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Gasoline prices and their relationship to drunk-driving crashes

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ABSTRACT

This study investigates the relationship between changing gasoline prices and drunk-driving crashes. Specifically, we examine the effects of gasoline prices on drunk-driving crashes in Mississippi by several crash types and demographic groups at the monthly level from 2004 to 2008, a period experiencing great fluctuation in gasoline prices. An exploratory visualization by graphs shows that higher gasoline prices are generally associated with fewer drunk-driving crashes. Higher gasoline prices depress drunk-driving crashes among young and adult drivers, among male and female drivers, and among white and black drivers. Results from negative binomial regression models show that when gas prices are higher, there are fewer drunk-driving crashes, particularly among property-damage-only crashes. When alcohol consumption levels are higher, there are more drunk-driving crashes, particularly fatal and injury crashes. The effects of gasoline prices and alcohol consumption are stronger on drunk-driving crashes than on all crashes. The findings do not vary much across different demographic groups. Overall, gasoline prices have greater effects on less severe crashes and alcohol consumption has greater effects on more severe crashes.

1. Introduction

In 2008, there were more than 300,000 alcohol-related automobile crashes in the United States (NHTSA, 2009). While drunk-driving crashes have declined substantially over the past three decades, drunk driving is still a serious problem and the leading cause of deaths on highways (Dang, 2008; NHTSA, 2009). Alcohol consumption has been found to explain much of the variation in drunk-driving crashes (Berger and Snortum, 1986; Young and Bielinska-Kwapisz, 2006), but drunk-driving crashes may also be affected by gasoline price changes. Gasoline prices are found to affect automobile crashes negatively in general—higher gasoline prices lead to fewer traffic crashes (e.g., Grabowski and Morrisey, 2004, 2006; Leigh and Geraghty, 2008; Leigh et al., 1991; Wilson et al., 2009). However, to our best knowledge, no studies have investigated gasoline price effects on drunk-driving crashes. This study attempts to fill the gap in the literature by examining the effects of gasoline prices on drunk-driving crashes.

Gasoline price changes may affect drunk-driving crashes in two possible directions—positive and negative. On one hand, higher gasoline prices may lead to fewer drunk-driving crashes. Such a relationship can come about through four possible paths. First, from the economic perspective, higher gasoline prices reduce purchases of alcohol for consumption, which in turn may reduce drunk-driving frequency and crash likelihood. The relationship between economic conditions (e.g., per capita income and employment rate) and drunk-driving crashes is found to be positive (Ruhm, 1996). When gasoline prices increase, discretionary expenditures for alcohol consumption may decrease. Consequently, people may consume less alcohol or drink at bars less often. People may also drink at bars or restaurants closer to their homes in order to reduce gasoline usage. Most empirical evidence suggests that alcohol consumption levels tend to be lower during poor economic conditions (e.g., Nelson, 1997; Ruhm, 1995; Ruhm and Black, 2002; Sloan et al., 1995). Lower alcohol consumption levels, in turn, are linked to fewer drunk-driving crashes (Berger and Snortum, 1986) and fatalities (Benson et al., 1999; Dang, 2008; Wilkinson, 1987; Young and Bielinska-Kwapisz, 2006).

Second, rising gasoline prices could cause some drivers to switch from personal vehicle usage to other transportation modes, such as public transportation, carpooling, biking, or walking (Currie and Phung, 2007, 2008; Haire and Machemehl, 2007). Third, a large

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body of literature suggests that higher gasoline prices reduce gasoline consumption and travel demand (see Goodwin et al., 2004 for a summary of the literature), which in turn reduces people's exposure to all types of crashes, including drunk-driving crashes. Fourth, there is some evidence that surging gasoline prices could cause drivers to drive more cautiously, such as driving more slowly and reducing sudden speeding and braking in order to increase fuel economy (Dahl, 1979; U.S. Congressional Budget Office, 2008). These behaviors then lower drivers' overall crash risk. This causal relationship may also apply to drunk drivers, especially those who are lightly intoxicated.

On the other hand, it is possible that higher gasoline prices will lead to more drunk-driving crashes. Some individual-level studies suggest that individuals consume more alcohol in response to the stress they face during economic hardship. For example, Dee (2001) found elevated rates of binge drinking during periods of high unemployment rates. Others have also found a connection between alcohol consumption and job loss (Catalano et al., 1993; Ettner, 1997) and personal economic strain (Pearlin and Radabaugh, 1976; Peirce et al., 1994). Higher gasoline prices could contribute to the economic stress of individuals, which in turn leads to an increase in alcohol consumption and alcohol-related crashes.

While both hypotheses about the relationship between changing gasoline prices and drunk-driving crashes seem reasonable, they are also contradictory. Our goal in this research is to test the two alternative hypotheses empirically. Specifically, we examine the effects of gasoline prices on drunk-driving crashes in Mississippi by age, gender, and race from 2004 to 2008. Drunk-driving crashes are partitioned into three types: fatal, injury, and property damage only (PDO). We also analyze gasoline price effects on all crashes in the same manner for comparison purposes. Most existing alcohol-related studies examine only fatal drunk-driving crashes (Kenkel, 1993). While fatal drunk-driving crashes evoke a more emotional response, they comprise only a small percentage of drunk-driving crashes. In fact, only 12.6% of all alcohol-related crashes in 2008 in the U.S. were fatal (NHTSA, 2009). By analyzing fatal, injury, and PDO drunk-driving crashes separately, we are able to gain a more comprehensive understanding of the relationship between gasoline prices and alcohol-related crashes. In the following sections, we first introduce our data and methodology, and then we report our findings on the relationship between gasoline prices and the three types of drunk-driving crashes by age, gender, and race.

2. Data and methods

2.1. Data

The data used for this study include information on drunk-driving crashes and all crashes (both by fatal, injury, and PDO categories) as well as monthly per-gallon gasoline prices. We also obtained data on the crashes that allowed for analysis of crashes per vehicle miles traveled, crashes per capita, and the age, gender, and race of each driver involved. Drunk-driving crashes could also be affected by several other factors. As such, we included several such variables as controls in our analysis of the relationship between gasoline prices and drunk-driving crashes. These control variables are alcohol consumption, unemployment rate, and seat belt usage. Drunk-driving crashes could also be affected by other variables, including driving behaviors, vehicle characteristics, road conditions, and weather (Fu, 2008). However, our data reflect drunk-driving crashes in Mississippi at the monthly level, and these other factors cannot be easily aggregated to the state level and presumably have much less explanatory effect on traffic safety than at the individual level. Therefore, these factors are not used in this study.

2.1.1. Drunk-driving crashes

Researchers examining factors that influence vehicle crashes generally use crash rates generated from data provided by the Fatal Accident Reporting System of the National Highway Traffic Safety Administration (e.g., Grabowski and Morrisey, 2004; Leigh et al., 1991; Wilson et al., 2009). These data enumerate all of the fatal crashes in the U.S. but do not contain information on injury and PDO crashes. As described previously, the majority of drunk-driving crashes are nonfatal, so using data for only fatal crashes cannot provide adequate analysis of the effects of gasoline prices on drunk-driving crashes of all types.

This study uses data enumerating fatal, injury, and PDO drunk-driving crashes to analyze the effects of gasoline prices. The Mississippi Highway Patrol (MHP) provided data on the three types of drunk-driving crashes in Mississippi at the monthly level from April 2004 to December 2008, which was a period of great fluctuation in gasoline prices. However, the data were only available for 57 months; this small number of observations could substantially limit the statistical results. A crash was considered a drunk-driving crash if at least one of the drivers was determined to have a blood alcohol content (BAC) of 0.08 g/dl or higher (Robertson et al., 2009). For each drunk-driving crash, the MHP data included the crash type as well as the age, gender, and race of each driver, which allowed us to examine gasoline price effects on drunk-driving crashes by these different crash types and different demographic groups. We also combined crash data with transportation data from the Mississippi Department of Transportation to calculate crashes per vehicle miles traveled (VMT) and with annual population estimations from the U.S. Bureau of the Census to calculate crashes per capita.

In Mississippi, the only crashes that are not mandated to be reported are PDO crashes with property losses less than $500. All fatal, injury, and alcohol-related crashes are required to be reported regardless of the property loss involved. However, it is known that police reports of drunk-driving conditions are not always accurate, and minor crashes are often not reported to police (Kim et al., 1995). In addition, about 2% of law enforcement agencies in Mississippi did not report crashes electronically in the studied period and thus their crashes are not included in the data analysis (personal communication with Captain Randy Ginn, Mississippi Highway Patrol, June 21, 2010). As we focused on crash counts rather than crash rates in this study, the impacts of under-reporting should not be serious (Kim et al., 1995).

2.1.2. Gasoline prices

We obtained monthly per-gallon prices for regular-grade unleaded gasoline from the U.S. Department of Energy's Energy Information Administration (EIA) for the period 2004–2008. Because the EIA does not provide gasoline prices at the state level, we approximated Mississippi prices using average prices from states in the Gulf Coast region. Gasoline prices are adjusted for inflation (in January 2009 dollars) and are used as the primary explanatory variable.

2.1.3. Alcohol consumption

Alcohol consumption has direct effects on drunk-driving crashes (Benson et al., 1999; Berger and Snortum, 1986; Dang, 2008; Wilkinson, 1987; Young and Bielinska-Kwapisz, 2006). Because safe-driving capabilities are impaired by alcohol consumption, drunk-driving crashes generally rise with per capita alcohol consumption. Alcohol consumption is often measured using the driver's BAC level in existing drunk-driving studies (Mayhew et al., 2003; Roudsari et al., 2009; Schwilke et al., 2006). Alcohol consumption is also measured using alcohol consumption (in gallons)