Is Beer Safer than Spirits? How the Change in Consumption Shares of Alcoholic Beverage Types Affects Traffic Mortality in Young People

Ist Bier sicherer als Schnaps? Wie der Konsumanteil verschiedener alkoholischer Getränke die Zahl jugendlicher Verkehrstoter beeinflusst

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Abstract

This paper uses cross-state and cross-regional time series to estimate the effect of the variation in shares of alcohol beverage types on traffic fatalities in young people, with particular emphasis on consumption of beer versus spirits, or "hard liquor". Depending on the specification, consumption shares matter for traffic fatalities in the 15-19 year age group, but results are not conclusive. Initial state median income is however a strong predictor of lower traffic mortality rates in ensuing years.

Key Words

alcohol consumption; traffic mortality; alcohol control laws

Zusammenfassung

Dieser Beitrag verwendet Querschnittsdaten von Bundesstaaten und Zeitreihen verschiedener Regionen der USA, um den Effekt des Konsumanteils von Bier versus hochprozentiger alkoholischer Getränke auf die Zahl der jugendlichen Verkehrstoten zu messen. Die Resultate sind nicht eindeutig und hängen von der genauen Spezifikation der Schätzung ab. Was jedoch gezeigt werden kann, ist, dass es einen klar negativen Zusammenhang zwischen dem Median Einkommen eines Bundesstaates (einer Region) und der zukünftigen Verkehrssterblichkeitsrate gibt.

Schlüsselwörter

Alkoholkonsum; Verkehrssterblichkeit; Gesetze zur Beschränkung von Alkohol

"There is no doubt that beer is much less injurious to health than are spirituous liquors. Nor is there any doubt that the great change in the habits of the people in this country from consumption of spirits to malt liquors has been promotive of temperance… People who drink moderately of good beer are not likely to become drunkards or to injure their health."[1]

1 Introduction

Though written in 1887, the quote above conveys a modern perception: that beer is a relatively low potency drink made from wholesome products like barley and hops, while spirits are a high-potency drink distilled from grain with little or no nutritional benefit. Wine also enjoys a salubrious aura, thanks to its association with scenic vineyards and the purported benefits of antioxidants and resveratrol, a component of red wine.

From the standpoint of beverages as alcohol delivery system, however, it makes no difference which beverage is consumed; a standard drink of any of the three – a twelve ounce beer, a 5 ounce glass of wine, or a one and one-half ounce "shot" of spirits – all contain the same amount of alcohol. What may matter for the consequences of alcohol consumption are factors such as context, as in why people drink and the social environment in which drinking takes place; the effect of the beverage on appetite, beer being a filling beverage, wine being enjoyed often with food; or price, with wine and spirits normally associated with a wider range of prices, especially on an alcohol-equivalent basis.

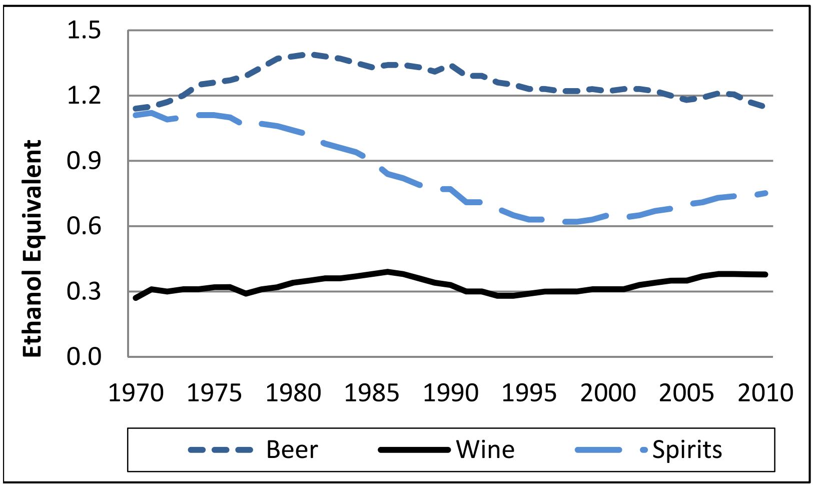
It is clear that alcohol consumption of any type has both health benefits and health costs. From a public policy perspective the focus is usually on the costs, and mainly because there are significant external

[1] "Exaggerated Assertions of Prohibitionists," editorial in the *Philadelphia Record (Dem)*, as compiled by *Public Opinion* (May-Oct, 1887).

costs. The focus of this paper is on the social costs of excessive alcohol consumption, with particular emphasis on how shifting shares of alcohol consumption across beverage types may have negative consequences for young people below the legal drinking age.

There is a large literature on the effects of alcohol control policies on traffic fatalities, arguably the most prominent consequence of alcohol overconsumption. WAGENAAR et al. (2010) summarize the effects of alcohol tax and price policies on traffic fatalities and other negative consequences, including suicide, violence, and sexually transmitted diseases. GRANT (2010) summarizes the effects of legislation aimed directly at driving under the influence, including blood alcohol content limits, administrative license revocation, minimum drinking age, and zero tolerance for young drivers. This paper follows previous work in using traffic fatalities as a symptom of alcohol abuse, but differs from it by considering the type of alcohol consumed and by measuring teen traffic fatalities relative to total fatalities so as to control for legislation intended to curb alcohol-related fatalities generally, as explained in the empirical section below.

Figure 1. Annual *per capita* consumption of alcoholic beverages in the U.S., in gallons of ethanol equivalent



Sources: National Institute on Alcohol Abuse and Alcoholism and the Brewers Institute

As shown in figure 1, trends in the amount and type of alcohol consumed reflect the changing tastes of the American drinking public. Per capita beer consumption in the US peaked in 1981, fell throughout the 1980s and 1990s, and then leveled out before dipping just below 1.2 gallons of ethanol equivalent per capita in 2010. Because consumption of all alcoholic beverages was falling on a per capita basis during much of the period, however, beer gained as a *share* of all alcoholic beverages consumed until 1994, at 57.3 percent, before falling to a 2010 share of just over 50 percent. Wine and spirits have both gained in recent years, with wine making steady gains throughout the period, and spirits making a comeback from a low of 29 percent in 1998 to its 2010 share of 33 percent. Demographics undoubtedly play a role in the evolution of consumption behavior; the percent of the prime beer-drinking population ages 20-35 peaked in 1981 and has declined steadily since. The effect of the age distribution on beer consumption has been documented elsewhere; see FREEMAN (2011).

The gain in spirits share has come during a period when the voluntary ban on television spirits advertising fell by the wayside.[2] The ban itself was evidence of the public's perception of spirits as a potentially more dangerous product, as wine and especially beer have been long time staples of television advertising.

The consumption shares of beverage types also vary across states of the US. For the two largest states, California and Texas, beer accounts for 46 percent of all alcohol in California and 62 percent in Texas. Spirits account for over 40 percent of all alcohol sold in New Hampshire but only 22 percent in Ohio, and there are many other examples. Changes in the share patterns also vary across states, with some states maintaining relative constant shares and others experiencing sizable shifts.[3]

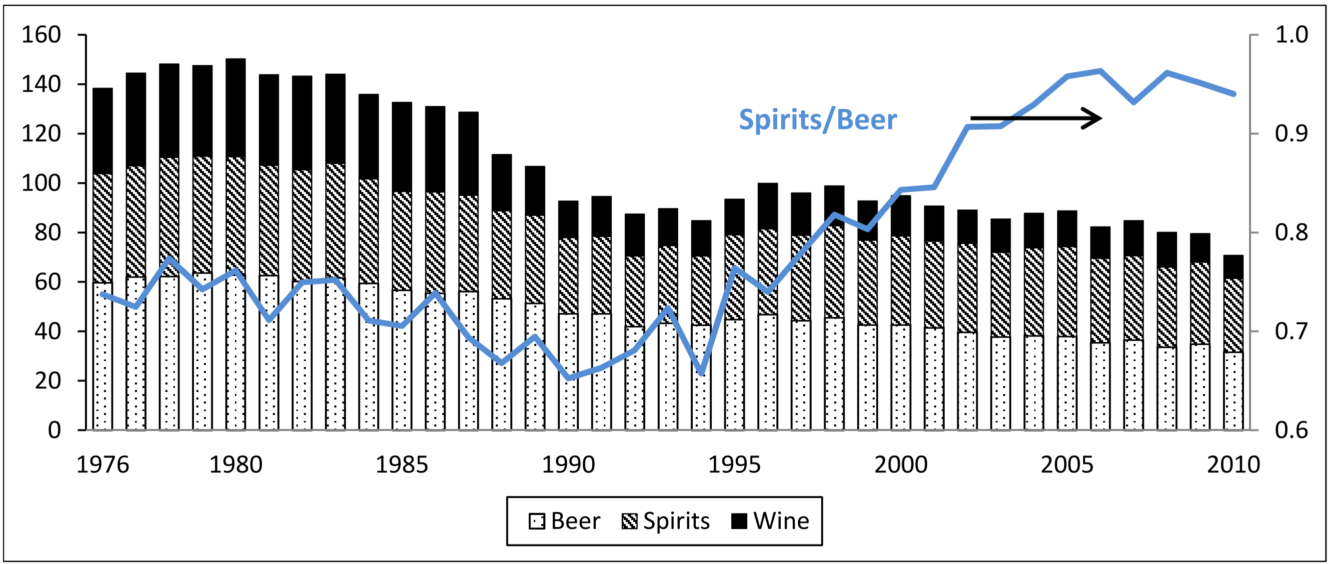
The plan of the paper is to use cross-state and cross-regional time series to estimate the effect of the variation in shares of alcohol beverage types on traffic fatalities in young people, with particular emphasis on consumption of beer versus spirits, or "hard liquor".

One public policy question that this research hopes to address is the rationale for differential treatment of alcohol beverage types with respect to adver-

2 In 1996 Seagram aired an ad for Crown Royal Canadian Whiskey on KRIS-TV, an ABC affiliate in Corpus Christi, Texas, breaking a long-standing, voluntary industry ban on broadcast liquor ads. The ban had been in effect for 60 years on radio (since 1936) and 48 years (since 1948) on television. Source: Alcohol Policies Project, Center for Science in the Public Interest, retrieved at http://www.cspinet.org/booze/liquor_chronology.htm.

3 Some of the cross-state variation is due to cross-border sales to take advantage of lower taxes, less restrictive point of sale laws, internet sales, and open versus state-licensed sales of spirits.

Figure 2. Beverage choice: 12th graders



Note: Self-reported alcohol use by 12th graders in the last 30 days, percent reporting use by beverage, left axis. Numbers may add to more than 100 percent as some 12th graders report use of multiple beverages. Solid line is the ratio of percent reporting use of spirits divided by percent reporting use of beer.
Source: JOHNSTON et al. (2011)

tising, distribution requirements, wholesale price maintenance, and selling hours. Any evidence that can be adduced from the data can be useful in designing a more efficient system of alcohol beverage control.

The plan of the paper is as follows. In Section II, some evidence is presented on the "switch to spirits," along with a brief review of the literature on the effects of the switch. Section III describes the data and the proposed empirical tests. Section IV provides the results, and Section V contains some discussion and the conclusions.

2 Background and Previous Research

Monitoring the Future (JOHNSTON et al., 2011) is an ongoing study of the behaviors, attitudes, and values of American secondary school students, college students, and young adults. Each year, a total of approximately 50,000 8th, 10th and 12th grade students are surveyed: 12th graders since 1975, and 8th and 10th graders since 1991.[4] Because 12th graders are usually of driving age but not drinking age, our focus is on their responses to questions on alcohol use.

Alcohol use and binge drinking have declined among 12th graders, especially during the first half or so of the period 1976 to 2010. The earlier years were marked by increases in the Minimum Legal Drinking Age (MLDA) in many states from 18 or 19 to 21 (all were at 21 by 1988) and a widespread campaign against underage drinking by Mothers Against Drunk Driving (MADD), the insurance industry, and state and local governments.

More 12th grade boys drink than girls; in 2010 about 44 percent of boys and 38 percent of girls reported use of some form of alcohol. Similarly, more whites drink than blacks or Hispanics: in 2010 about 45 percent of whites, 31 percent of blacks, and 40 percent of Hispanics reported alcohol use. With the exception of blacks, whose rate of use has not fallen in recent years as fast as that of other groups, the ratios of use between boys and girls and whites and other groups have fluctuated in narrow ranges throughout the sample, implying similar rates of change by sex and race/ethnicity over time.

The percentage of high school seniors drinking spirits has remained more or less constant over the past 15 years, even as the use of beer and wine has steadily fallen. As a result spirits use has approached parity with beer today, as shown by the solid line in figure 2.

Reasons adduced for the increased preference of spirits over other forms of alcohol include ease of concealment, higher alcohol content, and more palatable taste when mixed with soft drinks (ABC NEWS, 2007). These factors have always been present, however, so it is not clear that they are behind the increasing trend in relative use of spirits. Perhaps more com-

[4] For further details on the surveys, see the Monitoring the Future website (http://monitoringthefuture.org/).

pelling are explanations that include the aforementioned relaxation of the self-imposed ban on TV advertising and the introduction of a wide variety of flavored alcoholic beverages such as "hard lemonade" aimed at the youth market.[5]

The question remains, however, as to whether *what* young people drink has a bearing on the potential personal and social costs. MALDONADO-MOLINA et al. (2010) tested the effect of beverage type at age 13 on drinking behaviors at age 14 and found that use of spirits was associated with increased drunkenness and subsequent alcohol use. The study was limited by its small sample, the age of its participants, and its focus on urban youth. SIEGEL et al. (2011) found that riskier patterns of drinking and other negative behaviors were found among users of spirits and beer versus users of wine beverages, but as wine prevalence is already relatively low at 20% or less among 12th graders, it would be most unlikely for wine to account for a significant share of the social costs attributable to underage drinking. SIEGEL et al. did, however, note that among the sample of public school students in eight states, spirits was the strong preference as the beverage of choice at 44%, followed by beer at19% and malt beverages at 17%, with wine or wine coolers trailing at 7%.

If these preferences are indicative of the nation as a whole, it suggests that what adolescents *actually* drink, with self-reported consumption about equally split between beer and spirits, is different from what they would *prefer* to drink. Presumably, adolescent choice is constrained by beverage availability.[6]

The choice of spirits may reflect advantages of convenience and palatability when mixed with masking substances like soft drinks and juice or combined with fruit and frozen into ice pops. If this is the case, then spirits is a more "efficient" form of alcohol delivery, thus exacerbating the public policy problem by widening the wedge between private and social costs.

The following section describes the data and lays out the empirical approach to testing the hypothesis that the choice of beverage matters to the social costs of underage drinking.

3 Data and Empirical Approach

Annual data for apparent consumption at the state level is available by major type of beverage: spirits, beer, and wine.[7] These data are compiled by the National Institute for Alcohol Abuse and Alcoholism (NIAAA), and published on their website (LAVALLEE et al., 2010). Supplemental data on annual consumption is also available from the Brewers Almanac (BEER INSTITUTE, 2011), a trade publication.

The data available for underage drinking are self-reported surveys, like those conducted by Monitoring the Future, with the attendant issues of underreporting, self-serving bias, and misrepresentation. Still, these data can be useful in measuring trends, so long as the reporting issues stay more or less constant over time.

Fatality rates for motor vehicle accidents are taken from the Center for Disease Control (CDC, 2012) Compressed Mortality Files and updated from the National Highway Traffic Safety Administration (NHTSA, 2012) Fatality Analysis Reporting System (FARS).

Descriptive statistics for the variables used in the analysis are reported in table 1. Means are reported for the years 1984 and 2009, and maxima and minima for the latter year. Data are annual over the period 1979 through 2009; however, as noted below variables are expressed in five-year averages to mitigate small-state variability and potential problems with serial correlation.

Traffic fatalities have fallen for all age groups, and even faster for teenagers, who have much higher rates than the general population. Self-reported measures of drinking have also fallen for 12th graders, as has per capita consumption of alcohol for all ages. As seen earlier in figure 2, however, spirits consumption among young people has remained relatively steady while other forms of alcohol use have fallen.

5 Three Olives Vodka now comes in 21 flavors, including "Root Beer", "Cake", "Dude", and "Bubble [Gum]".

6 Because adolescents can only obtain alcohol from parents or through extralegal means, their consumption may be partly a result of their parents' tastes. Market preferences have tilted in favor of spirits, as shown in figure 1, but tastes among young people have shifted even faster.

7 "Apparent" consumption because cross-border sales to arbitrage tax differentials or to evade local restrictions on sales of alcoholic beverages are not captured. Because we are focused more on changes over time than absolute differentials across jurisdictions, these sales are of minor consequence.

Table 1. Variables used in the analysis, U.S. regions and states, 1984-2009 (five-year averages)

	1984	2009		
Variable	**Mean**	**Mean**	**Max**	**Min**
Traffic fatalities/100,000 population				
15-19 year-olds	40.6	23.9	48.6 (Wyoming)	9.7 (New York)
Non-15-19	20.3	14.4	27.7 (Mississippi)	5.9 (Massachusetts)
Unemployment rate (percent)	7.9	5.5	8.5 (Michigan)	3.4 (North Dakota)
Employment/population ratio (percent)	59.6	63.2	70.9 (North Dakota)	52.8 (West Virginia)
15-19 year olds, percent of total Population	8.7	7.1	7.9 (Utah)	6.3 (Nevada)
Median family income (1989), $		46,354	64,377 (Connecticut)	32,784 (Mississippi)
Total alcohol, gallons of ethanol equivalent per capita	3.2	2.7	4.8 (New Hampshire)	1.5 (Utah)
Beer share of total ethanol consumption (percent)	52.2	53.1	70.0 (West Virginia)	39.3 (Connecticut)
Spirits/beer proportion, 12th graders (percent)	71.1	95.0	103.5 (South)	88.5 (Northeast)
Binge drinking (any alcohol), 12th graders, last two weeks (percent)	38.8	25.4	28.9 (Northeast)	20.9 (West)
Binge drinking (beer), 12th graders, last two weeks (percent)	36.1	21.2	26.0 (Northeast)	18.8 (West)
Binge drinking (spirits), 12th graders, last two weeks (percent)	21.1	21.8	27.6 (Northeast)	17.3 (West)
Zero Tolerance Law (number of states)	5	48	NA	NA
Graduated driver's license (0-3, depending on number of provisions adopted)	0	1.67	3 (8 states)	0 (New Hampshire)

Source: NHTSA, Monitoring the Future, US Bureau of the Census

Our approach is to regress traffic fatalities for young people on alcohol use and other control variables, both at the state and the Census region levels.[8] NIAAA data on alcohol consumption and beverage choice will be used for the state-level regressions under the assumption that teen use mirrors use for the general population. Use of state-level data has the advantages of a larger sample and better controls for heterogeneity. Monitoring the Future data will be used for the region-level analysis.

The basic model for estimation can be expressed as:

(1) $y_{it} = \boldsymbol{\alpha}_i' \boldsymbol{d}_t + \beta_i' x_{\boldsymbol{it}} + e_{it},$

where y_{it} is traffic fatalities for region or state *U.S.* at time t; $\boldsymbol{d_t}$ is a vector of observed deterministic effects; $\boldsymbol{x_{it}}$ is a $k \times 1$ vector of regressors, including alcohol use; and the errors, e_{it}, have the multifactor structure

(2) $e_{it} = \gamma_i' f_t + \epsilon_{it},$

with $\boldsymbol{f_t}$ a vector of unobserved common factors, and ε_{it} an idiosyncratic error term uncorrelated with $\boldsymbol{f_t}$ or $\boldsymbol{x_{it}}$. We note that $\boldsymbol{d}_t = 1$ and $\boldsymbol{f}_t = 1$, $\gamma_i = \gamma$ and $\beta i = \beta$ is the traditional two-way fixed effects model.

The structure encompassed by system (1) and (2) provides significant flexibility in dealing with unit and time specific effects, as well as controls for cross-correlation in the error matrix. The following section reports results using various assumptions regarding the error structure (2).

8 The four Census regions of the United States represent groups of States as follows: 1) Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont; 2) Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin: 3) South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia; 4) West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

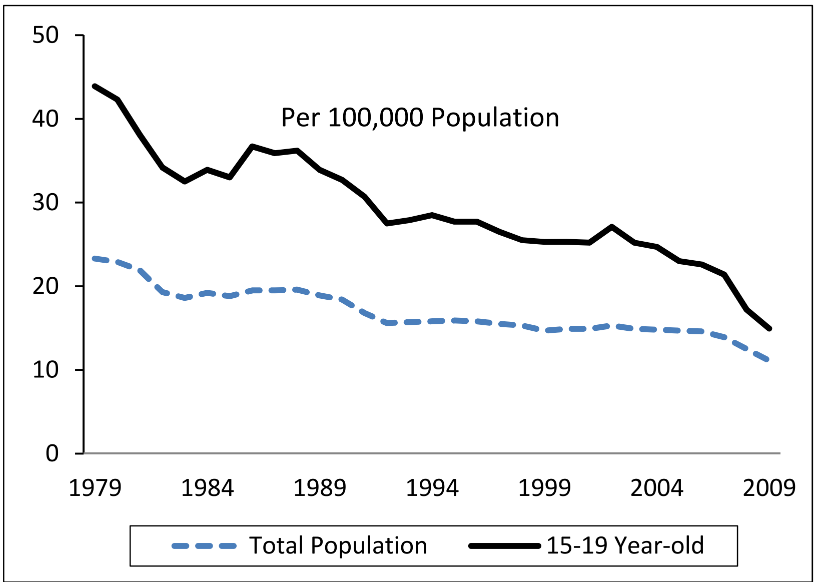
4 Empirical Results

The empirical results are grouped according to the regional and state-level results.

4.1 Monitoring the Future and Regional Data

Traffic fatality rates per 100,000 population for both 15-19 year olds and for the rest of the population have been falling over time as a result of advances in automotive engineering, traffic safety, and legal sanctions and social opprobrium against drunk driving. As shown in figure 3, fatality rates for young drivers have fallen faster than those of the general population, in part due to programs aimed specifically at this group, including stricter standards for alcohol consumption and lengthier probation prior to unrestricted driver's licensing.

Figure 3. U.S. traffic fatality rates



Note: fatality rates per 100,000 population, United States
Sources: CDC and NHTSA

In our initial set of regression estimates, we use the self-reported drinking measures from Monitoring the Future to control for young driver alcohol use. We also use fatality rates for non-15-19 year olds to control for the aforementioned improvements in engineering and safety control, alcohol control laws applied to the population generally, changing attitudes toward drunk driving, changes in enforcement, and other time-varying state specific trends in driving behavior such as vehicle miles traveled. The regional unemployment rate controls for young people's greater sensitivity to macroeconomic conditions, and the percentage of 15-19 year olds in the population controls for the greater risk associated with a larger population of young drivers and the increased opportunity for socialization.

Also included are laws specifically aimed at young drivers: the zero-tolerance measure makes any measurable alcohol in a young person's system a driving offense, and the graduated driver's license increases the probationary time and the requirements for unrestricted driving. "Zero Tolerance" is expressed as the percentage of states in the region that have the law on the books during a year. "Graduated Driver's License" can have a value of 0 to 3, depending on how many stages of graduated licensing are in effect, and is also average across states in the region.[9] The stages are those set forth by the Insurance Institute for Highway Safety (IIHS), as reported in NHTSA (2008).

The results of the regression of 15-19 year old fatality rates are displayed in table 2. Each regression uses fixed effects to control for region-specific characteristics.

The 15-19 year old rate tracks the rest of the population quite closely, and controlling for the influence of the other variables in the model, increases by almost two fatalities per 100,000 for every one fatality per 100,000 increase in the national rate. The coefficient of the unemployment rate is negatively signed, though statistically significant in only one case. The finding that higher unemployment results in lower fatalities is consistent with the recent literature on "recessions are good for your health", exemplified by RUHM (2000).

Coefficients of laws specific to young people also have expected signs and sizable effects, with each provision lowering the fatality rate by about 2 fatalities per 100,000 in most specifications. Cohort size also matters, with each percentage

[9] Not included, however, is the Minimum Legal Drinking Age (MLDA). All states had moved to an MLDA of 21 by 1989. Because we are using five-year averages, and because our sample begins in 1979, this means there is no variation in this measure for the majority of the sample. An earlier version of this paper included MLDA in the analysis, but its coefficient was never significant. Recent research has produced contradictory findings on the effectiveness of MLDA; see CARPENTER and DOBKIN (2011) and MIRON and TETELBAUM (2009) for opposing results.

Table 2. Regression of 15-19 year-old traffic fatality rates on alcohol consumption, driving laws, and economic variables. Census regions, annual data 1979-2009

Variable	(1)	(2)	(3)	(4)	(5)	(6)[a]
Fatality rate non-15-19	1.915* (16.5)	1.976* (17.9)	1.972* (17.7)	1.931* (16.3)	1.616* (8.03)	2.261* (15.4)
Unemployment rate	-0.197* (1.620)	-0.152 (1.295)	-0.176 (1.452)	-0.191 (1.560)	-0.149 (1.327)	-0.078 (0.542)
Binge last 2 weeks, any alcohol	0.102* (2.416)			0.104* (2.459)		
Binge last 2 weeks, spirits		0.117* (2.383)			0.090* (1.903)	0.073 (1.387)
Binge last 2 weeks, beer			0.082* (2.160)			
Spirits/beer proportion				0.014 (0.731)		
Zero Tolerance Law	-1.760* (1.892)	-2.281* (2.423)	-1.669* (1.777)	-1.866* (1.979)	-2.088* (2.284)	-3.555* (3.161)
Graduated Driver's License	-1.724 (1.470)	-2.691* (2.151)	-1.493 (1.268)	-2.251* (1.632)	-2.713* (2.276)	5.046* (3.741)
15-19 percent of Population	0.237* (2.333)	0.229* (2.228)	0.246* (2.411)	0.222* (2.141)	0.236* (2.142)	0.613 (1.465)
Lagged fatality rate					0.125 (1.618)	
R^2	0.972	0.972	0.972	0.972	0.973	0.968
N	124	124	124	124	120	124

[a] Model (6) uses 20-24 year old fatality rates and associated controls.
Notes: Asterisk signifies statistical significance at the 0.10 level or lower.
Source: author's calculation

point larger cohort of young people raising the risk of fatalities by about 2 per million. Finally, alcohol matters, but the type of alcohol consumed does not. Binge drinking has about the same effect on the fatality rate in all cases. And when the proportion of those responding "yes" to the question on binge drinking with spirits versus binge drinking with beer is included, that coefficient is insignificant and the other coefficients are unchanged.

As a check on the validity of the results, we first add the lagged dependent variable to test for persistence. We find that the coefficient of the lagged fatality rate is not significant, nor do the coefficients of the other variables change in a measurable way. Secondly, we estimate a similar model using the fatality rates for 20-24 year olds. The results for the older group tend to confirm the validity of the estimates for the younger group. The coefficients for the alcohol use variable and for unemployment are smaller and insignificant, and the non-20-24 fatality rate is larger. The coefficient for the graduated driver's license variable is significant and of the opposite sign, confirming the "shifting" effect of postponed driving noted in previous research (KIRACA-MANDIC and RIDGEWAY, 2010). The measured effect of the zero tolerance law is still negative and significant; perhaps the presence of this law signals enhanced enforcement of all alcohol-related traffic laws.

4.2 NIAAA and State-level Data

Using state level data offers more detail and a larger sample size for estimation, but the consequence is the greater heterogeneity across states. With the exception of North Dakota, fatality rates in all states have declined over the past twenty years. Cross-state variation in youth fatality rates is however highly persistent: simply regressing state fatality rates in 2009 against the rates in 1989 explains over half the variation in the 2009 rates, implying that controls for time-invariant effects will be essential in pooled estimation.

Because the 15-19 year old population is a small fraction of any state population and traffic deaths are relatively infrequent, year-to-year fatality rates can vary greatly, especially in smaller states. For this reason, and to mitigate the possibility of autocorrelation in the data, we use non-overlapping five-year averages of fatality rates in state-level regressions.[10] With thirty years of data grouped into six half-decades beginning in 1984 and ending in 2009 and 48 states, the sample size is 288 state-half-decades. Alaska, Hawaii and the District of Columbia are excluded, as they are in most of the literature on fatalities.

Table 3 reports the results of these state-level regressions in the same format as the regional regressions above. All variables are the same with the important exception of the alcohol variables. The estimations in table 3 use apparent consumption data for the state population as reported by the NIAAA. The two alcohol variables included in the models are the total consumption of ethanol, whether beer, wine, or spirits; and the share of beer in total consumption. The assumption is that consumption habits of young people mirror those of the rest of the population.

[10] The same regressions were run with annual data, with very similar results in coefficient sign and magnitude, but with less precision and more autocorrelation in the residuals. These results are available on request.

Table 3. Regression of 15-19 year-old traffic fatality rates on alcohol consumption, driving laws, and economic variables. State-level, annual data 1980-2009

Variable	(1)	(2)	(3)
Fatality rate non-15-19	1.546* (25.6)	1.812* (12.3)	1.477* (9.34)
Employment/ population	0.216* (3.433)	-0.167 (1.28)	0.149 (0.64)
Total ethanol *per capita*	-0.029) (0.61)	-0.002 (0.16)	0.050 (0.38)
Beer share of total ethanol consumption	0.825* (1.79)	1.335 (1.35)	0.967 (0.86)
Zero Tolerance Law	-4.588* (6.544)	-3.555* (4.533)	-0.893 (0.83)
Graduated Driver's License	-3.521* (2.630)	-1.552 (1.104)	4.207* (2.113)
15-19 percent of population	0.229 (0.228)	0.246 (.411)	0.222 (.141)
Fixed effects	None	State	State and year
R^2	0.865	0.902	0.911
N	288	288	288

Notes: Asterisk signifies statistical significance at the 0.10 level or less.
Source: authors' calculation

Model (1) in the first column of table 3 reports results using time-varying regressors with no fixed effects and the employment/population ratio as the cyclical indicator. The employment population ratio may better capture the level of economic activity as a measure of the proportion of the population directly engaged in the economy. Controlling for movements in overall fatality rate, the fatality rate for 15-19 year olds is procyclical, and the coefficients for the alcohol control laws are large and significant. Total alcohol consumption does not affect fatalities, but an increase in the share of beer in total consumption adds to the fatality rate.

In model (2) the introduction of state fixed effects has a dramatic effect on the results. Only the overall fatality rate and the zero tolerance variables now have significant effects, while the goodness of fit is improved. Neither of the alcohol variables now has any bearing on the results.

Adding year fixed effects in Model (3) further dilutes the results of the time-varying regressors. Only the overall fatality rate has an expected sign and a significant effect, with a smaller *t*-statistic than in the other models. The R^2 is again improved, and the Durbin Watson indicates that autocorrelation is not an issue. Admittedly, the use of overall alcohol consumption may not be the best proxy for alcohol abuse by younger populations, but these results suggest that fatality rates in young people are not much influenced either by the measures of alcohol herein employed, or by control laws specific to this age group.

4.3 The Long Term Change in Fatalities

Given that the state fixed effects model provides very little confirmation of any of the proposed regressors on traffic fatalities, perhaps because the regressors themselves have limited time variation, we take a longer view of the change in youth traffic fatalities at the state level to exploit the cumulative variation over time. Essentially the model becomes a cross-section of long-term changes in fatalities expressed as:

$$(3)\quad \Delta_{20} lfat_{i,2009} = \alpha + \beta lfat_{i,1989} + \boldsymbol{X_i \gamma} + \Delta_{20}\boldsymbol{Z_i \delta} + \epsilon_i .$$

The "Δ_{20}" denotes "twenty year change in" a variable, "*lfat*" is the natural logarithm of the 15-19 fatality rate, $\boldsymbol{X}$ is a vector of initial conditions, and $\boldsymbol{Z}$ is a vector of laws, alcohol consumption, and demographic variables. If β is negative, then so-called "β convergence" is said to characterize fatality rates: states with higher fatalities initially will have larger declines in subsequent years.[11] To measure the effect of traffic laws, we sum the number of years that the laws have been in place in the states over the twenty-year period 1989-2009. Thus the coefficient of a traffic law can be interpreted as the percent change in fatalities in this age group due to an additional year of the law being in effect.

The analysis begins in 1989 to obviate the effects of the increase in the Minimum Legal Drinking Age (MLDA), which took place in the various states at different times during the mid-1980s. The early 1980s also marked the initial big push by groups like Mothers Against Drunk Driving (MADD) and the Insurance Institute for Highway Safety (IIHS) to raise the awareness of the problem of drunk driving. These changes in social pressures and societal attitudes are not easy to capture in regression estimates, but undoubtedly had real effects on patterns of traffic fatalities.[12]

[11] Of course, a negative β will also result from simple regression to the mean in the context of convergence in economic growth. A finding of a non-negative β, on the other hand, is a strong indicator of persistence.

[12] Prior to these efforts, alcoholic characters were often portrayed as lovable or funny; having "one for the road" was encouraged! In addition, enforcement of alcohol control laws was uneven.

Table 4 presents the results of the analysis of growth rates in state 15-19 year old fatalities. Column 1 presents the results of a "pure" convergence test, using only the fatality rate at the 1989 origin as a regressor. The positive and insignificant coefficient suggests no convergence in rates across states, an unsurprising result considering the persistent differences in fatality rates across states. In column 2 we add the logarithm of state median household income in 1989 as a regressor. Income controls for the resources available in the state for public goods like upgraded roads, adequate law enforcement, educational efforts, and other initiatives to reduce traffic fatalities for young and old. The evidence is quite strong that initial income explains much of the progress in reducing traffic fatalities over the subsequent two decades; the coefficient indicates that a one percent increase in state median income will reduce traffic deaths by 1.25 percent. Initial income alone explains about 40% of the variation in the growth of fatalities across states.

Table 4. Regression of the growth in 15-19 year-old traffic fatality rates on alcohol consumption, driving laws, and economic variables. State-level, 1989-2009.

Variable	(1)	(2)	(3)	(4)	(5)	(6) (2009-1994)
Fatality rate 15-19, 1989	0.257 (1.61)	-0.318* (1.98)	-0.319* (2.21)	-0.286* (1.88)	-0.278* (1.90)	-0.162* (1.65)
Median income, 1989		-1.250* (5.68)	-0.754* (3.19)	-0.922* (4.29)	-0.936* (4.63)	-0.686* (-3.65)
Total alcohol *per capita*			0.560* (1.90)			0.625* (2.18)
Beer *per capita*				0.734 (1.07)		
Spirits *per capita*					0.797* (1.75)	
Beer share of total ethanol consumption			0.631 (0.84)			
Zero Tolerance Law			-0.007 (0.79)	-0.009 (0.94)	-0.006 (0.73)	-0.005 (0.86)
Graduated Driver's License			-0.037* (2.52)	-0.039* (2.62)	-0.032* (2.09)	-0.187* (1.66)
Seat belts			-0.031 (1.55)	-0.036* (1.88)	-0.044* (2.30)	-0.030* (2.05)
R^2	0.053	0.420	0.604	0.589	0.608	0.453
N	48	48	48	48	48	48

Notes: Dependent variable and alcohol types in log-difference, 1989 Fatality Rate and Median Income in log-levels. Traffic control laws in cumulative state-years. Asterisk signifies statistical significance at the 0.10 level or lower.
Source: authors' calculation

We also note that fatality rates converge when income is held constant. Thus it may be that efforts to reduce fatality rates would have resulted in more similar rates across states if resource availability had been the same. Alcohol consumption and traffic control laws are added to column 3. Increases in total alcohol consumption over the sample period are associated with increases in traffic fatalities. Changing the composition of that consumption, however, as shown by the share of beer in the total, appears to have had no effect. Of the control laws, only the graduated driver's license program explains a significant share of the variation in growth rates of fatalities. The effect of initial income is somewhat diminished but still strongly negative.

In column 4, beer consumption per capita is substituted for total alcohol consumption. Beer alone has no apparent measurable effect on the growth in fatalities. When spirits alone is used, however, in column 5, the coefficient is significant, suggesting that the variation in total consumption driven by spirits underlies the relationship between alcohol and the growth in fatalities. The significance of the relationship notwithstanding, the evidence that the switch to spirits over time is associated with increased fatality rates is far from conclusive.

In column 6, the analysis is repeated for the 15-year interval from 1994-2009 as a robustness check. The results are quite similar to the twenty-year analysis. An analysis was conducted for the 15-year interval 1989-2004 with similar results. As expected, the coefficients of the initial conditions are smaller as the magnitude of the dependent variable is less, covering fewer years, and the fit is not as good, but all of the major conclusions remain.

5 Conclusion

Based on the analysis of this paper, there are several tentative findings and a couple of firm conclusions.

Among the tentative findings are that self-reported levels of alcohol consumption are associated with traffic fatality rates for 15-19 year olds. Whether this reflects causality or simple correlation is still an open question. There may be other time-varying factors driving young people to risky behavior.

In no case however is the evidence convincing that the *type* of alcohol consumed makes a difference to the outcomes. Beer consumption is more often associated with negative outcomes than spirits consumption in the short run; in the long run the opposite is true. The differences are quite small, however, and not consistently significant.

After controlling for fatality rates in the general population, the coefficients of graduated driver's license and zero tolerance laws are negative and significant in region and state-level regressions. When included in regressions of the growth rate of fatalities, however, the coefficient of the zero tolerance law is never significant. GRANT (2010) also finds that zero tolerance laws have had little to no effect on fatalities in young drivers.

Cohort effects are relatively pronounced with respect to fatality rates. Higher percentages of young people leads to more fatalities, perhaps as a result of collectively risky behavior, perhaps as a result of the stress of greater competition for jobs, placement in school, sports and extracurricular activities, and social services.

Business cycles have no consistent effect. When significant, the unemployment rate and the employment-population ratio confirm that "recessions are good for your health" (RUHM, 2000). Because we are not measuring teenage employment directly, however, it may be that the use of variables at the total population level is insufficiently precise to capture the effect on young people.

Firm conclusions that can be drawn from the analysis are first that relative rates of youth traffic fatalities are highly persistent phenomena across states. Over fifty percent of current cross-state variation in fatalities can be explained by the cross-state variation of 20 years ago.

The most striking finding of this paper is the role of median state income as a protective factor against early death. A one percent difference in initial median state income results in a one percent decline in the growth of traffic fatalities over a twenty year period. Using the 1989 median state income of $46,500 and 1989 median state traffic fatality rate of 38.7 for 15-19 year-olds, an increase of one standard deviation in income would result in a decline of an additional 3 deaths per 100,000 population in 2009, or about 9 actual deaths for this age group in the median state.

That higher incomes are associated with greater longevity has been known at least since PRESTON (1975), and has been confirmed in many different settings. What is noteworthy here, however, is that Preston-type analyses are usually describing much wider discrepancies in income across countries that are much more heterogeneous than the collection of U.S. states. By contrast, U.S. states are relatively uniform in traffic legislation, alcohol control laws, public campaigns against drunk driving, and so forth, yet median income differences still explain a large percentage in the variation of youth fatalities.

One can conjecture that higher incomes result in newer, safer vehicles provided by the private sector, and in more attention and effort into enforcement, better roads, provision of health and social services, and education provided by the public sector. These are potential avenues for further research.

References

ABC NEWS (2007): Drinking Teens Eschewing Beer for Hard Liquor. URL: http://abcnews.go.com/Health/story?id=4508106&page=1, July 26, 2007.

BEER INSTITUTE (2011): The Brewers Almanac. Washington, DC.

CARPENTER, C. and C. DOBKIN (2011): The Minimum Drinking Age and Public Health. In: Journal of Economic Perspectives 25 (2): 133-56.

CDC (Centers for Disease Control) (2012): Compressed Mortality Files. Accessed at http://www.wonder.cdc. gov/mortsql.html.

FREEMAN, D.G. (2011): Beer in Good Times and Bad: A U.S. State-Level Analysis of Economic Conditions and Alcohol Consumption. In: The Journal of Wine Economics 6 (2): 231-251.

GRANT, D.P. (2010): Dead on Arrival: Zero Tolerance Laws Don't Work. In: Economic Inquiry 48 (3): 756-770.

JOHNSTON, L.D., P.M. O'MALLEY, J.G. BACHMAN and J.E. SCHULENBERG (2011): Monitoring the Future National Survey Results on Drug Use, 1975-2010. Volume I: Secondary school students. Institute for Social Research, The University of Michigan, Ann Arbor.

KARACA-MANDIC, P. and G. RIDGEWAY (2010): Behavioral Impact of Graduated Driver Licensing on Teenage Driving Risk and Exposure. In: Journal of Health Economics 29 (1): 48-61.

LAVALLEE, R.A., G.D. WILLIAMS and H. YI (2010): Surveillance Report #87: Apparent Per Capita Alcohol Consumption: National, State, and Regional Trends, 1970-2007. National Institute on Alcohol Abuse and Alcoholism, Division of Epidemiology and Prevention Research, Bethesda, MD.

MALDONALDO-MOLINA, M.M., J.M. REINGLE, A.L. TOBLER and K.A. KOMRO (2010): Effects of Beverage-Specific Alcohol Consumption on Drinking Behaviors among Urban Youth. In: Journal of Drug Education 40 (3): 265-80.

MIRON, J.A. and E. TETELBAUM (2009): Does the Minimum Legal Drinking Age Save Lives? In: Economic Inquiry 47 (2): 317-36.

NHTSA (National Highway Traffic Safety Administration) (2012): Fatality Analysis Reporting System (FARS). Accessed at http://www.fars.nhtsa.dot.gov/Main/index.aspx.

– (2008): Graduated Driver Licensing System. DOT HS 810 888W. Washington, DC.

PRESTON, S.H. (1975): The Changing Relation between Mortality and Level of Economic Development. In: Population Studies 29 (2): 231-49.

RUHM, C.J. (2000): Are Recessions Good For Your Health? In: The Quarterly Journal of Economics 115 (2): 617-650.

SIEGEL, M.B., T.S. NAIMI, J.L. CREMEENS and D.E. NELSON (2011): Alcoholic Beverage Preferences and Associated Drinking Patterns and Risk Behaviors among High School Youth. In: American Journal of Preventative Medicine 40 (4): 419-26.

WAGENAAR, A.C., A.A. TOBLER and K.A. KOMRO (2010): Effects of Alcohol Tax and Price Polices on Morbidity and Mortality: A Systematic Review. In: American Journal of Public Health 100 (11): 2270-2278.

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