# Impacts of Gas Price on Passenger Vehicle Use and Greenhouse Gas Emissions

**Policy Brief**

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## Policy Description

Gas prices are influenced both by market forces and by government policy, through gas taxes as well as other policies. Gas taxes in the U.S. have historically been set based on infrastructure funding needs, rather than as a way to influence demand. Gas prices are comparatively lower in the U.S. than in European and other developed countries that rely more heavily on gas taxes.

There is a substantial body of literature that explores the impact of gas price on travel behavior. These studies investigate the impact of modifications in the gas price on vehicle-miles traveled (VMT) and on gas demand.

## Impact of Gas Prices

Increases in gas price can affect VMT and gas consumption in several ways. In the short run, travelers have only a limited number of options for reacting to changes in gas prices. They can adapt their driving style to improve fuel efficiency (e.g. by traveling at more fuel-economical speeds, or by avoiding rapid accelerations and breaking), reduce their VMT (e.g. by making fewer trips or switching to other modes), or rely more heavily on the more efficient vehicle if the household has more than one. In the long run, travelers may make more changes: they can buy a more efficient car, or switch to an alternative fuel or hybrid vehicle. In the even-longer run, gas prices may influence where households decide to live as well as where employers choose to locate.

Short-run fluctuations in gas price may lead to temporary changes in driving behavior, but consumers might return to old driving patterns when gas prices return to their previous level. Long-run changes in gas price have more permanent effects on VMT and gas consumption. The important point is that as gas prices have fluctuated substantially over the past fifteen years in the U.S., consumers may have grown to understand that short-term changes in gas price are transitory and so may only react to longer-term trends.

Most studies that investigate the impact of gas prices on travel behavior report the *elasticity* of gasoline consumption and VMT with respect to gas price. This measure is the ratio of the observed percentage change in gas consumption or VMT to the corresponding percentage change observed in gas price. For example, an elasticity for gas consumption of -0.1 means that a 1 percent increase in gas price is associated with a reduction in gas consumption of 0.1 percent. A negative elasticity means that gas consumption or VMT declines when gas price increases, while the closer the absolute value of the elasticity is to zero, the more "inelastic" it is (that is, the percentage change in gas consumption or VMT is small relative to the percentage change in gas price).

Not all aspects of travel behavior are equally affected by changes in gas price. For example, commuting trips tend to be more stable and less influenced by gas price changes than leisure trips.

***Effect Size***

Many studies have analyzed the impact of gas price on gas consumption and VMT. Effect sizes vary considerably depending on the year of the study, the methodology and the data that were used for the estimation of elasticities (see Table 1). Gas consumption is relatively inelastic with respect to gas price. Most recent studies report rather low elasticities, ranging from -0.02 to -0.1 in the short run and between -0.2 and -0.3 over longer periods of time. VMT is also relatively inelastic with respect to gas price, with most recent studies reporting short-run elasticities ranging from -0.03 to -0.10 and long-run elasticities ranging from -0.13 to -0.30.

The elasticity of gas consumption tends to be greater than the elasticity of VMT by factors of 1.5 to 2. The elasticity of gas consumption reflects the combined effect of several changes, including changes in VMT and changes in average vehicle fuel efficiency (which are also affected by changes in gas price). Similarly, long-run elasticities are usually greater than short-run elasticities by a factor of 2 to 3 (Goodwin et al., 2004) owing to the time-lag needed for more permanent changes to take place.

Several recent studies, including U.S. studies, suggest that the price elasticity of gas consumption is decreasing over time, i.e. gas consumption has become more inelastic (less price responsive) in recent years. This trend might be the result of structural and behavioral changes in the U.S. since the 1970s, such as the implementation of Corporate Average Fuel Economy program (CAFÉ) efficiency standards. Lower elasticities might also result from shifts towards more auto-dependent land-use patterns, growth in per capita and household income, and reductions in public transportation services (Hughes et al., 2008).

**Table 1. Impact of Gas Price on Major Travel Demand Measures**

| Study | Study location | Study year(s) | Results | |
|---|---|---|---|---|
| | | | Travel Demand Measures | Estimated Impact of Gas Price[†] |
| Lin and Prince (2013) | U.S.A. - nationwide | 2001-2006 | Gas Demand | -0.017 to -0.093 (SR)<br>-0.258 to -0.292 (LR) |
| Hughes et al. (2008) | U.S.A. - nationwide | 2001-2006 | Gas Demand | -0.034 to -0.077 (SR) |
| Hymel, Small and Van Dender (2010) | U.S.A. - nationwide | 1966-2004 | Gas Demand | -0.055 (SR)<br>-0.285 (LR) |
| Goodwin et al. (2004)* | International | Various years | Gas Demand | -0.25 (SR)<br>-0.64 (LR) |
| Dahl and Sterner (1991)* | U.S.A. - nationwide | Before 1989 | Gas Demand | -0.22 to -0.31 (SR)<br>-0.8 to -1.01 (LR) |
| Espey (1998)* | U.S.A. - nationwide | 1929-1993 | Gas Demand | 0 to -1.36 (SR)<br>0 to -2.72 (LR) |
| Hymel, Small and Van Dender (2010) | U.S.A. - nationwide | 1966-2004 | VMT | -0.026 (SR)<br>-0.131 (LR) |
| Burt and Hoover (2006) | Canada | 2000 | VMT | -0.08 (cars)<br>-0.195 (light trucks) |
| Boilard (2010) | Canada | 1970-2009 | VMT | -0.091 to -0.093 (SR)<br>-0.256 to -0.762 (LR) |
| Goodwin et al. (2004)* | International | Various years | VMT | -0.10 (SR)<br>-0.29 to -0.31 (LR) |

*[†]SR = Short-Run, LR=Long-Run*

**Review of previous studies from the literature*

Elasticities tend be higher when gas price is higher, at least in the short run. A recent study also highlights the role of price volatility: the impact of gas price on gas consumption is lower (demand is less elastic) when price volatility is high (Lin and Prince, 2013). In other words, if the change in gas price is perceived as temporary, a traveler is less likely to change driving and fuel consumption. The study also suggests that most studies that ignore the effects of variance in fuel prices might overestimate the long-run elasticity and underestimate the short-run elasticity of gas demand with respect to fuel price. As suggested by the authors, this might have important implications for government policies that may impact volatility of gas prices, as price volatility might eventually reduce the expected changes in VMT associated with any increases in fuel price.

One study found that VMT is more elastic for higher-income households than lower-income households (Wang and Chen, 2013). Although the latter are less able to afford increases in gas prices, more of their travel is necessary rather than discretionary, and they may have less flexibility to reduce their driving.

Evidence on the changes in behavior that underlie the reduction in VMT is limited. Studies show that increases in gas prices are associated with increases in transit ridership. For instance, a study in Philadelphia showed a significant relationship between gas price and transit ridership, with regional transit service (i.e. longer distance transit) gaining more than local service (Maley and Weinberger, 2009). Similar results were found in a study of the effects of gas price variability on transit ridership in nine U.S. cities (Maghelal, 2011). The impact of increases in gas prices on other modes has not been studied.

### *Evidence Quality*

Reported elasticities depend on the methodology and data used, as well as the time period of the study (elasticities have been changing over time, as noted above). Most studies estimate price elasticities of gas consumption and VMT through robust time-series analyses that measure the change in gas consumption or VMT (measured at the level of states or countries) associated with a change in price over a specified period of time.

However, the definition of short-run vs. long-run is not consistently established in the literature. Usually, long-run effects are measured for time periods longer than one year, though some studies define long-run as five or even ten years.

Moreover, it is often difficult to separate the effects of fuel price from the effects of other variables, for example, changes in fuel economy standards for new vehicles that also affect gas consumption. In addition, it is difficult to control for concurrent changes in other variables (average household income, modifications in the public transportation services, or macroeconomic variables) that might dampen or amplify the effect of gas price on gas consumption and VMT.

### *Caveats*

Elasticities may vary by context, depending on the availability of alternatives to driving and the ease with which travelers can drive less. Similarly, the local effects of changes in gas price can be affected by specific conditions of the market and psychological reactions to price levels in each specific time and location. For these reasons, the empirical effects of gas price on gas demand and travel behavior in a specific context might diverge significantly from the results obtained in the reported studies (which usually provide averages at a nationwide level). Similarly, results from one study may not be easily transferrable to other contexts (especially in the presence of rather different economic, land use, and cultural characteristics).

Most studies examine the effect of an increase in gas prices; it is not clear whether a *decrease* in gas prices would have an effect of the same size.

**GHG Emissions**

In general, the degree to which reductions in gas consumption and VMT translate into reductions in GHG emissions depends on vehicle technology, and on speeds and other aspects of vehicle operation. Studies confirm that higher gas prices are associated with lower GHG emissions from passenger automobile travel (Maghelal, 2011).

**Co-benefits**

The response of households to increases in gas prices may produce additional co-benefits. Reductions in VMT in response to gas price increases may improve air quality, with benefits for health, and reduce congestion, with benefits for the economy. Shifts from driving to active travel modes, including transit, walking, and bicycling, are likely to improve health through increased physical activity. New vehicle sales triggered by gas price increases may promote job creation and growth in gross domestic product (GDP). However, increased gas prices will impact household budgets, potentially leading to reduced spending on other items or reduced travel or a combination of both, particularly for low-income households. Increases in gas taxes rather than market prices have the benefit of generating revenues that can be invested in the transportation system.

**Examples**

As mentioned earlier, gas taxes have not been used in the U.S. for the purpose of influencing driving. Arguably that is not true in Europe, where gas taxes are higher than in the U.S., in part to provide incentives to drive less and use other travel modes more. In the U.S., market factors (supply and demand) have been the key determinant of gas prices, and over the long-term those factors are influenced by global markets. Due in large part to growing international demand, average gas prices in the U.S. have more than doubled in the last 10 years, increasing from $1.39 per gallon in 2002 to $3.69 per gallon in 2012.[1] In the past few years, new supplies of oil and gas have been developed, leading the U.S. Energy Information Administration to project an increase in the U.S. domestic oil production from 5.65 million barrels per day in 2011 to 8.09 million barrels in 2014. Increased domestic supply has largely stabilized gas prices in the U.S. for now, but growing international demand could drive prices higher in the future.

Due to both market forces and policy choices, gas prices in Europe are considerably higher than in the U.S. The price for unleaded gas in the 27 countries of the European Union averaged €1.460 per liter, or approximately $7.50 per gallon, on November 26, 2013.[2] Gas taxes in the European Union range between €0.359 per liter (approximately $1.84 per gallon) in Romania and €0.747 per liter (approximately $3.84 per gallon) in the Netherlands,[3] compared to $0.184 of federal tax and $0.382 of state tax per gallon in California (adjusted annually), which currently has the highest state gas tax in the U.S.[4]

To date, neither U.S. states nor the federal government have used gas taxes as a policy instrument to reduce driving. Regardless of policy choices, if the recent experience of increasing gas prices due to market factors continues, fuel consumption and VMT would be expected to decline, though the percentage decline is likely to be small relative to the percentage increase in the price.

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