Senior Project

Department of Economics

"An Analysis of Excise Taxes on Beer and Related Fatalities"

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Abstract

As alcohol increases the incidence of traffic fatalities (one of the leading causes of death among all age groups), controlling alcohol consumption has been a policy focus for governments throughout the late 20th century to today. Much literature and research has maintained that death rates for alcohol-involved accidents are greater among younger consumers, supporting a minimum legal drinking age of 21 in the United States. Other literature confirms that taxation is by far the most effective policy for regulating alcohol consumption; this study aims to test the effectiveness of alcohol taxation policy on reducing alcohol-related traffic fatalities (in particular underage fatalities) in the 21st century.

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I. Introduction

According to the Centers for Diseases Control and Prevention (CDC, 2009), unintentional injury is the leading cause of death in the United States for all age groups between 1 and 44 and ranks within the top ten of every age demographic; a vast majority of these deaths are by motor vehicle collisions and accidental poisoning. As these causes of death threaten such a broad spectrum of citizens, it is important to analyze the contributing factors of these deaths and, if possible, determine how to prevent them. From 2001-2005, there were 13,819[1] alcohol-attributable deaths in just motor vehicle traffic incidents. Including the vast array of accidental death as well as disease, over 80,000 people's deaths were linked to alcohol. The nominal amount of traffic fatalities related to alcohol has decreased since the late 1980s, and in order to prevent more deaths, it is important to discover why this rate has been declining.

Given that the minimum legal drinking age (MLDA) is 21 years old throughout the U.S. as of 1989, the incidence of underage fatalities linked to alcohol (4700 deaths between 2001-2005, with 2075 involving traffic accidents) is indeed remarkable, suggesting the existence of a "black" market to provide those under 21 with these substances. While there may be differences in the price structure of a black market (individuals pay a risk premium in order to illicitly obtain goods[2]), the law of demand should remain the same. Thus, increases in the price level of alcohol should decrease its consumption, and hence decrease mortality rates. Understanding the demand for alcohol among underage consumers (for this paper, the focus will be particularly on 16-20 year-olds) is crucial to understanding what measures are effective in combatting drunk driving. Consumers in this age range typically have smaller income than their older counterparts, thus

[1] Alcohol-Related Disease Impact, Centers for Disease Control and Prevention
[2] Zuesse, E. (1998). An hypothesis regarding pricing of black-market goods. *Journal of Economic Behavior and Organization,34*(3), 499-503.

one might argue that there is an innately high elasticity; any increase in the price of alcohol would more greatly affect and consume a greater portion the smaller income. However, due to the illegal nature of the transactions, there may not be much of an effect for any small increase in price. Underage consumers already pay a risk premium to middlemen who will provide the good. As alcohol can be an addictive substance, it is also possible that some underage consumers are already forming an addiction, making their demand more inelastic.

The general elasticity of fatality for alcohol-related deaths with respect to alcohol excise taxes will most likely be relatively inelastic. I aim to examine whether the relationship between alcohol excise taxes and underage alcohol-related traffic fatalities is significantly different than the relationship between taxes and the general population's alcohol fatality rate, as well as note whether this is a positive or negative relationship. While excise taxes do affect relative price, there are other factors which determine the overall price, therefore using taxes as a proxy for price may not provide the demand relationship noted in previous literature.

II. Literature Review

Much of the literature stresses that the real alcohol tax rate is one of the most significant factors affecting traffic mortality rates. Christopher Ruhm (1996) estimated a fixed effect model, accounting for the differences between the states, showing that alcohol tax rates could lower traffic mortality rates by anywhere between .24 and .34 deaths per 10,000 people,for the general population and between 0.34 and 0.44 per 10,000 for those aged 18 to 20. This relationship, however, was quite different before accounting for state-based fixed effects; the sign of the coefficient became positive, indicating incorrectly that increases in tax rates would increase mortality rates. Cook, Ostermann and Sloan (2005) contended that perhaps there might be a positive effect on mortality of those aged 35-69, as this demographic is more likely to drink moderately (which has positive health benefits from reduced heart disease and stroke) than binge heavily. They hypothesized that if there was a strong enough positive effect on mortality for this cohort, then perhaps further analysis on the equity of alcohol taxation would be necessary; if lower alcohol tax rates could save enough lives for middle-aged persons, perhaps the effect could counteract the loss of lives in younger strata. On the contrary, the results showed little effect (only up to 200 lives lost or saved) for this group, thus the authors advocate that taxation policy continue as it has.

Carpenter, Kloska, O'Malley, and Johnston (2007) confirmed the main conclusion in the alcohol taxation literature. This paper used the data from the Monitoring the Future survey to study how teen drinking habits respond to alternative control policies such as zero-tolerance laws, which prohibit any individual under the age of 21 from driving with a blood-alcohol content (BAC) greater than 0.02. Again, alcohol excise taxes are found to be the most significant and effective deterrents of consumption. Arranz and Gil (2009) examined the effects of excise taxation on alcohol consumption, and also morbidity, in Spain. Once more the negative relationship between taxes and fatality rates was reaffirmed; however there was no mention of implications of underage offenses, which is most likely due to Spain's lower MLDA and higher driving age. The authors also noted a strong negative relationship between the magnitude of sanctions for traffic violations and the mortality rate. They also call out subsidies to alcohol producers as another potential contributor to traffic morbidity, as they lower the price level.

Son and Topyan (2011) shed an interesting light on the dynamics of alcohol consumption. The authors divided alcohol users into demographic strata in order to more accurately track the effects of a particular alcohol tax on the consumption of specific alcoholic beverages by age group. Demographically, beer drinkers are more likely to get into motor vehicle accidents than wine or spirit drinkers. Also, beer taxes will negatively affect consumption among relatively younger strata more heavily than older age groups. In fact, when the regression accounted for three different alcohol taxes on traffic mortality, only beer taxes had a significant effect. Therefore, it is suggested that the most effective policy to combat underage drinking would be higher beer taxes rather than alcohol taxes in general.

Ruhm (1996) stressed the importance of including variables for all other alcohol control policies, although this may have led to a multicollinearity problem. The issue is that many states have a tendency to implement many similar regulations concerning drunk driving, so the effects of one policy may be absorbed by a host of other variables; this can lead to misinterpretation of the coefficients of regressors which may be significant or insignificant, but one cannot conclude that these policies are ineffective. Ruhm also cited the state of the macroeconomy, primarily concerning population and unemployment, as a contributor to traffic flows to control for natural variance in traffic fatalities; there are more fatal accidents in more populated areas, and when unemployment is high, there are less fatal accidents due to reduced driving habits associated with normal work schedules. Carpenter et al. (2007) also evaluated other alcohol control variables, although they found that since the MLDA is already 21 in all states, and most states already have stringent zero-tolerance statutes in place, the marginal benefits to society of raising the MLDA or toughening laws would be marginal at best. They agreed that taxation is still the most effective policy.

Carpenter and Dobkin (2011) focus mainly on the effects of the MLDA set at 21. They contest the argument set by the Amethyst Initiative that the raising of the MLDA encourages more risky and dangerous drinking activity. The authors rebut this notion, but pose many interesting questions along the way concerning the broader spectrum of costs and benefits related to alcohol. The authors determined that 21 is a reasonable equilibrium age where the consumer surplus from demand for alcohol outweighs the social costs (including injury, crime, victimization from crime, property damage, risky sexual behavior and reduced work force productivity) by comparing modern fatality data with that of in the 1970s and 1980s, when drinking ages under 21 were common. They then contend that if the MLDA were again lowered to 18, the total cost of each additional drink purchased would be more than $15 beyond the price of the drink itself.

A good portion of the literature concerned itself with time ranging from the 1970s to 1990s; this time was full of great variation in data for taxation, alcohol regulations, and traffic fatalities. The more modern time set (2001-2010) being used for this paper shows much less variation in all categories; therefore, it may be difficult to estimate a similar relationship to previous literature. This paper aims to analyze this relationship and see if it has dramatically changed since the 1980s, as well as analyze the differences between underage and general relationships between excise taxes and alcohol-related traffic fatalities.

III. Data & Methodology

My model will be mostly based off Ruhm's (1996) Fixed Effects model. Using data from 2001 to 2010, I will focus on fatalities under the age 21. While they are legal drivers, they are illegal drinkers. I will also construct a model which will use traffic fatalities of the entire population as the independent variable.

The dependent variable is a death rate for alcohol-related traffic fatalities per 10,000 individuals (D_{it}) in a state (i) in a given year (t). The total number of alcohol-related fatalities in a state in a given year was divided by the population of the state to compute an estimation of an alcohol-related mortality rate. The number of fatalities was aggregated from the Fatality Analysis Reporting System (FARS) data from the National Highway Traffic Safety Administration (NHTSA) ranging from 2001 to 2010. To compute the death rate, any data points where alcohol was not reported as a factor of the accident were eliminated. Excise tax figures (T_{it}), measured in cents per 31-gallon barrel were collected from the Beer Institute's *Brewers Almanac*. Several state-particular traffic proxies ($\boldsymbol{TP_{it}}$) are included to help explain natural variance in fatality rates. They include per capita GDP, the number of licensed drivers under 25, the total number of miles driven by drivers in a state and the unemployment rate. In order to account for perceived probability of punishment for driving under the influence, a law enforcement variable (*E*) measured as the number of police officers at the state and local level within a state is included. An OLS model will be estimated to see any relationships that may exist in the raw data. This model will include year dummies and correct heteroscedasticity with heteroscedasticity-constant standard errors. Two-way fixed effects will be also used to estimate the models in order to measure unobserved differences between the states and unobserved differences over time.

In summary, the relationship between taxation and mortality rates is modeled as follows:

$$D_{it} = \beta_i + \beta_t + \beta_1 T_{it} + \boldsymbol{\beta_2 TP_{it}} + \beta_3 E_{it} + \varepsilon_{it} \quad (1)$$

A second model will be estimated to discover the effects on underage fatalities:

$$D(< 21)_{,it} = \alpha_i + \alpha_t + \alpha_1 T_{it} + \boldsymbol{\alpha_2 TP_{it}} + \alpha_1 E_{it} + \mu_{it} \quad (2)$$

IV. Regression Analysis

Although the model is based on that of Ruhm (1996), many fundamental changes were necessary. The data set for Ruhm was from the 1980s, a dynamic period for drinking regulations, both for the general population and for underage drinking. With the more current data, there are little to no changes in these regulations. For instance, every state had changed their MLDA back to 21 by the 1990s, so there is no variation in this variable. Therefore, while very pertinent to Ruhm, it has no impact on my results. Furthermore, the status of current per se and consumption regulations across the nation remains rather static; Few states had changed laws relating to blood-alcohol content had changed requirements at all from 2001-2010, thus the fixed-effects model cannot create an unbiased estimate. That said, these inter-state differences would be absorbed into the fixed-effects model. Ruhm's logic for using the fixed effects model remains true (that there are inherent differences between states that cannot be accurately measured, leading to an omitted-variable bias); however, the regulatory variables are part of this inherent difference. If the model is constructed with these variables, the software will be unable to accurately estimate the relationship, as fixed-effect dummy variables will be a linear combination of the regulatory dummy variables

The results for the OLS estimates had surprisingly significant results; in Ruhm's OLS model, there was a positive relationship, leading to his rationale that the fixed-effects model was necessary. Here (Table 1), the results are that a one percent increase in the real tax rate would lead to a 0.03992 decrease in the overall alcohol-related fatality rate and a 0.01583 decrease in the underage fatality rate. Counting that anywhere from 28-30% of the population is under the age 21 during this time, the underage effect could be interpreted as around a decrease of 0.05459 deaths related to alcohol as a portion of the population under 25. This model also upholds the significance of several control variables: the state unemployment rate, the number of total miles driven in the state normalized by population and the portion of the population under the age 25; these variables had maintained their expected signs. The miles driven and population portion under 25 increase the probability of being in any traffic accident, and a lower unemployment rate (which leads to higher disposable income levels) increases consumption, and thus mortality. These results seem to uphold previous literature, yet this model has little explanatory power (R^2 values of .37 and .28, respectively).

In order to account for the unobservable differences between states across time, a two-way fixed effects model was estimated. Here, there is no statistically significant relationship between beer excise taxes and alcohol-related traffic fatalities; furthermore, the coefficient for the general population is positive while that for the underage population is negative. These results would suggest a lack of true relationship between these variables. The F-test for the fixed effects was significant beyond the 99% confidence level in both models. Significance among control variables for this model changed, the state-level fixed effects perhaps absorbing some of the explanatory power. Here the portion of population under 25 is still statistically and economically significant. Income per capita is significant in this model, showing a negative relationship; as per capita income rises, the fatality rate decreases. While this initially seems to violate the law of demand, it could easily be explained that higher income individuals have a greater opportunity cost to drunk driving, thus they may limit their consumption or find alternative transportation when drunk. With R^2 values of 0.88 and 0.76, there is much more explanatory power in this model.

V. Conclusions

Although the model results are insignificant, this does not necessarily mean that excise taxes are not an important factor in alcohol-related traffic fatalities; the lack of variance in data cannot explain the variation in traffic fatalities. As there has been no significant change in alcohol tax rates since the administration of George H.W. Bush (and thus, a net decrease in real excise tax rates), using data after this time period may provide biased and incorrect estimates. Also, as other alcohol control variables (such as the minimum legal drinking age) have remained relatively constant as well, it is impossible to judge their effectiveness. Deferring to past literature, the alcohol excise tax rate should still be the most effective control for alcohol-related traffic fatalities; if policymakers were to raise taxes, past literature suggests that there would be a decrease in traffic fatalities. If these tax rates were to change, it would also provide data variance that may allow for testing if this relationship holds today. Perhaps if the range of the data set were expanded into preceding years, there would be greater variance in the data for all variables and allow for a more robust estimate.

The fact that the negative relationship between taxes and the fatality rate found by OLS estimation disappears when applying fixed effects could be explained in several ways. Firstly, it is entirely possible that there is no significant effect of excise taxes on alcohol-related fatalities; excise taxes are but a proxy for actual market price, which is only a small factor in determining an individual's prevalence to driving drunk, and thus probability of death in a traffic accident. There are many unobservable factors at the individual level which may have their own effects. Perhaps the state-level fixed effects are absorbing part of the explanatory power of taxation; taxation policy may be determined by unobservable factors in a state, primarily values and morals. That said, states which have an anti-alcohol bias (relatively speaking) may have inherently higher tax rates than other states. If this is the case, other regression techniques (2SLS, Difference in difference) could be implemented to examine whether the relationship does indeed exist.

VI. Tables

Table of Descriptive Statistics					
Variable	Description	Source	Minimum	Mean	Maximum
D_{it}	Death rate for alcohol-related traffic accidents, per 10,000	Fatality Analysis Reporting System, National Highway Traffic Safety Administration	0.04735	0.4941	2.185
$D(<21)_{it}$	`` ``, for individuals under the age 21	`` ``	0.00468	0.07999	0.6045
Log(*Tax_{it}*)	Log of excise taxes on 31-gallon barrels of beer, in 1982-1984 USD	*The Brewer's Almanac*, The Beer Institute	-4.743	-2.328	-0.5036
Traffic Proxy Indicators (*TP_{it}*)					
log(rGDP)	Real GDP per capita (Base=1982-1984)	Bureau of Labor Statistics	9.489	9.941	11.23
Under25	Population portion under 25	*Highway Statistics,* U.S. Department of Transportation	0.03060	0.09537	0.1481
Miles	Total miles driven, divided by state population	`` ``	0.00597	0.01045	0.01846
Unemp	State unemployment rate	Bureau of Labor Statistics	2.483	5.683	13.73
Police	Ratio of law enforcement employees to population	U.S. Department of Commerce	0.00205	0.00316	0.00766

Table 1

OLS Estimation		
Variable	**D** (General Population)	**D** (Underage Fatallities)
log(Tax)	-0.03992**	-0.01583***
	(0.01761)	(0.00450)
log(rGDP)	-0.01729	-0.02593
	(0.08661)	(0.02532)
Miles	83.92***	9.9297***
	(9.685)	(2.434)
Under25	3.804***	1.173***
	(1.158)	(0.3062)
Unemployment	-0.01765	-0.01032***
	(0.01005)	(0.00262)
Police	11.09	-2.9995
	(17.52)	(4.136)
R^2	0.3698	0.2783
Numbers in parentheses are heteroscedasticity consistent standard errors.		
*** denotes significance at the 90% significance level**		
**** denotes significance at the 95% significance level**		
***** denotes significance at the 99% significance level**		

Table 2

Two-way Fixed Effects Estimation		
Variable	**D** (General Population)	**D** (Underage Fatalities)
log(Tax)	0.2314	-0.07698
	(0.4374)	(0.1446)
log(rGDP)	-0.5713**	-0.1980**
	(0.2649)	(0.0880)
Miles	12.67	-8.700
	(18.85)	(6.273)
Under25	2.562**	0.7581*
	(1.246)	(0.4308)
Unemployment	-0.01194	-0.00425
	(0.0103)	(0.00342)
Police	0.5785	1.090
	(31.61)	(10.86)
R^2	0.8799	0.7562
F-test for Fixed Effects	32.69	15.31
	Pr>F: <.0001	Pr>F: <.0001

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