Zwick Center for Food and Resource Policy

Working Paper Series

No. 23

Alcohol-Related Motor Vehicle Crash Risk and the Location of Alcohol Purchase

Chad Cotti

Richard A. Dunn

Nathan Tefft

November 4, 2013

Charles J. Zwick Center for Food and Resource Policy
Department of Agricultural and Resource Economics
College of Agriculture and Natural Resources
1376 Storrs Road, Unit 4021
Storrs, CT 06269-4021
Phone: (860) 486-2836
Fax: (860) 486-1932
ZwickCenter@uconn.edu

Alcohol-Related Motor Vehicle Crash Risk and the Location of Alcohol Purchase

Chad Cotti[a], Richard A. Dunn[b], and Nathan Tefft[c,d]

[a]Department of Agricultural and Resource Economics, College of Agriculture and Natural Resources, and Department of Economics, College of Liberal Arts and Sciences, University of Connecticut, Storrs, CT 06268, USA

[b]Department of Agricultural Economics, College of Agriculture and Life Sciences, and Department of Economics, College of Liberal Arts, Texas A&M University, College Station, TX 77843 USA

[c]Department of Health Services, School of Public Health, University of Washington, Seattle, WA 98195, USA, phone: 206-221-5897, fax: 206-543-3964, email: tefft@uw.edu

[d]Corresponding Author

Keywords: Alcohol Drinking, Motor Vehicles, Economics, Taxes

Acknowledgments: The authors thank the Kilts-Nielsen Data Center at The University of Chicago Booth School of Business for providing the NHCPD data (http://research.chicagobooth.edu/nielsen/). Author order is alphabetic and lead authorship is shared among all of the authors.

Abstract: In this study, we examine how the probability of driving after a binge-drinking episode varies with the location of consumption and type of alcohol consumed. We also investigate the relationship between the location of alcohol purchase and the number of alcohol-related fatal motor vehicle crashes. We find that binge-drinkers are significantly more likely to drive after consuming alcohol at establishments that sell alcohol for on-premises consumption, e.g., from bars or restaurants, particularly after drinking beer. Further, per capita sales of alcohol for off-premises consumption are unrelated to the rate of alcohol-related fatal motor vehicle crashes. When disaggregating alcohol types, per capita sales of beer for off-premises consumption are negatively associated with the rate of alcohol-related fatal motor vehicle crashes. In contrast, total per capita sales of alcohol from all establishments (on- and off-premises) are positively related to the rate of alcohol-related fatal motor vehicle crashes and the magnitude of this relationship is strongest for beer sales. Thus, policies that shift consumption away from bars and restaurants could lead to a decline in the number of motor vehicle crashes.

INTRODUCTION

Unintentional motor vehicle crashes are a leading cause of mortality and morbidity in the U.S. In 2005, the latest year for which cost reports are available, there were 43,667 deaths attributable to fatal crashes, resulting in an estimated total cost of $49.5billion. In the same year, motor vehicle crashes resulted in 218,554 hospitalizations, totaling $26.3billion in medical expenditures and lost work productivity (Centers for Disease Control and Prevention, 2013a).

Numerous studies have documented a positive relationship between the amount of alcohol consumed and the risk of causing a motor vehicle crash (Anda RF Remington PL, 1988; Borkenstein et al., 1964; Corrao et al., 1999; Fabbri et al., 2001; Taylor & Rehm, 2012; Taylor et al., 2010; Zador et al., 2000). In 2010, nearly one-third of the 32,885 deaths from fatal motor vehicle crashes involved a driver impaired by alcohol (National Highway Traffic Safety Administration, 2010). Moreover, of the 43,731 acute alcohol-related deaths per year in the U.S. between 2001 and 2005, 13,810 were attributable to motor vehicle crashes. Reducing the number of drunk-driving fatalities is therefore a major public health priority in the United States.

Several authors have noted that the location of alcohol consumption plays an important role in determining the overall risk of a fatal motor vehicle crash (Cotti & Tefft, 2011; Manning et al., 1989; Ruhm, 1995). For example, the decline in fatal motor vehicle crashes in the U.S. following the 2008 financial crisis was partly attributable to a decline in the number of miles driven (Cotti & Tefft, 2011). Naimi et al. (2009) find that driving after a binge drinking event was substantially more likely when the event occurred in a bar or club as compared to the drinker’s home. A related study found that two-thirds of individuals who reported driving after a binge drinking event also reported that beer was the predominant type of alcohol consumed during the event (Naimi, 2007). Yet, to our knowledge, no studies have examined how consumption location and type of alcohol consumed influence drunk driving risk simultaneously. More importantly, no studies have directly linked consumption location to the number of alcohol-related motor vehicle crashes. This is an important gap in the current literature, as effective policy design clearly requires information about the roles that quantity consumed, type of alcohol consumed, and location of consumption each play in determining crash incidence.

Therefore, this study seeks to quantify the effect of *on-premises consumption* (e.g., at bars and restaurants) relative to *off-premises consumption* (e.g., purchases from supermarkets, convenience stores and liquor stores) on two outcomes: the probability of driving after a binge-drinking episode and the number of fatal motor vehicle crashes. Further, it investigates how these relationships vary by the type of alcohol purchased.

The results from this study can inform important policy debates. For example, one proposal to reduce alcohol-related motor vehicle crashes would increase the alcohol excise tax to reduce total consumption of alcohol (Baker et al., 2012). If the consumption of alcohol purchased for on-premises consumption was primarily responsible for causing fatal motor vehicle crashes, however, then a more targeted approach that only increased the tax on alcohol purchased at bars, restaurants, and other on-premises establishments may provide more net social welfare, i.e., reduce an equivalent number of crashes while taxing fewer individuals. These questions cannot be adequately addressed given existing research that has largely ignored the role of consumption location.

METHODS

The relationship between location of alcohol consumption and motor vehicle crash risk will be examined in two separate analyses. First, we will utilize individual-level data to study the relationship between the location of consumption, the type of alcohol consumed and the probability of driving after a binge-drinking event. Second, we will utilize aggregate data at the state- and market-level to study the relationship between consumption location, alcohol type, and the alcohol-related motor vehicle crash rate.

Location of consumption and driving after binge-drinking

Data

We examine the relationship between the location of alcohol consumption, alcohol type, and the probability of driving after a binge-drinking episode using data drawn from the 2003, 2004, and 2008 surveys of the Behavioral Risk Factor Surveillance System (BRFSS) (Centers for Disease Control and Prevention, 2013b).[1] The 2003 and 2004 BRFSS Binge Drinking module data from have been used previously to study the relationship between driving and binge drinking both by the location of consumption (Naimi et al., 2009) and by alcohol subtype (Naimi et al., 2007). This portion of our analysis therefore serves to confirm earlier findings by extending the data to include the more recent 2008 survey and to present results that simultaneously consider consumption location and alcohol type, which foreshadow results from our market- and state-level analyses.

Across the three years, respondents in 22 states participated in the Binge Drinking module, which includes questions about the respondent's last binge drinking occasion, if any. We first record the quantity of each category of alcohol consumed at the last binge drinking occasion

[1] The Binge Drinking module was included only in 2003, 2004, and 2008.

from responses to the following three questions: “During the (most recent occasion when you had 5 or more alcoholic beverages), about how many [beers, including malt liquor | glasses of wine, including wine coolers, hard lemonade, or hard cider | liquor, including cocktails], did you drink?”.[2]

The primary location of where the binge-drinking event occurred is obtained from the question “During this most recent occasion, where were you when you did most of your drinking?”, to which valid responses are “At your home, for example, your house, apartment, condominium, or dorm room”, “At another person’s home”, “At a restaurant or banquet hall”, “At a bar or club”, “At a public place, such as at a park, concert, or sporting event”, and “Other”. Consumption at home, at another home, or at a public place is categorized as consumption of alcohol purchased from off-premises establishments.[3] Consumption at a bar or at a restaurant is categorized as consumption of alcohol purchased from on-premises establishments.

The quantity and location of alcohol consumption is linked to reported driving behavior using responses to the question “Did you drive a motor vehicle, such as a car, truck, or motorcycle during or within a couple of hours after this occasion?”.

In addition to Binge Drinking module responses, we include several demographic and economic characteristics as control variables in the analysis. These include respondent age and indicator variables for the following characteristics: male, race/ethnicity (white, black, Hispanic),

---

[2] In 2008, the questions were revised so that the number of wine drinks was recorded separately from wine coolers, etc. We summed those separately recorded values to be comparable with the earlier measures. As discussed later, our regression results were robust to various methods of controlling for the difference in module structure, including the omission of responses from the 2008 module.

[3] It is likely that alcohol consumed at a park was purchased from a store, while alcohol purchased at a concert or sporting event is evidently on-premises making assignment to on- or off-premises ambiguous. As will be clear, however, assigning all such responses as off-premises will tend to understate the difference between on- and off-premises consumption.

education level (high school graduate, some college education, college graduate), marital status, income categories, and employment status.

Statistical analysis

To study associations between self-reported binge drinking location, alcohol consumption and driving behavior, a series of probit models are estimated. In each case, whether a respondent reports driving in the hours following after a binge drinking event is regressed on drinking location and alcohol quantity/type according to the following general model:

$$(1) \qquad g\big(E(d_i)\big) = \beta_0 + l_i\beta_l + a_i\beta_a + X_i\beta_X$$

where d_i indicates whether a respondent reports driving, l_i is a vector of indicators for the location of alcohol consumption, a_i is a vector of counts of the number of drinks of each type of beer, wine, and liquor, and X_i is a vector of demographic and economic control variables. The probit models are estimated using maximum likelihood estimation such that the link function $g(\cdot)$ is the inverse normal cumulative distribution function. All standard errors are calculated using a heteroscedasticity-robust estimate of variance (Huber, 1967; White, 1980).[4]

Location of purchase and the rate of fatal alcohol-related motor vehicle crashes

Data

Because there is no single data source that provides information on alcohol purchases for both on-premises and off-premises consumption, two separate datasets are required to examine the

[4] We tested the robustness of the main results to the inclusion of a battery of interacted fixed effects, specifically the complete set of state of residence-by-year-by-month indicator variables. In these models we also clustered the standard errors by the same subgroups. The results are little changed and are available upon request.

relationship between the location of alcohol purchase, the type of alcohol purchased, and the number of alcohol-related motor vehicle crashes..

The Alcohol Epidemiologic Data System (AEDS) reports annual sales of ethanol by volume from beer, wine, and spirits at the state-level (LaVallee & Yi, 2012). Ethanol sales are divided by state intercensal population estimates to calculate annual per capita sales for each alcohol type (United States Census Bureau, 2012). These are then summed to construct annual per capita ethanol sales. AEDS does not separate sales data according to on-premises (e.g., bars and restaurants) or off-premises (e.g., liquor stores, supermarkets, convenience stores) establishments and are explicitly designed to be aggregated at the state-level for analysis.

Information about alcohol sales from off-premises establishments is taken from the Nielsen Homescan Consumer Panel Data (NHCPD) (The Kilts Center for Marketing at Chicago Booth, 2013). Using a UPC bar-code scanner, participants in NHCPD are asked to report all household grocery purchases after each shopping trip, including any beer, wine, or spirits from supermarkets, convenience stores, liquor stores, beer distributors, etc. The UPC code uniquely identifies the type of alcohol item purchased (beer, wine or spirit), along with the liquid volume of the item. For purposes of comparability between datasets, liquid volume is converted to ethanol by volume following the AEDS methodology of assuming that the proportion of ethanol in alcoholic beverages is 0.045 for beer, 0.129 for wine, and 0.411 for spirits (LaVallee & Yi, 2012). Summing over each alcohol type yields total ethanol purchases from off-premises establishments.

The NHCPD utilizes a sampling design that permits national and Nielsen market-level estimates of per capita sales of beer, wine and spirits from off-premises establishments by volume using sampling weights provided by the Nielsen Corporation (The Kilts Center for Marketing at Chicago Booth, 2012). Of the 54 market areas that Nielsen has defined, however, none correspond exactly to the borders of a state and 12 span more than one state. Further, there are 19 states that are covered by more than one Nielsen market. Finally, Nielsen has added market areas over time, so that NHCPD is an unbalanced panel at the market-level.

As the geographic units of AEDS (state) and NHCPD (market) do not overlap cleanly, each dataset must be analyzed separately or significant measurement error could weaken inference. Moreover, while AEDS reports total ethanol sales by state since 1970, NHCPD is only available from 2004 to 2009. Hence, the subsequent analysis of alcohol-related motor vehicle crashes is restricted to this time period.

Data on motor vehicle crashes come from the Fatality Analysis Reporting System (FARS) (National Highway Traffic Safety Administration, 2013). A crash is defined as *alcohol-related* if any driver involved in the crash exhibited positive blood alcohol content (BAC). As BAC is not collected for every crash, the standard practice of using the imputed BAC provided in the FARS dataset is employed here (Klein, 1986; NHTSA, 2002; Rubin et al., 1998). State-level alcohol-related motor vehicle crash rates are calculated by dividing the count of alcohol-related fatal crashes in a state and year by the state intercensal population estimate from the U.S. Census Bureau. Market-level alcohol-related fatal crash rates are calculated dividing the count of alcohol-related fatal crashes in the counties that comprise each market area by the combined intercensal population estimates of those counties (United States Census Bureau, 2012). The legally-impaired fatal crash rate at both the state and market level is calculated similarly except counting only those crashes where the driver exhibited a BAC of at least 0.08.

Statistical analysis

To examine the relationship between the location of alcohol purchase and alcohol-related fatal crash risk, two fixed-effects regression models are estimated. By including geographic fixed-effects, any factors that are constant within a geographic area, regardless of whether they are observable or unobservable to the researcher, are eliminated from the estimating equation and cannot bias the estimated relationships of the time-varying controls that remain. In addition, year fixed-effects are also included to address any unobserved country-wide changes that affect all geographic areas at the same time. Intuitively, the fixed-effects approach bases identification on within-area variation by measuring whether the alcohol-related motor vehicle fatal crash rate tended to be above or below its historical mean in area *i* (adjusting for country-wide shocks) when the share of sales from off-premises establishments was above its historical mean in area *i* (adjusting for country-wide shocks).[5]

In the first fixed-effect regression, the independent variable of interest is the total per capita sales of alcohol at the state level:

$$(2) \qquad ARFA_{st} = \alpha_1 lnA_{st} + \alpha_2 lnNARFA_{st} + \sigma_s + \tau_t + \varepsilon_{st}$$

where $ARFA_{st}$ is the rate of fatal alcohol-related motor vehicle crashes in state *s* and year *t*; A_{st} is the per capita total alcohol sales; $NARFA_{st}$ is the non-alcohol-related fatal crash rate in state *s* and year *t*. The terms σ_s and τ_t are state and year fixed-effects, respectively; and ε_{st} is the total effect of time-varying unobserved attributes. By taking the natural log of A_{st} and $NARFA_{st}$, the estimated coefficients α_1 and α_2 can be interpreted as semi-elasticities. That is, α_1 is the

[5] We formally test whether the fixed effects or random effects approach is preferable for all aggregate level analysis. Results of the Hausman tests (available upon request) are highly significant, indicating that the fixed effects approach is preferable in our situation. Nevertheless, estimation results are robust to either random or fixed effects approaches.

predicted effect on the rate of fatal alcohol-related motor vehicle crashes when per capita alcohol consumption increases by 1%. Doing so allows for ready comparison between coefficients associated with variables that have very different units of measurement.

The non-alcohol-related fatal crash rate is included to summarize time-varying attributes that influence overall crash risk across locations, e.g., gas prices, miles driven, general economic activity, highway construction, and weather patterns. This is an important independent variable for two reasons. First, it parsimoniously controls for both observed and unobserved characteristics that influence crash risk, and thus is expected to be positively related to fluctuations in the alcohol-related fatal crash rate (Adams & Cotti, 2008). Second, it is easily constructed from the FARS data at both the state and market level. Although controls like gas prices, miles driven, general economic activity, highway construction, and weather patterns could be included to account for variation in crash risk over time at the state-level, comprehensive data does not always exist to construct these measures at the market levels. Therefore, the non-alcohol-related crash rate can be used to account for time variation in crash risk across location in a manner that is consistent across geographic unit. Nevertheless, we will demonstrate that the results are robust to the inclusion of a battery time-varying risk characteristics at the state-level, where such an analysis is feasible without introducing pronounced measurement error.

In the second fixed-effects regression, the independent variable of interest is total per capita sales of alcohol for off-premises consumption by Nielsen market:

$$(3) \qquad ARFA_{mt} = \beta_1 lnAOP_{mt} + \beta_2 lnNARFA_{mt} + \mu_m + \theta_t + v_{mt}$$

where $ARFA_{mt}$ is the fatal alcohol-related motor vehicle crash rate in market m and year t; AOP_{mt} is the per capita alcohol sales for off-premises consumption; $NARFA_{mt}$ is the natural log of non-alcohol-related fatal crash rate in market m in year t. The terms μ_m and θ_m are market and year fixed-effects, respectively; and v_{mt} is the total effect of time-varying unobserved attributes. The coefficients β_1 and β_2 are again interpreted as semi-elasticities

Per capita ethanol sales for off-premises consumption would be measured with error if NHCPD participants do not report all alcohol purchases, but previous research found high concordance between reported purchases in NHCPD and receipt records verified by supermarkets (Einav et al., 2008). While different attitudes toward alcohol consumption across markets may cause small, varying degrees of misreporting, these attitudes are unlikely to have changed meaningfully during the short time period under consideration. Hence, any difference in relative under-reporting should be constant across markets and thus easily accommodated by the fixed-effects regression design.

To see this analytically, define the calculated share of alcohol from off-premises establishments, s_{mt}, as the true share, S_{mt}, plus a potential time-invariant sources of measurement error: r_m, the tendency to under-report within market *m*. Subtracting the mean value of s_{mt} within market *m* over all *t* yields:

$$(4) \qquad s_{mt} - \overline{s_m} = S_{mt} + r_m - \overline{S_m} - \overline{r_m} = S_{mt} - \overline{S_m}$$

where the last equality follows because the mean of r_m over all years is r_m. Hence, using the reported sales for off-premises establishments in place of true sales should not bias the estimated relationship when a fixed-effects approach is adopted.

Equations (2) and (3) are estimated using weighted least squares (WLS) because these specifications have a known heteroscedasticity. Specifically, efficient estimates are generated by WLS where the weight assigned to an observation for geographic area i, w_i, is the inverse of the estimated asymptotic variance of the error: $w_i = n_i * (P_i) * (1 - P_i)$, where P_i is the alcohol-related fatal crash rate in area i and n is the corresponding population of area i. All standard errors are clustered at the market level to allow for non-independence of observation from the same location over time (Bertrand et al., 2004). Statistical analyses were conducted using STATA version 12 (StataCorp, College Station, TX).[6]

RESULTS

Location of consumption and driving after binge-drinking

Table 1 reports summary statistics for respondents to the Binge Drinking module in the 2003, 2004, and 2008 BRFSS and with non-missing demographic and economic characteristics (representing 92.8% of module respondents for a total of 20,872 individuals included in the analysis). Respondents' most recent binge drinking events mostly involved beer, with an average of nearly 5 beer drinks, followed by liquor drinks (1.5) and wine (0.9). The most common binge drinking locations were at home (40.5%), at a bar or club (26.7%), and at someone else's home (15.8%), while binge drinking occurred at each of the remainder of the locations in less than 10% of cases.

Table 2 displays the average predicted probabilities of driving after binge drinking by consumption location. Estimates for alcohol purchased from off-premises and on-premises establishments are based on the results from estimating a probit model that includes a fully

[6] Specifically, for the aggregate level analysis we use the "xtreg" command with the "fe" option selected to account for location fixed-effects. Year fixed effects were included using the "i." factor variables command.

interacted set of location and alcohol type measures as well as demographic and economic control variables (estimation results available upon request). Here, the average predicted probability of driving after binge drinking is 22.6% if preceded on by consumption of alcohol purchased from on-premises establishments, compared with only 7.4% if preceded by consumption of alcohol purchased from off-premises establishments (these probabilities are estimated with tight 95% confidence intervals). This suggests a substantially higher risk of alcohol-involved motor vehicle crashes following consumption of alcohol purchased from on-premises establishments, which we explore directly in the next section. These results are broadly similar to earlier findings based on the 2003 & 2004 survey waves (Naimi et al., 2009).

Next, we compared average predicted probabilities of drunk driving after consumption of alcohol from off- and on-premises establishments across alcohol type and consumption level by estimating three separate probit models that interact the on-premises and alcohol category indicators for each alcohol type (estimation results available upon request). The three panels of Figure 1 show the increased probability of driving after binge drinking if the alcohol consumed was purchased from on-premises establishments.[7] Importantly, the probabilities of driving after consumption of alcohol from on-premises vs. off-premises establishments become statistically indistinguishable at the 95% level after 6-8 drinks for wine and liquor and after 12-14 drinks for beer.

The second column of probabilities in Table 2 is calculated from a probit estimation for all consumption locations, disaggregating the purchase location off- and on-premises establishments (estimation results available upon request). This column yields three distinctly separable

[7] Off- and on-premises driving probabilities were constructed using the "margins" (with contrasts) and "marginsplot" commands in Stata/MP 12.1 based on probit models with fully interacted location and alcohol measures. Standard errors are Bonferonni-adjusted.

categories of location, by probability of reporting subsequent driving. The lowest probability occurs at home, likely because when binge drinking at home one does not need to drive home after the event. In contrast, the probability of driving is roughly seven times higher if the binge-drinking event occurred at a bar: 24.3% versus 3.4% (p<0.001).

Location of purchase and alcohol-related fatal crashes

The top panel of Table 3 reports summary statistics for alcohol sales from AEDS and fatal motor vehicle crashes from FARS at the state level. On average, there were nearly two non-alcohol related fatal crashes for every alcohol-related fatal crash. Beer is the alcoholic beverage most commonly purchased in the U.S. (1.02 gallons of ethanol per capita), spirits are second (0.64 gallons of ethanol per capita), while wine purchases are last overall (0.30 gallons of ethanol per capita).

The bottom panel of Table 3 reports similar information for off-premises alcohol sales from NHCPD and fatal motor vehicle crashes from FARS by Nielsen market. The motor vehicle crash patterns described at the state level are repeated at the market level, although, as the average market in the sample is smaller than the average state, totals are somewhat smaller. A notable difference is the breakdown of purchase amount by alcohol type. When considering purchases from off-premises establishments, spirits rather than beer are purchased in the greatest quantity (0.23 gallons vs. 0.17 gallons). As beer is most commonly purchased overall (over 50%), this indicates that beer is overwhelmingly the most common purchase at on-premises establishments (e.g. bars and restaurants).

Table 4 displays coefficient estimates from fixed-effects regressions studying how alcohol purchases (both overall and from off-premises establishments) influence the alcohol-related fatal motor vehicle crash rate. The first column estimates that per capita ethanol consumption has a strong positive relationship with the alcohol-related fatal motor vehicle crash rate (p=0.009). The estimated semi-elasticity of 0.353 implies that a 10 percent increase in per capita alcohol purchases would increase the number of alcohol-related fatal motor vehicle crashes by 3.53 per one million residents. This translates to approximately 21 more fatal crashes for a hypothetical state with the mean US state population. Coefficient estimates for the non-alcohol-related fatal crash rate indicate a strong positive relationship with alcohol-related crashes (*p*=0.006).

The second column of Table 4 implements the analysis outlined in equation (3), which repeats the first analysis except with data from the NHCPD in order to focus on purchases for off-premises consumption. The estimate is close to zero, precisely estimated and far from statistical significance (p=0.600), suggesting that off-premises consumption does not play an important role in fatal drunk driving crashes. This result is consistent with findings from the BRFSS analysis presented in Table 2, which showed a dramatically lower risk of drunk driving behavior following binge drinking using alcohol purchased for off-premises consumption.[8]

In a robustness check, we re-estimated the relationship between per capita alcohol consumption and the alcohol-related fatal crash rate under different sets of controls: only state and year fixed-effects; state and year fixed-effects and the non-alcohol-related fatal crash rate; and state and year fixed-effects along with per capita vehicle miles travelled, the gasoline tax rate, the unemployment rate, per capita income, per capita highway construction expenditures, average temperature and precipitation (all in their natural log, estimation results available upon request[9]).

[8] Results at the state and market level are robust to calculating accident rates based on those who are legally-impaired (BAC of 0.08 or above).

[9] Data on area vehicle miles traveled were collected from the Federal Highway Administration - Traffic Volume Trends database (U.S. Department of Transportation, 2013a). Gas tax information was collected from the Tax Foundation (The Tax Foundation, 2013). Information on state unemployment rates and per capita personal income

The estimated semi-elasticity of the alcohol-related fatal crash rate with respect to per capita alcohol consumption is 0.465 ($p<.01$) with only state and year fixed-effects compared to 0.380 ($p<.01$) and 0.361 ($p<.01$) when including the non-alcohol-related fatal crash rate and the full set of time-varying controls, respectively. These results suggest that: 1) it is important to control for the potential influence of time-varying factors associated with crash risk, and 2) including the non-alcohol-related fatal motor vehicle crash rate in the set of explanatory variables is a parsimonious method of doing so that performs just as well as including a large set of time-varying attributes.

Alcohol Subcategories Analysis

Both the AEDS and NHCPD break alcohol purchases (both total and off-premises) into three subgroups: beer, wine, and spirits. This allows for a more detailed investigation of the underlying alcohol-crash relationship. Hence, in Table 5 we replicate the analysis presented in Table 4, substituting beer, wine, and spirits for the relevant aggregate measure of alcohol purchases presented in equations (1) and (2).

The first column of Table 5 clearly demonstrates that the purchase location of beer (p=0.012) is largely responsible for the positive relationship between aggregate alcohol sales and alcohol-related crashes. In addition, the second column of Table 5 reveals that as off-premises beer sales rise, there is a decline in fatal drunk driving crashes (p=0.039). Together these estimates again indicate that shifts in consumption from on-premises to off-premises play an important role in alcohol-related crash risk.

---

was collected from the Bureau of Labor Statistics (U.S. Bureau of Labor Statistics, 2013) and the Bureau of Economic Analysis (U.S. Department of Commerce, 2013). Data on weather outcomes was collected from the National Climatic Data Center's Land-Based Station Data (National Oceanic and Atmospheric Administration, 2013). State expenditures on road construction were obtained from the U.S. Department of Transportation (U.S. Department of Transportation, 2013b).

DISCUSSION

Based on both individual-level and aggregate data, the preceding analysis has made an important contribution to the literature on alcohol-related crash risk by quantifying the relative danger of different alcohol types purchased for on-premises consumption, such as at bars and restaurants. Updating the work of Naimi, et al. (2009) by incorporating more recent data, we found that individuals who binge-drink using alcohol purchased for on-premises consumption are nearly three times more likely to drive afterwards: 22.6% versus 7.4%. Those who consume alcohol at bars are more than seven times more likely to drive than individuals who consume alcohol at home: 24.3% versus 3.4%.

More importantly, we demonstrated that reductions in on-premises consumption are associated with a decrease in the number of alcohol-related fatal motor vehicle crashes. Further, increases in per-capita volume of alcohol purchased for off-premises consumption have no meaningful effect on the alcohol-related motor vehicle crash rate. In contrast, the total per capita volume of alcohol purchased from all sources is positively related to the alcohol-related motor vehicle crash rate.

The purchase location of beer appears to be particularly important in determining the relative risk of a motor vehicle crash. Individuals who primarily imbibed beer purchased for on-premises consumption during a binge-drinking event were more likely to drive afterwards than individuals consuming wine or liquor. Further, state-level alcohol-related motor vehicle crash rates were only positively associated with per capita beer purchases, while purchases of beer for off-premises consumption were negatively related to market-level alcohol-related motor vehicle crash rate. These results suggest that on-premises beer consumption may pose a particularly heightened risk of alcohol-involved traffic crashes. Of course, there is nothing inherently more dangerous about the alcohol contained in beer. Rather, individuals who present a particularly high risk of drunk driving are more likely to consume alcohol at an on-premises establishment, and when doing so their alcohol of choice is generally beer.

In addition to providing the first estimates of the relative risk associated with the location of alcohol consumption disaggregated by alcohol type, these findings offer important insights into potential mechanisms that might be used to reduce motor vehicle crashes. For example, there have been numerous calls to increase the tax on alcohol (Baker et al., 2012; Kerr et al., 2013; Manning et al., 1989; Naimi et al., 2007, 2009). Yet, our results suggest that tax-induced changes to consumption of alcohol purchased from stores will have little to no effect on alcohol-related crashes. Rather, it would be more effective to increase the tax on alcohol purchased for on-premises consumption, thereby reducing the amount of alcohol consumed at bars and restaurants.

Relative to a tax increase on all alcohol purchases, an increase only on purchases for on-premises consumption would also tend to mitigate the potential reallocation of consumption to bars and restaurants in other jurisdictions by making at-home consumption comparatively more attractive. Although research has documented that motor vehicle crash risk is lower in areas where on-premises consumption is highly restricted or in areas with fewer retail outlets (Campbell et al., 2009; Jewell & Brown, 1995), other studies have found that heterogeneous alcohol/bar-related policy treatment across jurisdictions that lead individuals to drive farther may lead to increases in drunk driving crashes (Adams & Cotti, 2008; Baughman et al., 2001).

While our results indicate policies that shift alcohol consumption away from bars and restaurants would reduce deaths from motor vehicle crashes, it is important to recognize that drunk driving is not the only negative consequence of alcohol consumption. Excessive alcohol consumption is also associated with mortality from other causes (Danaei et al., 2009; McGinnis & Foege, 1999; Mokdad et al., 2004; Rivara et al., 2004); greater risk of injury from accidents (Rehm et al., 2003) or being a victim of sexual assault (Abbey, 2002; Benson et al., 2007; Miller et al., 2007; Mohler-Kuo et al., 2004; Rapoza & Drake, 2009); greater incidence of domestic violence (Kyriacou et al., 1999; Leonard, 2001); higher health care expenditure (Bouchery et al., 2011); increased propensity to commit crime (Carpenter & Dobkin, 2008; Carpenter, 2007; Greenfeld, 1998); and greater risk of contracting a sexually transmitted disease or becoming pregnant (Cooper & Orcutt, 2000; Cooper, 2002; Leigh, 2002; Naimi et al., 2003; Thompson et al., 2005). It is therefore necessary to document whether these outcomes are also influenced by the location of alcohol consumption so that well-meaning attempts to reduce alcohol-related crashes do not cause unanticipated increases in other negative public health outcomes.

In addition, taxation on alcohol purchased from any location imposes a cost on individuals who consume and sell alcohol responsibly. Increasing the tax on alcohol for on-premises consumption potentially reduces the welfare of patrons and the income of business owners. With roughly 227,000 full-service restaurants and 43,000 drinking establishments employing nearly five million workers in 2011 (United States Census Bureau, 2011), a full accounting of the benefits of such a tax must be constructed to address both its desirability and political feasibility.

Although the aggregate analysis includes controls for unmeasured, time-invariant area characteristics and observable time-varying characteristics, it also has potential limitations. Self-reported purchase data may be subject to measurement error. Compared with other data sources and estimation techniques, the NHCPD offers an accurate survey of purchases (Einav et al., 2008) and, as described in detail earlier, the fixed-effects research design accounts for important sources of mismeasurement. Nevertheless, the behavioral mechanism that causes variation in per capita alcohol consumption within states and market areas is an important issue, as a causal interpretation of the parameter estimates assumes that the source of this variation is not itself directly altering crash risk. While we are reassured that the results using individual-level data from BRFSS are consistent with the aggregate analyses using data from AEDS and NHCPD, this issue deserves consideration in future research.

It is also worth noting an additional finding that may be useful to other researchers in this literature. In the state-level analysis, we found the estimated semi-elasticity of the alcohol-related fatal crash rate with respect to per capita alcohol consumption is 0.465 ($p<.01$) with only state and year fixed-effects compared to 0.380 ($p<.01$) and 0.361 ($p<.01$) when including the non-alcohol-related fatal crash rate and the full set of time-varying controls, respectively. This suggests that our parsimonious model appropriately accounts for general accident risk. A rich set of time-varying controls may be unavailable for all levels of geographic aggregation, but the non-alcohol-related fatal crash rate will be calculable whenever the alcohol-related fatal crash rate is calculable.

References

Abbey, A. (2002). Alcohol-related sexual assault: A common problem among college students. *Journal of Studies on Alcohol and Drugs*, (14), 118. Alcohol Research Documentation, Inc.

Adams, S., & Cotti, C. (2008). Drunk driving after the passage of smoking bans in bars. *Journal of Public Economics*, 92(5), 1288–1305. Elsevier.

Anda RF Remington PL, W. D. F. (1988). Alcohol and fatal injuries among us adults: Findings from the nhanes i epidemiologic follow-up study. *JAMA*, 260(17), 2529–2532. Retrieved from http://dx.doi.org/10.1001/jama.1988.03410170077037

Baker, S. P., Bishai, D. M., & Hu, G. (2012, June 22). Opinion: How to maintain drop in US driving deaths. *The Christian Science Monitor*. Boston, MA. Retrieved from http://www.csmonitor.com/Commentary/Opinion/2012/0622/How-to-maintain-drop-in-US-driving-deaths

Baughman, R., Conlin, M., Dickert-Conlin, S., & Pepper, J. (2001). Slippery when wet: the effects of local alcohol access laws on highway safety. *Journal of Health Economics*, 20(6), 1089–1096. Retrieved from http://www.sciencedirect.com/science/article/pii/S0167629601001035

Benson, B. J., Gohm, C. L., & Gross, A. M. (2007). College women and sexual assault: The role of sex-related alcohol expectancies. *Journal of Family Violence*, 22(6), 341–351. Springer.

Bertrand, M., Duflo, E., & Mullainathan, S. (2004). How Much Should We Trust Differences-In-Differences Estimates? . *The Quarterly Journal of Economics* , 119 (1), 249–275. Retrieved from http://qje.oxfordjournals.org/content/119/1/249.abstract

Borkenstein, R. F., Crowther, R. F., SHUMATE, R. R., ZiEL, W. B., et al. (1964). The Role of the Drinking Driver in Traffic Accidents (Bloomington, Indiana University, Department of Police Administration).

Bouchery, E. E., Harwood, H. J., Sacks, J. J., Simon, C. J., et al. (2011, November 1). Economic Costs of Excessive Alcohol Consumption in the U.S., 2006. *American journal of preventive medicine*. Elsevier Science,. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0749379711005381?showall=true

Campbell, C. A., Hahn, R. A., Elder, R., Brewer, R., et al. (2009). The effectiveness of limiting alcohol outlet density as a means of reducing excessive alcohol consumption and alcohol-related harms. *American journal of preventive medicine*, 37(6), 556–569. Elsevier.

Carpenter, C. (2007). Heavy alcohol use and crime: Evidence from underage drunk-driving laws. *Journal of Law and Economics*, 50(3), 539–557. JSTOR.

Carpenter, C., & Dobkin, C. (2008). The drinking age, alcohol consumption, and crime. *AEJ–Applied Microeconomics, forthcoming*.

Centers for Disease Control and Prevention. (2013a). Injury Prevention & Control: Data & Statistics (WISQARS). http://www.cdc.gov/injury/wisqars/index.html, Accessed 02.04.2013.

Centers for Disease Control and Prevention. (2013b). Behavioral Risk Factor Surveillance System. http://www.cdc.gov/brfss/, Accessed 23.08.2013.

Cooper, M. L. (2002). Alcohol use and risky sexual behavior among college students and youth: Evaluating the evidence. *Journal of Studies on Alcohol and Drugs*, (14), 101. Alcohol Research Documentation, Inc.

Cooper, M. L., & Orcutt, H. K. (2000). Alcohol use, condom use and partner type among heterosexual adolescents and young adults. *Journal of Studies on Alcohol and Drugs*, 61(3), 413. Alcohol Research Documentation, Inc.

Corrao, G., Bagnardi, V., Zambon, A., & Arico, S. (1999). Exploring the dose-response relationship between alcohol consumption and the risk of several alcohol-related conditions: a meta-analysis. *Addiction*, 94(10), 1551–1573. Carfax Publishing, Taylor & Francis Ltd. Retrieved from http://dx.doi.org/10.1046/j.1360-0443.1999.9410155111.x

Cotti, C., & Tefft, N. (2011). Decomposing the Relationship between Macroeconomic Conditions and Fatal Car Crashes during the Great Recession: Alcohol- and Non-Alcohol-Related Accidents. *The B.E. Journal of Economic Analysis & Policy*, 11. Retrieved from http://www.degruyter.com/view/j/bejeap.2011.11.issue-1/bejeap.2011.11.1.2860/bejeap.2011.11.1.2860.xml

Danaei, G., Ding, E. L., Mozaffarian, D., Taylor, B., et al. (2009). The preventable causes of death in the United States: comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS medicine*, 6(4), e1000058. Public Library of Science.

Einav, L., Leibtag, E., & Nevo, A. (2008). Not-so-Classical Measurement Errors: A Validation Study of Homescan. *National Bureau of Economic Research Working Paper Series*, No. 14436. Retrieved from http://www.nber.org/papers/w14436

Fabbri, A., Marchesini, G., Morselli-Labate, A. M., Rossi, F., et al. (2001). Blood alcohol concentration and management of road trauma patients in the emergency department. *The Journal of Trauma and Acute Care Surgery*, 50(3), 521–528. LWW.

Greenfeld, L. A. (1998). *Alcohol and crime: An analysis of national data on the prevalence of alcohol involvement in crime*. US Department of Justice, Office of Justice Programs, Bureau of Justice Statistics.

Huber, P. J. (1967). The behavior of maximum likelihood estimates under nonstandard conditions. *Proceedings of the fifth Berkeley symposium on mathematical statistics and probability* (Vol. 1, pp. 221–233).

Jewell, R. T., & Brown, R. W. (1995). Alcohol availability and alcohol-related motor vehicle accidents. *Applied Economics*, 27(8), 759–765. Taylor & Francis.

Kerr, W. C., Patterson, D., Greenfield, T. K., Jones, A. S., et al. (2013). U.S. Alcohol Affordability and Real Tax Rates, 1950–2011. *American Journal of Preventive Medicine*, 44(5), 459–464. Retrieved from http://www.sciencedirect.com/science/article/pii/S0749379713000652

Klein, T. (1986). *A METHOD FOR ESTIMATING POSTERIOR BAC DISTRIBUTIONS FOR PERSONS INVOLVED IN FATAL TRAFFIC ACCIDENTS*. Retrieved from http://trid.trb.org/view.aspx?id=310222

Kyriacou, D. N., Anglin, D., Taliaferro, E., Stone, S., et al. (1999). Risk factors for injury to women from domestic violence. *New England journal of medicine*, 341(25), 1892–1898. Mass Medical Soc.

LaVallee, R. A., & Yi, H. (2012). *Surveillance Report #95: Apparent Per Capita Alcohol Consumption: National, State, and Regional Trends, 1977-2010*. Bethesda, MD.

Leigh, B. C. (2002). Alcohol and condom use: a meta-analysis of event-level studies. *Sexually transmitted diseases*, 29(8), 476–482. LWW.

Leonard, K. (2001). Domestic violence and alcohol: what is known and what do we need to know to encourage environmental interventions? *Journal of Substance Use*, 6(4), 235–247. Informa UK Ltd UK.

Manning, W. G., Keeler, E. B., Newhouse, J. P., Sloss, E. M., et al. (1989). *The taxes of sin: do smokers and drinkers pay their way?* Rand.

McGinnis, J. M., & Foege, W. H. (1999). Mortality and morbidity attributable to use of addictive substances in the United States. *Proceedings of the Association of American Physicians*, 111(2), 109–118. Wiley Online Library.

Miller, J. W., Naimi, T. S., Brewer, R. D., & Jones, S. E. (2007). Binge drinking and associated health risk behaviors among high school students. *Pediatrics*, 119(1), 76–85. Am Acad Pediatrics.

Mohler-Kuo, M., Dowdall, G. W., Koss, M. P., & Wechsler, H. (2004). Correlates of rape while intoxicated in a national sample of college women. *Journal of Studies on Alcohol and Drugs*, 65(1), 37. Alcohol Research Documentation, Inc.

Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual causes of death in the United States, 2000. *JAMA: the journal of the American Medical Association*, 291(10), 1238–1245. Am Med Assoc.

Naimi, T. S., Brewer, R. D., Miller, J. W., Okoro, C., et al. (2007). What Do Binge Drinkers Drink?: Implications for Alcohol Control Policy. *American Journal of Preventive Medicine*, 33(3), 188–193. Retrieved from http://www.sciencedirect.com/science/article/pii/S0749379707002838

Naimi, T. S., Lipscomb, L. E., Brewer, R. D., & Gilbert, B. C. (2003). Binge drinking in the preconception period and the risk of unintended pregnancy: implications for women and their children. *Pediatrics*, 111(Supplement 1), 1136–1141. Am Acad Pediatrics.

Naimi, T. S., Nelson, D. E., & Brewer, R. D. (2009). Driving After Binge Drinking. *American Journal of Preventive Medicine*, 37(4), 314–320. Retrieved from http://www.sciencedirect.com/science/article/pii/S0749379709004577

National Highway Traffic Safety Administration. (2010). *Traffic Safety Facts 2010: Alcohol-Impaired Driving*. Washington, DC. Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/811606.PDF

National Highway Traffic Safety Administration. (2013). Fatality Analysis Reporting System (FARS). http://www.nhtsa.gov/FARS, Accessed 10.04.2013.

National Oceanic and Atmospheric Administration. (2013). National Climatic Data Center: Land-Based Station Data. http://www.ncdc.noaa.gov/data-access/land-based-station-data, Accessed 06.09.2013.

NHTSA. (2002). *Transitioning to multiple imputation –A new method to impute missing blood alcohol concentration (BAC) values in FARS*.

Rapoza, K. A., & Drake, J. E. (2009). Relationships of hazardous alcohol use, alcohol expectancies, and emotional commitment to male sexual coercion and aggression in dating couples. *Journal of studies on alcohol and drugs*, 70(1), 55. Alcohol Research Documentation, Inc.

Rehm, J., Gmel, G., Sempos, C. T., & Trevisan, M. (2003). Alcohol-related morbidity and mortality. *Alcohol Research and Health*, 27(1), 39–51.

Rivara, F. P., Garrison, M. M., Ebel, B., McCarty, C. A., et al. (2004). Mortality attributable to harmful drinking in the United States, 2000. *Journal of Studies on Alcohol and Drugs*, 65(4), 530. Alcohol Research Documentation, Inc.

Rubin, D., Shafer, J., & Subramanian, R. (1998). *Multiple imputation of missing blood alcohol concentration (BAC) values in FARS*.

Ruhm, C. J. (1995). Economic conditions and alcohol problems. *Journal of Health Economics*, 14(5), 583–603. Retrieved from http://www.sciencedirect.com/science/article/pii/0167629695000240

Taylor, B., Irving, H. M., Kanteres, F., Room, R., et al. (2010). The more you drink, the harder you fall: A systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. *Drug and Alcohol Dependence*, 110(1–2), 108–116. Retrieved from http://www.sciencedirect.com/science/article/pii/S0376871610000712

Taylor, B., & Rehm, J. (2012). The Relationship Between Alcohol Consumption and Fatal Motor Vehicle Injury: High Risk at Low Alcohol Levels. *Alcoholism: Clinical and Experimental Research*, 36(10), 1827–1834. Retrieved from http://dx.doi.org/10.1111/j.1530-0277.2012.01785.x

The Kilts Center for Marketing at Chicago Booth. (2012). Kilts-Nielsen Consumer Panel Dataset Manual. Chicago, IL.

The Kilts Center for Marketing at Chicago Booth. (2013). Nielsen Datasets. http://research.chicagobooth.edu/nielsen/, Accessed 02.04.2013.

The Tax Foundation. (2013). State Tax and Spending Policy. http://taxfoundation.org/tax-topics/state-tax-and-spending-policy, Accessed 02.04.2013.

Thompson, J. C., Kao, T.-C., & Thomas, R. J. (2005). The relationship between alcohol use and risk-taking sexual behaviors in a large behavioral study. *Preventive medicine*, 41(1), 247–252. Elsevier.

U.S. Bureau of Labor Statistics. (2013). Local Area Unemployment Statistics. http://www.bls.gov/lau/, Accessed 08.03.2013.

U.S. Department of Commerce. (2013). Bureau of Economic Analysis Regional Economic Accounts. http://www.bea.gov/regional/index.htm, Accessed 06.09.2013.

U.S. Department of Transportation. (2013a). Traffic Volume Trends. http://www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm, Accessed 10.04.2013.

U.S. Department of Transportation. (2013b). Research and Innovative Technology Administration, Bureau of Transportation Statistics: State Transportation Statistics. http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/state_transportation_statistics/index.html, Accessed 06.09.2013.

United States Census Bureau. (2011). County Business Patterns. http://www.census.gov/econ/cbp/, Accessed 03.09.2013.

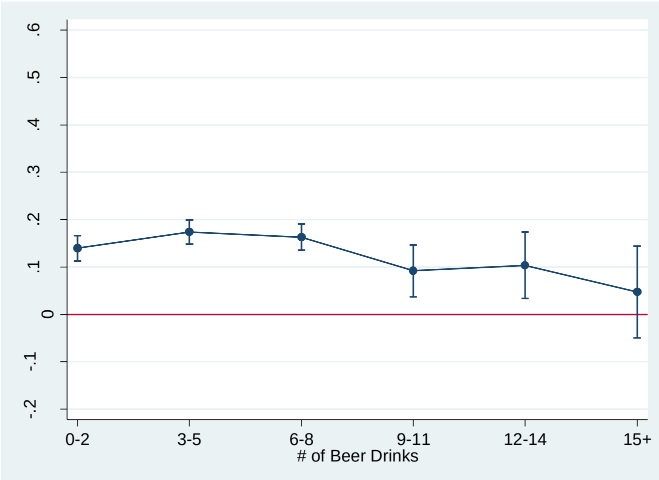
United States Census Bureau. (2012). National Intercensal Estimates (2000-2010). http://www.census.gov/popest/data/intercensal/national/nat2010.html, Accessed 23.02.2013.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica: Journal of the Econometric Society*, 817–838. JSTOR.

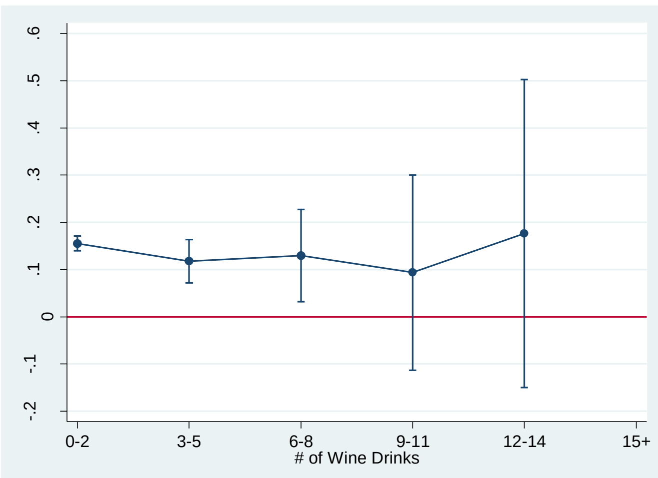
Zador, P. L., Krawchuk, S. A., & Voas, R. B. (2000). Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: an update using 1996 data. *Journal of Studies on Alcohol and Drugs*, 61(3), 387. Alcohol Research Documentation, Inc.

Figure 1. Contrasts of On- & Off-premises Driving Probability by Alcohol Category

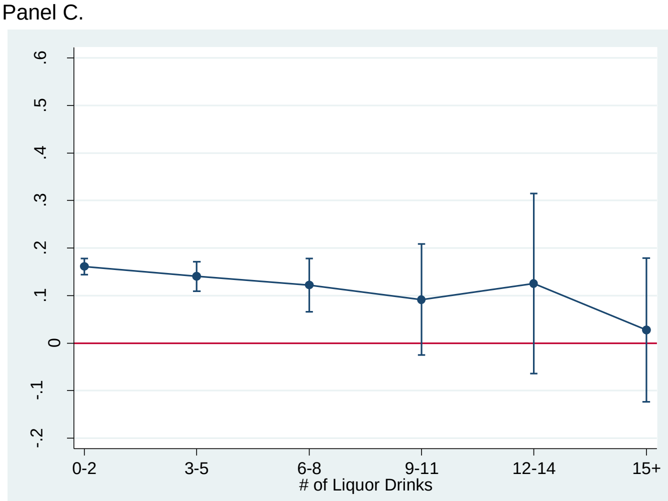
Panel A.



Panel B.



Panel C.



Notes: Contrasts of on- and off-premises driving probabilities were were constructed using the "margins" (with contrasts) and "marginsplot" commands in Stata/MP 12.1 based on probit models with fully interacted location and alcohol measures. Data are from the 2003, 2004, & 2008 Behavioral Risk Factor Surveillance Survey (BRFSS) Binge Drinking module (see Table 1).

Table 1. BRFSS Descriptive Statistics (n = 20,872)

	Mean	Std. Dev.	Max
# of drinks consumed during most recent binge-drinking event			
Beer Drinks	4.795	3.843	69
Wine Drinks	0.862	2.037	54
Liquor Drinks	1.530	2.670	35
Proportion of binge-drinking events by location of consumption			
At Home	0.405		1
At Other Home	0.158		1
At Restaurant	0.071		1
At Bar/Club	0.267		1
At Public Place	0.049		1
At Other	0.050		1
Proportion that drive after binge	0.124		1
Age (years)	41.274	13.505	99
Male (%)	0.645		1
Married (%)	0.514		1
Race/ethnicity of respondent (%)			
White	0.897		1
Black	0.036		1
Hispanic	0.072		1
Highest educational level attained (%)			
High School Grad	0.465		1
Some College	0.459		1
College Grad	0.465		1
Household income (%)			
Income \$10k to \$15k	0.040		1
Income \$15k to \$20k	0.059		1
Income \$20k to \$25k	0.084		1
Income \$25k to \$35k	0.134		1
Income \$35k to \$50k	0.188		1
Income > \$50k	0.459		1

Table continued on next page.

Table 1 (Continued)

	Mean	Std. Dev.	Max
Employment status (%)			
Employed for wages	0.665		1
Self-employed	0.125		1
Out of work for > 1 year	0.014		1
Out work for < 1 year	0.035		1
Homemaker	0.029		1
Student	0.037		1
Retired	0.072		1
Unable to work	0.023		1

Notes: Summary of individuals without non-responses to the 2003, 2004, & 2008 Behavioral Risk Factor Surveillance Survey (BRFSS) Binge Drinking module. Some categories are not reported for brevity, but their means can be inferred: Other Race, No High School Diploma, Income < $10k.

Table 2. Average Predicted Probabilities by Consumption Location

	Probabilities		95% Confidence Interval	
Off-premises consumption	0.074		0.069	0.078
Home		0.034	0.030	0.038
Other home		0.147	0.135	0.159
Public space		0.149	0.126	0.171
Other		0.110	0.091	0.129
On-premises consumption	0.226		0.216	0.236
Bar		0.243	0.232	0.255
Restaurant		0.180	0.159	0.200

Notes: Average predicted probabilities of driving after binge drinking and their confidence intervals were calculated using the "margins" command in Stata/MP 12.1 based on probit models with fully interacted location and alcohol measures (estimation results available upon request).

Table 3. AEDS, NHCPD, and FARS Annual Descriptive Statistics: 2004-2009

Panel A: State-Level: AEDS and FARS (n=306)	Mean	Std. Dev.	Min	Max
Alcohol Related Fatal Motor Vehicle Crashes	256.32	266.67	11.00	1338.00
Alcohol Related Fatal Motor Vehicle Crash Rate (per 10,000)	0.49	0.22	0.12	1.30
Non-Alcohol Related Fatal Motor Vehicle Crashes	459.91	470.93	17.00	2569.00
All Alcohol Purchases (gallons ethanol per capita)	1.96	0.44	0.96	3.69
All Beer Purchases (gallons ethanol per capita)	1.02	0.17	0.53	1.45
All Wine Purchases (gallons ethanol per capita)	0.30	0.16	0.08	0.87
All Spirits Purchases (gallons ethanol per capita)	0.64	0.22	0.30	1.53
Population (in 10,000s)	587.84	655.75	50.91	3696.12
Panel B: Market-Level: NHCPD and FARS (n=244)	Mean	Std. Dev.	Min	Max
Alcohol Related Fatal Motor Vehicle Crashes	178.07	90.62	35.00	561.00
Alcohol Related Fatal Motor Vehicle Crash Rate (per 10,000)	0.40	0.15	0.09	0.90
Non-Alcohol Related Fatal Motor Vehicle Crashes	320.19	174.47	75.00	1067.00
Off-Premises Alcohol Purchases (gallons ethanol per capita)	0.53	0.16	0.22	0.99
Off-Premises Beer Purchases (gallons ethanol per capita)	0.17	0.06	0.05	0.35
Off-Premises Wine Purchases (gallons ethanol per capita)	0.13	0.05	0.03	0.32
Off-Premises Spirits Purchases (gallons ethanol per capita)	0.23	0.09	0.08	0.55
Population (in 10,000s)	488.25	282.37	103.18	1698.87

Notes: Panel A presents descriptive statistics for aggregated AEDS and FARS data by state (including Washington, DC). Panel B presents descriptive statistics for aggregated NHCPD and FARS data by 54 Nielsen Scantrack markets (not all markets have sufficient data to produce representative aggregate statistics in every year).

Table 4: Location of purchase and the rate of fatal alcohol-related motor vehicle crashes

	Alcohol-Related Fatal Crash Rate (per 10,000 people)	
	State Level: AEDS	Market Level: NHCPD
Log All Purchases (gallons ethanol per capita)	0.353**	
	(0.146)	
Log Off-Premises Purchases (gallons ethanol per capita)		-0.0124
		(0.0235)
Log Non-Alcohol-Related Fatal Crash Rate	0.118***	0.197***
	(0.0410)	(0.0567)
Observations	306	244
R-squared	0.593	0.585
Number of clusters	51	54

Notes: Each column presents estimates from a separate weighted least squares regression, where the weight is the inverse of the estimated asymptotic variance of the error. Location and year fixed effects are included in both models. Robust clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Alcohol Subcategories Analysis

	Alcohol-Related Fatal Crash Rate (per 10,000 people)	
	State Level: AEDS	Market Level: NHCPD
All Beer Purchases (gallons ethanol per capita)	0.297**	
	(0.114)	
All Wine Purchases (gallons ethanol per capita)	-0.0644	
	(0.0507)	
All Spirits Purchases (gallons ethanol per capita)	0.0295	
	(0.102)	
Off-Premises Beer Purchases (gallons ethanol per capita)		-0.0348**
		(0.0165)
Off-Premises Wine Purchases (gallons ethanol per capita)		0.00302
		(0.0215)
Off-Premises Spirits Purchases (gallons ethanol per capita)		0.0213
		(0.0217)
Observations	306	244
R-squared	0.601	0.594
Number of clusters	51	54

Notes: Each column presents estimates from a separate weighted least squares regression, where the weight is the inverse of the estimated asymptotic variance of the error. Controls for the log of the non-alcohol-related fatal crash rate, as well as location and year fixed effects are included in both models. Robust clustered standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$