GASOLINE PRICES AND TRAFFIC SAFETY: AGE AND GENDER VARIATIONS

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GASOLINE PRICES AND TRAFFIC SAFETY: AGE AND GENDER VARIATIONS

ABSTRACT
Gasoline prices have significant effects on traffic safety. However, existing literature has failed to adequately investigate the effects: the literature has examined only fatal incidents rather than total traffic incidents. This study analyzes the effects of gasoline prices on total traffic incidents and on the incidents by age and gender. The results suggest that gasoline prices have negative short-term effects on traffic safety: as gasoline prices increase, overall traffic incident rates decrease. Gasoline prices have disproportionate effects in reducing traffic incident rates for young drivers and female drivers, longer-term effects on drivers who are 24 years and older, and no effects on male drivers. This study fills the gap in the literature by contributing to the understanding of gasoline price effects on traffic incidents by examining all traffic incidents instead of only fatal incidents and by examining incidents by age and gender.

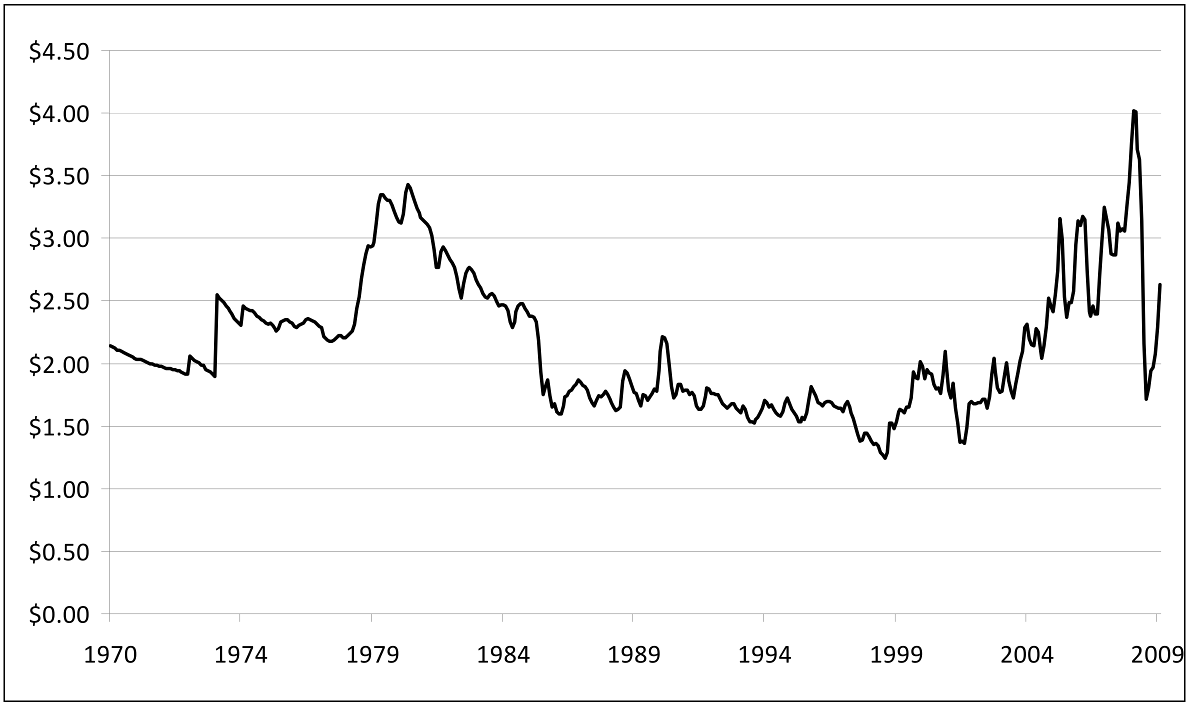
KEYWORDS: gasoline prices, traffic incidents, traffic safety, age, gender

INTRODUCTION
Crude oil prices historically have behaved in a cyclical fashion. Price swings have resulted in part from periods of oversupply or shortage, which often are related to episodes of war or crisis in the Middle East and other oil-producing regions (Williams 2008). In 1960, the Organization of Petroleum Exporting Countries (OPEC) was formed. OPEC was first able to influence international oil prices in 1972 as a result of the Yom Kippur War between Israel, Syria, and Egypt. The OPEC nations placed an oil embargo upon nations that supported Israel, resulting in the oil crisis of 1973–1974. In the late 1970s and into the 1980s, the Iranian Revolution and the Iran-Iraq war, and their consequent reductions of oil production and the second oil embargo, caused oil prices to double between 1978 and 1981. Yet, beginning in 1982, OPEC began reducing production quotas in an effort to stabilize prices. The price of oil therefore remained weak until 1990, until the Iraqi invasion of Kuwait and the first Gulf War. After this initial spike in oil prices, prices decreased until 1994. The American economy was operating at a high level, and Pacific Rim demand was high. In late 1997, following the East Asian Crisis, oil prices began to decrease until late 1998. However, following U.S. and world economic growth, oil prices surged again until early 2001. Then, in late 2001, in the face of a weakening U.S. economy and the September 11 terrorist attacks, oil prices fell into 2002. Yet, by 2003, an improving American economy, rising Asian demand, and the beginning of the American war in Iraq (and consequent loss of Iraqi oil production) all contributed to rising oil prices. Oil prices continued to rise into 2004 and 2005 as the U.S. dollar weakened, Asian energy needs remained high, excess oil production continued to diminish, and oil inventories of the Organization for Economic Co-operation and Development countries decreased (see Figure 1).

The international fluctuation of oil prices produces complex social and spatial implications for human society. Individuals adjust their commuting behaviors in response to increased transportation costs. The public bears the burden of rising costs of consumer goods. Transportation and land use planners respond to lower traffic levels and transformed residential patterns. Decision makers react to changed community structures and demographic compositions. Among these effects, this paper concerns the effects of gasoline prices on traffic safety (which encompasses both decreases and increases in traffic incidents or traffic crashes). Between 2000 and 2007, over 40,000 deaths due to traffic incidents occurred annually in the

United States (NHTSA 2009). In 2008, when gasoline prices reached $4 per gallon, U.S. roadway deaths fell: 37,313 deaths due to vehicle traffic incidents occurred in 2008, which is 9.1% lower than in 2007 and the fewest since 1961 (Thomas 2009). In the past, high gasoline prices have had similar correlations with roadway deaths. For example, traffic fatalities fell more than 16% from 1973 to 1994 when the oil crisis occurred (Thomas 2009).

FIGURE 1 Average gasoline prices (in June 2009 dollars) in the U.S., 1970–2009



Data source: Energy Information Agency, U.S. Department of Energy.

Although a limited number of studies have examined the effects of gasoline prices on traffic safety (Grabowski and Morrisey 2004, 2006; Leigh and Geraghty 2008; Leigh and Wilkinson 1991), they have only reported on fatal incidents. This paper extends the research by examining total traffic incidents to more accurately reflect the impact gasoline prices have on traffic safety. Specifically, we employ time geography theory to investigate the effects of gasoline prices on total traffic incident rates from April 2004 to December 2007 in Mississippi (chosen because we have access to the data). We will further analyze these effects by age and gender to explore the possible variations of these effects. This manuscript subsequently is organized into five sections. The next section discusses the application of time geography theory to interpret gasoline price effects on traffic safety and reviews the findings of existing studies. The following two sections introduce the data and methods used. The results section reports the effects of gasoline prices on total traffic incident rates as well as the incident rates by age and gender. Finally, this manuscript summarizes the findings and recommends strategies for decision makers to consider for reducing traffic incidents.

PRIOR RESEARCH AND TIME GEOGRAPHY THEORY

In this section, we develop a conceptual framework for understanding and examining the complex dynamics of gasoline prices on traffic safety. To do so, we build upon time geography theory, which is used to examine the relationships between behaviors of affected individuals and their spatial and temporal constraints.

Previous Empirical Findings

Existing research typically has examined traffic accidents and fatalities as functions of traffic characteristics, road conditions, climate, and socio-demographic characteristics (Quddus 2008). Most studies have failed to consider how traffic safety is affected by gasoline prices. There is no research on the effects of gasoline prices on total traffic incidents, and only a limited number of studies have analyzed the impact of gasoline prices on traffic fatalities. For example, Leigh and Wilkinson (1991) found that higher gasoline prices lead to fewer traffic fatalities, and Leigh and Geraghty (2008) found that the surge in oil prices in the late 1970s and early 1980s was correlated with a decrease in fatal traffic crashes. From 1972 to 1975, nominal and real gasoline prices increased 58.7% and 23.4%, while traffic deaths and the fatality rate decreased by 18.5% and 20.4%, respectively. From 1979 to 1982, nominal and real gasoline prices increased 46.6% and 10.2%, while traffic deaths and the fatality rate decreased by 14.4% and 15.4%, respectively. Grabowski and Morrisey (2004) found that a 10% increase in gasoline prices reduces traffic fatalities by 2.3% over a two-year period and by more than twice that figure for young drivers. Furthermore, they argue that a significant cause of the stability of traffic fatality rates throughout the 1990s was low gasoline prices. They argue that if gasoline prices had remained constant at a high of $2.13 (in 2002 dollars), then over 92,000 fewer traffic fatalities would have occurred in the period from 1985 to 2000. Grabowski and Morrisey (2006) conceptualized the price of gasoline as an exogenous variable and found that increasing state gasoline taxes by one cent caused a 0.45% decrease per capita in fatalities and a 0.42% decrease per capita in fatalities per vehicle mile traveled (VMT).

In addition, the studies that have examined the effects of gasoline price on fatal traffic incidents have examined the effects by age but not by gender. This study adds to the knowledge on how gasoline prices affect traffic safety by examining both age and gender. The cohort by age that has the highest incident rate is young drivers under age 24, who lack significant driving experience and are more likely to be involved in risky driving behaviors (Leigh and Wilkinson 1991). Young drivers may underestimate incident risk in part due to their lack of driving experience. Leigh and Wilkinson (1991) found that a state with young drivers one percentage point higher than a bordering state will have a fatality rate more than 8% higher. Rising gasoline prices may reduce the risky driving behaviors of young drivers by reducing their distance and time traveled as well as by possibly causing them to alter their driving habits so as to be more fuel efficient. Grabowski and Morrisey (2004) found that gasoline price increases have a higher impact on younger drivers than older drivers: with a 10-cent reduction in gasoline prices, the fatality rate increased by 4.4% for drivers 18 to 20 years old but by 3.9% for drivers 21 to 24 years old.

Time Geography Theory

With this paper, we expand the literature by examining the effects of gasoline prices on total traffic incidents, not only fatal traffic incidents, by age and gender. To do this, we apply time geography theory. Originally developed by Hägerstrand (1970), time geography theory studies the relationships between the behavioral possibilities of individuals and the various spatial and temporal constraints on those behaviors (Miller 1991; Yu and Shaw 2007). The core notion of time geography is that an individual's existence and activities are constrained by spatial and temporal attributes (Pred 1977). Time geography theory asserts that an individual can only participate in activities in one single location in space at one single time (Miller 1991). Three types of constraints on their activities exist: capability constraints, authority constraints, and coupling constraints (Hägerstrand 1970). Capability constraints refer to biological (e.g., sleeping and eating) and physical (e.g., vehicle ownership, time availability, maximum speed of travel) limitations that restrict an individual from participating in activities. Authority constraints represent limitations to accessing particular areas (e.g., military bases). Coupling constraints indicate limitations for two or more individuals to participate in an activity in the same location at the same time interval. The spatial and temporal patterns of an individual's movements are dictated by these three types of constraints.

An individual's movements in space over time generate a *space-time path*, which can be understood as a series of lines in a three-dimensional system in which space is represented by a two-dimensional plane and time is represented by the vertical axis. However, any space-time path is only one of many possible space-time paths that can be taken by an individual in a given time interval. All the points that an individual can reach from an origin location to a destination location at a given time interval comprise a *space-time prism*. The prism is determined by the intermediate locations between the origin and destination points, the time required for participation in activities at those locations, and the travel time between each point. The space-time path and space-time prism are the two most essential concepts of time geography, and they provide a valuable measure of an individual's accessibility within particular spatial and temporal constraints (Miller 1991).

Conceptual Framework

Time geography theory has been utilized to study various elements of transportation accessibility, such as bus services (Lenntorp 1976), commute modes and times (Burns 1979), transportation geographic information systems (Miller 1991), disparities in gender accessibility (Kwan 1998), and information and communication technologies (Yu and Shaw 2007). However, time geography theory has not yet been used for studying traffic safety. We assert that time geography theory can be effective for explaining the effects of gasoline prices on traffic safety. We understand gasoline prices as one type of capability constraint. Gasoline price increases reduce an individual's ability to afford the same amount of gasoline as consumed at cheaper prices, causing an individual to drive less total distance, in turn reducing exposure to traffic incidents. Higher gasoline prices reduce transportation accessibility by reducing lengths and frequencies of space-time paths and sizes of space-time prisms, leading to lower probabilities of traffic incidents for individuals.

We conceptualize gasoline prices as influencing traffic safety through five intermediate factors: trip frequency and distance, commute modes, residential relocation, driving behaviors, and vehicle fuel efficiency. First, rising gasoline prices could cause people to drive shorter distances by reducing trip frequency (fewer space-time paths) and distance (shorter space-time paths) as well as to make more multi-purpose (chained) trips rather than single-purpose trips (shorter total length of space-time paths). Second, an increase in gasoline prices could cause some drivers to switch from personal vehicle usage to other commuting modes, such as using public transportation, carpooling, biking, or walking (fewer motor vehicle space-time paths and fewer destinations reached by motor vehicle). Third, increased gasoline prices could induce workers, especially low- and medium-income automobile commuters who live far from their workplaces, to relocate closer to their workplaces (shorter space-time paths). Fourth, surging gasoline prices could cause people to drive in a more fuel-efficient manner, such as driving more slowly and reducing sudden speeding and braking. Fifth, an increase in gasoline prices could persuade some drivers to switch to fuel-efficient vehicles in the long term, which are generally lighter (and therefore more vulnerable if hit by a larger vehicle but likely to cause less damage to the other vehicle or pedestrian in a crash) but equipped with better safety technologies (the net effects of lightness and safety have been found to be insignificant [Leigh and Wilkinson 1991]).

As addressed in the first three possible effects listed, rising gasoline prices reduce the frequency and total lengths of motor-vehicle-based space-time paths of an individual during a given time interval—i.e., an individual is traveling less and for shorter distances by car—which in turn reduces the likelihood of a traffic incident occurrence for that individual. The effects of gasoline prices on the five intermediate factors eventually lead to greater traffic safety. Reductions in trip frequency and distance, switching to non-personal vehicle travel modes, relocation closer to workplaces, and employing more fuel-efficient driving habits will eventually decrease the overall distance traveled (total lengths of space-time paths), which in turn lowers the probability of traffic incidents. Thus, we expect that as gasoline prices increase (as the capability constraint becomes stronger), traffic incident rates will decrease.

Control Variables

The conceptual links through which gasoline prices affect traffic safety are complex. They have not been tested in existing studies. This study does not attempt to test these conceptual links, either. Measurement of the intermediate links might have potentially large errors and the conceptual links might be imprecise. Instead of modeling the effects by these links, this research directly models the effects of gasoline prices on traffic safety by controlling for variables that are associated with traffic safety.

The use of seat belts has been shown to have positive effects on reducing traffic fatalities (Evan and Graham 1991); therefore, the seat belt usage rate will be used as a control variable. When measuring seat belt usage, previous studies have used the implementation of seat belt laws and treated it as a dummy variable (e.g., Grabowski and Morrisey 2004). However, drivers may react to safety regulations by increasing other risky driving behaviors, as discussed in the risk compensation research (e.g., Adams 1995) and the Peltzman (2004) effect. Thus, the seat belt usage rate is a better measure than the implementation of seat-belt laws.

Alcohol consumption is also used as a control variable. Risk assessment and safe driving capabilities are impaired by alcohol consumption (Leigh and Wilkinson 1991). Some studies argue that the implementation of drinking-and-driving laws can impose positive effects on reducing traffic fatalities and treat the implementation of the laws as a dummy variable (e.g., Grabowski and Morrisey 2004). This study uses the representation of alcohol consumption, which is a more detailed measure of the effects that alcohol consumption has on traffic safety.

Unemployment rate will also be used as a control variable because economic conditions affect an individual's capability to consume gasoline and have therefore been found to affect traffic incidents (Graham and Glaister 2003; Leigh and Wilkinson 1991; Quddus 2008). Areas with high unemployment rates are more vulnerable to rising gasoline prices.

Other variables, such as driving behaviors and vehicle characteristics, are argued to affect traffic safety (Leigh and Geraghty 1991, 2008). However, such data were unavailable when this analysis was conducted. These variables will be used for future studies when the data become available.

DATA

Most studies that analyze gasoline price effects on traffic safety (e.g., Grabowski and Morrisey 2004; Leigh and Wilkinson 1991) are based on Fatal Accident Reporting System (FARS) data, which consider only fatal incidents. This study analyzes the effects of gasoline prices on all types of traffic incidents. The data used in this study are Mississippi traffic incident data from April 2004 to December 2007 provided by the Mississippi Highway Patrol and include driver's license service data and electronic crash report data. The data contain detailed information on vehicles, drivers, and passengers involved in traffic incidents as well as the types of traffic incidents (fatal and non-fatal).

Regular-grade unleaded gasoline price data were obtained from the Energy Information Administration (EIA) of the U.S. Department of Energy for the period 1970 to 2008. The EIA does not collect gasoline price information specifically for Mississippi but provides average prices for all Gulf Coast states. This study, therefore, applies average prices for the Gulf Coast states to approximate the prices in Mississippi. Gasoline price data are also adjusted for inflation. VMT data were acquired from the Mississippi Department of Transportation and population estimates came from the U.S. Census Bureau; these two data sets were used for calculating incident rates. Seat belt usage data were provided by the Social Science Research Center of Mississippi State University, who had prepared it for the Mississippi Department of Public Safety. Alcohol consumption data came from the Annual Statistics Abstracts of Brewers Almanac, and unemployment data were obtained from the U.S. Bureau of Labor Statistics.

METHODS

In this study, semi-log regression models are utilized for examining the effects of gasoline prices on traffic incidents. Semi-log models are often used to model traffic incident rates because of skewness (Dee 2001). Moreover, semi-log model estimates are more robust than grouped logistic models as regards magnitude and precision (Grabowski and Morrisey 2004). The specification for the semi-log models is:

$$ln(r) = \beta X + \lambda K + \mu$$

where

r refers to incident rates;

X refers to gasoline prices and control variables;

β refers to coefficients of *X*;

K refers to month-fixed effects;

λ is the coefficient for month-fixed effects; and

μ is the randomly distributed error term.

The total incident rate is measured per capita and per VMT. Incident rates by age (15–23 and 24+ years old) and gender (male and female) are measured by per capita in their corresponding population cohorts. Therefore, six different traffic incident rates are studied. Each measure is used as a dependent variable in a semi-log model. Traffic incident rates are functions of gasoline prices, seat belt usage, alcohol consumption, and unemployment rate.

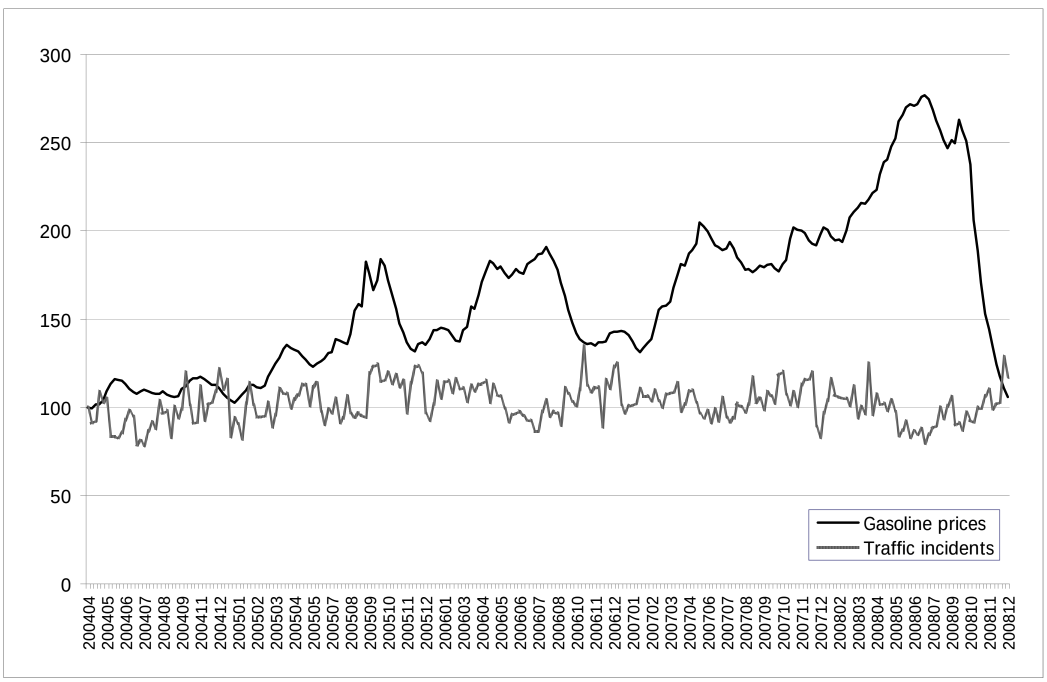
Existing studies suggest that the short-term and long-term effects of gasoline prices on traffic fatalities may be different (Dahl and Sterner 1991; Grabowski and Morrisey 2004). The gasoline price threshold, however, is ambiguous. In this study, we follow the Grabowski and Morrisey (2004) study to measure gasoline prices at the current time, a 1-year lag, a 2-year lag, a 3-year lag, and a 4-year lag; the first measure represents short-term effects while the latter four represent long-term effects. Month-fixed effects control for unobserved seasonal variation in traffic incident rates, such as weather conditions.

RESULTS

Correlation between Gasoline Prices and Traffic Incidents

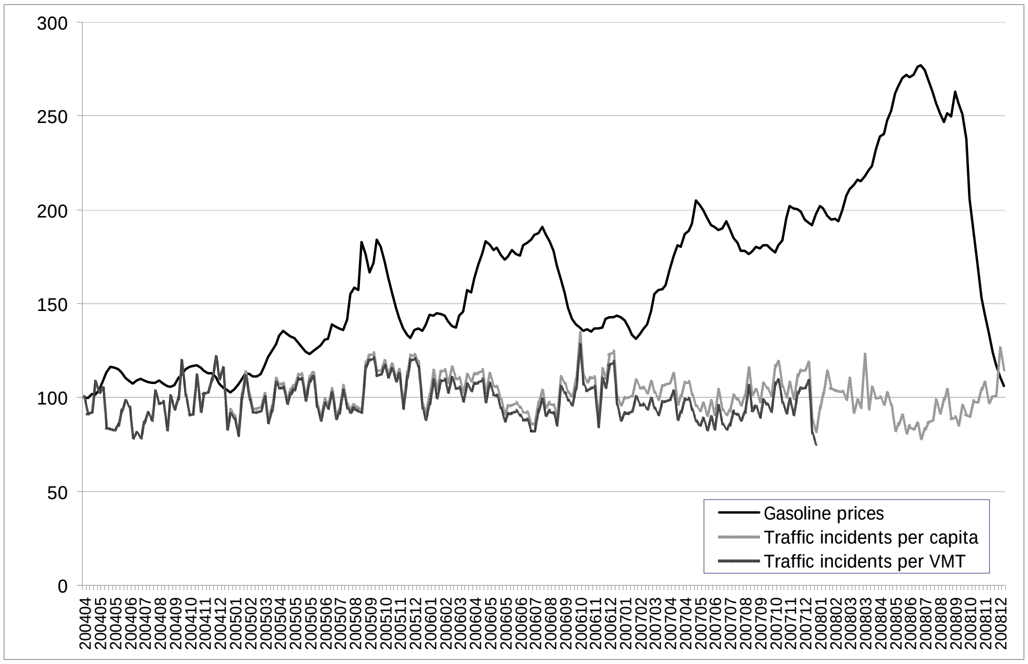
We first plot the relationship between gasoline prices and traffic incidents on a graph. Figure 2 shows the correlation between gasoline prices (adjusted for inflation) and the number of traffic incidents in Mississippi from April 2004 to December 2008. Both gasoline prices and traffic incidents are standardized by indices (the first week of April 2004 = 100) to better visualize the correlation between their corresponding lines. Figure 2 clearly illustrates a negative relationship between gasoline prices and the number of traffic incidents: when gasoline prices increase, the number of traffic incidents decreases; when gasoline prices decrease, the number of traffic incidents increases. This pattern can be observed especially in the periods of March–October 2006, January–September 2007, and March–December 2008.

FIGURE 2 Gasoline prices and traffic incidents in Mississippi, 2004–2008



Traffic incident counts are further converted to traffic incident rates for comparison to gasoline prices. We used two measures of traffic incident rates: one by population and the other by VMT (the 2008 VMT data are unavailable). Figure 3 shows a similar pattern in the relationship between gasoline prices and traffic incident rates: as gasoline prices increase, both measures of traffic incident rates decrease; as gasoline prices decrease, both measures of traffic incident rates increase. This pattern is visible from March–October 2006, January–September 2007, and March–December 2008, identical to the pattern observed in Figure 2.

FIGURE 3 Gasoline prices and traffic incident rates in Mississippi, 2004–2008



Gasoline Prices and Total Traffic Incident Rates

We then examine the effects of gasoline prices on total traffic incident rates (per capita and per VMT) at the monthly level by using semi-log regression models (Table 1). It was found that gasoline price at the current time has significant negative effects on traffic incidents per capita; a one-cent increase in the inflation-adjusted gasoline price is associated with a 0.109% decrease in monthly total incidents per capita. Evaluated at the mean price of $2.13, this coefficient implies an elasticity of –0.23. Gasoline prices at the 1-year, 2-year, 3-year, and 4-year lags were found to have no statistically significant effects on traffic incidents per capita. The per VMT measure offers very similar findings to the per capita measure. Thus, the results suggest that gasoline prices have short-term but not long-term effects on reducing traffic incident rates. As discussed in the literature review section, gasoline prices act as one type of capacity constraint. When gasoline prices increase, people drive less; the total lengths of their space-time paths will be reduced, which in turn decreases the probability of being involved in traffic incidents.

The findings are reasonable compared to the results from existing literature. For example, Grabowski and Morrisey (2004) found that a one-cent increase in gasoline price is associated with a 0.06% decrease in monthly fatal crashes per capita, which implies an elasticity of –0.14 at the mean price studied. Gasoline prices have stronger effects on total traffic incidents (0.11% from this study) than on fatal incidents (0.06% from the Grabowski and Morrisey 2004 study), because total traffic incidents include not only fatal incidents but also non-fatal incidents.

TABLE 1 Least squares estimates of semi-log regression models for traffic incidents per capita and per VMT, April 2004-December 2007, Mississippi

	Per capita	Per VMT
Gasoline price at the current time	–0.00109*	–0.00110*
	(.00041)	(.00041)
Gasoline price at a 1-year lag	–0.00046	–0.00047
	(.00044)	(.00044)
Gasoline price at a 2-year lag	0.00004	–0.00001
	(.00062)	(.00062)
Gasoline price at a 3-year lag	0.00110	0.00112
	(.00095)	(.00095)
Gasoline price at a 4-year lag	0.00036	0.00032
	(.00113)	(.00113)
Seat belt usage rate	–0.00973	–0.01412
	(.00776)	(.00776)
Alcohol consumption (gallons per capita)	0.22963**	0.18637*
	(.07064)	(.07060)
State unemployment rate	0.05373***	0.05140***
	(.01261)	(.01260)
Month-fixed effects	Yes	Yes
Constant	0.34381	1.12492
	(1.75353)	(1.75255)
Adjusted R^2	0.45	0.46

*Notes: * significant at p≤0.05 for a two-tail test; ** significant at p≤0.01 for a two-tail test; *** significant at p≤0.001 for a two-tail test; standard errors in parentheses.*

Gasoline Prices and Incident Rates by Age and Gender

Previous research has suggested that the effects of gasoline prices on traffic incident rates may differ by age and gender (Van den Bossche et al. 2007). Thus, we further partitioned the incident data by age and gender to re-run semi-log models (Table 2). To examine the age variation, we ran semi-log regression models for incident rates of the younger population (15–23 years old) and the older population (24+ years old) separately. As shown in Table 2, it was found that gasoline price at the current time has significant negative effects on the traffic incident rate of younger populations; a one-cent increase in the inflation-adjusted gasoline price is associated with a 0.18% decrease in monthly total incidents per capita, which is higher than the percentage decrease in overall traffic incident rates. Evaluated at the mean price of $2.13, this coefficient implies an elasticity of –0.38. Gasoline prices at the 1-year, 2-year, 3-year, and 4-year lags were found to have no statistically significant effects on the traffic incident rates of younger populations. Younger populations tend to have lower incomes than older populations and thus are more vulnerable to gasoline price changes. When gasoline prices increase, younger populations will not be able to consume as much gasoline as previously. Thus, the frequency and total length of their space-time paths are reduced, which in turn reduces their exposure to traffic incidents.

Table 2 also shows that gasoline price at the current time has significant negative effects on the incident rate of older populations; a one-cent increase in the inflation-adjusted gasoline price is associated with a 0.082% decrease in monthly total incidents per capita, which is a much lower percentage than the percentage decrease of the incident rate of younger populations. Evaluated at the mean price of $2.13, this coefficient implies an elasticity of –0.17. Different from the effects on incident rates of younger populations, it was found that gasoline price at a 1-year lag has significant effects on incident rates of older populations: a one-cent increase in the inflation-adjusted gasoline price is associated with a 0.086% decrease in monthly total incidents per capita, implying an elasticity of –0.18. The reason that gasoline prices have longer effects on the incident rate of older populations may be that older populations have more family responsibilities and thus react in a more conservative manner; older populations are more mature and cautious in expecting an immediate price decrease to original lower levels. Gasoline prices at 2-year, 3-year, and 4-year lags were found to have no statistically significant effects on the traffic incident rate of older populations. In sum, gasoline prices have stronger short-term effects on reducing the traffic incident rate of younger populations than that of older populations, but gasoline price effects on older populations can extend into one year after the initial increase.

TABLE 2 Least squares estimates of a semi-log regression model for monthly traffic incidents by age and gender, April 2004-December 2007, Mississippi

	Age		Gender	
	15–23 years	24+ years	Male	Female
Gasoline price at the current time	–0.00180**	–0.00082*	–0.00075	–0.00148**
	(.00053)	(.00039)	(.00039)	(.00048)
Gasoline price at a 1-year lag	0.00103	–0.00086*	–0.00041	–0.00032
	(.00056)	(.00042)	(.00041)	(.00051)
Gasoline price at a 2-year lag	0.00075	–0.00014	–0.00011	0.00031
	(.00081)	(.00060)	(.00059)	(.00073)
Gasoline price at a 3-year lag	0.00158	0.00181	0.00147	0.00215
	(.00124)	(.00092)	(.00090)	(.00111)
Gasoline price at a 4-year lag	0.00053	0.00120	0.00089	0.00122
	(.00147)	(.00109)	(.00107)	(.00132)
Seat belt usage rate	–0.02220*	–0.01194	–0.01349	–0.01668
	(.01006)	(.00750)	(.00736)	(.00904)
Alcohol consumption (gallons per capita)	0.09289	0.25022***	0.20083**	0.22562**
	(.09154)	(.06824)	(.06701)	(.08228)
State unemployment rate	0.04326*	0.06780***	0.06078***	0.06079***
	(.01634)	(.01218)	(.01196)	(.01469)
Month-fixed effects	Yes	Yes	Yes	Yes
Constant	–7.97458***	–13.45448***	–11.95866***	–12.77966***
	(2.27223)	(1.69387)	(1.66333)	(2.04244)
Adjusted R^2	0.25	0.57	0.49	0.38

*Notes: * significant at p≤0.05 for a two-tail test; ** significant at p≤0.01 for a two-tail test; *** significant at p≤0.001 for a two-tail test; standard errors in parentheses.*

To determine whether the effects of gasoline prices on traffic incident rates differ between genders, we ran semi-log regression models for the incident rates of males and females separately. The results in Table 2 indicate that gasoline prices have neither short-term nor long-term effects on the traffic incident rate of males. This suggests that males' driving behaviors are not affected by gasoline price changes. A large proportion of males' trips are work related (Meyer 2004; Rosenbloom 2004); because work-related trips are not optional, the number and frequency of males' trips are much less affected by gasoline price changes. Thus, males' space-time paths and prisms are less vulnerable to gasoline price changes.

Table 2 reveals that gasoline price at the current time has significant negative effects on the traffic incident rate of females; a one-cent increase in the inflation-adjusted gasoline price is associated with a 0.148% decrease in females' monthly total incidents per capita, which is a higher percentage increase than that for the incident rate of the overall population. Evaluated at the mean price of $2.13, this coefficient implies an elasticity of –0.32. Gasoline prices at 1-year, 2-year, 3-year, and 4-year lags were found to have no statistically significant effects on traffic incident rates of females. Females tend to have more non-work-related trips such as trips for recreational shopping and taking children to school or other events (Meyer 2004; Rosenbloom 2004). Rising gasoline prices increase living costs, which in turn reduces the allocatable funds for non-work related trips. Females will reduce the lengths and frequencies of their trips more than males. Therefore, females' space-time paths and prisms are more discretionary, and thus, more vulnerable to gasoline price increases.

CONCLUSION AND DISCUSSION

When examining gasoline price effects on traffic safety, previous studies have focused on only fatal incidents and ignored other types of incidents. This study is a step toward filling this gap in the literature because it investigates the effects of gasoline prices on total (fatal and non-fatal) traffic incidents as well as age and gender variations by using traffic incident data from Mississippi from April 2004 to December 2007. The results show a clear negative relationship between gasoline prices and traffic incident rates. It was found that gasoline prices have negative short-term effects on total traffic incident rates (a one-cent increase in price is associated with a 0.11% decrease in monthly total incidents per capita or per VMT) but no statistically significant long-term effects. Regarding age variations, it was found that gasoline prices have negative short-term effects on the traffic incident rate of the younger population (a one-cent increase in price is associated with a 0.18% decrease in monthly total incidents per capita) and both short-term and longer-term effects on the traffic incident rate of the older population (a one-cent increase in price is associated with a 0.082% decrease in the monthly incident rate and a 0.086% decrease in the incident rate one year later). Regarding gender variations, it was found that gasoline prices have no statistically significant effects on the traffic incident rate of males but do have negative short-term effects on the incident rate of females (a one-cent increase in price is associated with a 0.148% decrease in the monthly incident rate of females). Put short, the effects of gasoline prices are disproportionate for younger populations and females, longer for older populations, and none for males.

There are abundant research opportunities to further study the effects of gasoline prices on traffic safety. First, future research needs to be conducted for other states. Although this study adds to the knowledge of gasoline price effects on traffic safety, its data cannot necessarily be generalized to the entire U.S. Second, the effects of gasoline prices on traffic safety can be examined at the individual level. Existing studies have only focused on the aggregate level; an analysis at the individual level may provide more insight into gasoline price effects on traffic safety. Third, the data could be further partitioned by race, levels of income, and educational attainment. Partitioning the data will help identify population cohorts whose traffic incident probabilities are most reduced due to gasoline price increases. Fourth, traffic incident sites can be geocoded and thus we can investigate the spatial effects of gasoline price increases on traffic safety by employing spatial econometric models.

The findings of this research suggest that higher gasoline prices lead to lower traffic incident rates. However, the results should not necessarily be interpreted as increasing gasoline prices would result in a net societal benefit. Although higher gasoline prices do reduce traffic crashes in the short term, it is possible that in the long term increased gasoline prices could raise indirect costs for the entire society, which might ultimately exceed the benefits of a lower crash rate.

The findings do suggest, however, that if decision makers wish to reduce traffic accident rates, increased gasoline taxes are a significant option because raised gasoline prices affect traffic safety directly (Leigh and Wilkinson 1991). While higher gasoline prices due to crude oil price increases are not favored, higher gasoline taxes might be used. The additional tax revenues can be used for improving transportation infrastructure or other purposes. Compared to other industrial countries, the United States imposes very low gasoline taxes (only $0.46 per gallon of gasoline (federal and state) for the first quarter of 2009; International Energy Agency 2009). Federal and state taxes account for, on average, 24% of gasoline prices from 2000 to 2007, and 15% in 2007.

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