gasoline Prices, Policy, and Total Gasoline Consumption

The nationwide increase in gasoline prices since 2003 has not merely slowed the rate of growth in gasoline consumption. Through the third quarter of 2007, real consumer purchases of gasoline—which can be thought of as a measure of quantities consumed—had fallen slightly in 8 of the preceding 10 quarters, compared with purchases the year before (see Summary Figure 1). Such declines, although small, occurred despite continued population growth, changing patterns of residential development and job location, and technological change, all of which have encouraged the increasing consumption of gasoline, particularly in recent decades.

The increase in gasoline prices and the response of consumers to higher prices have important implications for government policies that would reduce gasoline consumption. Such policies can produce better outcomes for society than would result from pure market forces, because the consumption of gasoline imposes social costs—environmentally damaging emissions, for example—that are not reflected in the price of gasoline.

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7. In some of the intervening years, average fuel economy increased, but never by more than 0.2 mpg. CBO's calculations of average fuel economy are based on annual vehicle sales and closely mirror the Environmental Protection Agency's calculations based on model year sales. (See Environmental Protection Agency, *Fuel Economy,* www.epa.gov/fueleconomy.)

Two important policy tools that encourage people to drive more-fuel-efficient vehicles (and thus reduce gasoline consumption) are the federal corporate average fuel economy (CAFE) standards and federal and state gasoline taxes.[8] CAFE standards require manufacturers to design and sell larger numbers of fuel-efficient cars and light trucks than the market would otherwise demand. Higher taxes reduce gasoline consumption by raising the retail price of gasoline, with the same effects on driving behaviors and vehicle choices that would result from a market-driven price increase. In contrast, stricter CAFE standards, while reducing gasoline consumption, also reduce the per-mile costs of driving and thus partially offset the effects of higher gasoline prices on total miles driven and on freeway speeds.

Higher prices for gasoline affect both types of policies. By increasing the market demand for fuel-efficient vehicles, higher gasoline prices reduce the economic costs—to manufacturers and to consumers—of achieving stricter CAFE standards. Also, with higher gasoline prices, the average gasoline tax—or any given increase in that tax—is now a smaller share of the price of gasoline than it was in the past. (The average gasoline tax, including state levies, is currently about 46 cents per gallon, of which 18.4 cents is the federal tax.) Consequently, a given (cents per gallon) increase in the gasoline tax would have a smaller effect on fuel economy in new vehicles and on fuel-saving changes in the way motorists drive. However, because the higher gasoline prices would themselves encourage greater fuel efficiency, a smaller tax would be needed if that were the policy goal.

8. For an analysis of the correspondence between gasoline taxes and CAFE standards, in terms of fuel savings, see Congressional Budget Office, *The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax*. That analysis is based on a gasoline price of $1.50 per gallon, but the same methodology can be used with different gasoline prices. For national average gasoline taxes as of March 2007, see American Petroleum Institute, www.api.org/policy/tax/stateexcise/upload/March_2007_gasoline_and_diesel_summary_pages.pdf.