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THE VIRTUOUS TAX:
LIFESAVING AND CRIME-PREVENTION EFFECTS OF THE 1991 FEDERAL ALCOHOL-TAX INCREASE

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ABSTRACT

On January 1, 1991, the federal excise tax on beer doubled, and the tax rates on wine and liquor increased as well. These changes are larger than the typical state-level changes that have been used to study the effect of price on alcohol abuse and its consequences. In this paper, we develop a method to estimate some important effects of those large 1991 changes, exploiting the interstate differences in alcohol consumption. We demonstrate that the relative importance of drinking in traffic fatalities is closely tied to per capita alcohol consumption across states. As a result, we expect that the proportional effects of the federal tax increase on traffic fatalities would be positively correlated with per capita consumption. We demonstrate that this is indeed the case, and infer estimates of the price elasticity and lives saved in each state. We repeat this exercise for other injury-fatality rates, and for nine categories of crime. For each outcome, the estimated effect of the tax increase is negatively related to average consumption, and that relationship is highly significant for the overall injury death rate, the violent crime rate, and the property crime rate. A conservative estimate is that the federal tax reduced injury deaths by 4.7%, or almost 7,000, in 1991.

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1. Introduction

Thirty years of economic research has established that consumer choices about drinking are responsive to prices in the expected way (Chaloupka et al. 2002; Cook 2007). It is reasonable to conclude that alcohol excise taxes are "virtuous" in that by raising prices they reduce alcohol abuse and related consequences for public health and safety. Indeed, a number of studies have explored the direct effect of alcohol taxes on injury mortality, crime, and other negative consequences of abuse. Some but by no means all of the reported findings support this hypothesis. At this point it is difficult to distinguish between two possible explanations for the inconsistent results: a substantive explanation (that the reduction in drinking that results from tax-induced price increases in fact does not have much effect on some of these outcomes) and an explanation based on the lack of statistical power. The latter explanation is plausible: analyses based on observed changes in state excise-tax rates have been limited by the fact that in recent decades it has been rather rare for state legislatures to change tax rates, and changes that have occurred have typically been small. In effect, "nature" has failed to perform the experiment that scholars need to achieve more confident results.

Actually, there has been one notable instance of a large excise tax increase, but it has been bypassed as a possible source of evidence. On January 1, 1991, the federal tax on beer doubled (to about a nickel per drink), and tax rates on wine and spirits were also increased. Alcohol prices jumped an average of 6 percent (adjusting for overall inflation). The problem for would-be evaluators is that because this change was nationwide, it did not come paired with any obvious control group.

In this paper, we propose and implement a simple method for estimating the effects of this national tax increase that does make use of interstate differences – not in tax changes (which were uniform), but rather in persistent differences in drinking. Our working hypothesis is that the proportional effect of an alcohol tax increase on, say, traffic fatalities, is positively related to a state's per capita alcohol consumption. Simply put, relatively "wet" states will benefit more from a given tax increase than "dry" states. We provide evidence in support of that hypothesis (including the strong positive correlation between per capita consumption and the percent of traffic fatalities that involve drinking), and then use it to justify a new method for estimating the effect of the federal tax change on injury deaths and crime.

The method involves estimating cross-section regressions with per capita alcohol consumption as the independent variable, for which the dependent variables are proportional changes in the outcome variables around the time of the federal tax increase. We generate these estimates for all injury deaths (total, and then for suicide, homicide, and motor-vehicle deaths separately), as well as for nine categories of crime. In every case, the estimated effect is negative, and in most cases the null hypothesis can be confidently rejected. Our interpretation of these estimates rests on two linked assumptions: (1) alcohol abuse causes higher proportions of injury deaths and crime in wet states than dry; and (2) an alcohol tax increase reduces injury deaths and crime that are caused by alcohol abuse, *cet. par*.

This approach provides a joint test of the two assumptions, and also provides the basis for estimating the impact of the tax increase at different points in the spectrum of "wetness." For example, we predict that wetter states like California, Florida, and Wisconsin enjoyed greater proportional reductions in injury deaths and crime than did drier states like Utah, West Virginia, and Kansas. Thus our approach may be of interest in documenting heterogeneity in the "treatment effects" of alcohol taxes. Instead of attempting to estimate the average treatment effect, we estimate the spectrum of treatment effects associated with a particular moderator – per capita consumption. Our approach contributes to a recent body of literature that seeks to estimate the structure of heterogeneous policy effects (Ananat & Michaels, 2008; Bitler, Gelbach, & Hoynes, 2006; Neumark, Schweitzer, & Wascher, 2004; Blank & Schoeni, 2003).

Our substantive findings provide consistent support for a conclusion that the alcohol-price elasticity for several outcomes is closely related to average alcohol consumption. For injury fatalities, we find strong and consistent results for traffic and overall. For our crime categories, we find strong and consistent results for overall violent crime, aggravated assault, robbery, overall property crime, burglary, and motor-vehicle theft. The gradient relating per capita consumption to price elasticity is about twice as steep for violent crime as for property crime.

We proceed as follows. The next section summarizes relevant knowledge linking drinking to injury and crime, and the effects of alcohol control measures on drinking and related outcomes. We then characterize the federal tax increase of 1991 more fully, documenting its effects on alcohol prices. Section 4 develops our regression specification and documents the relationship between per capita consumption and the proportion of traffic fatalities that involve alcohol. Section 5 presents results for injury mortality and then crime. Section 6 reports the results of alternative specifications, concluding that the results are highly robust. A final section concludes.

2. Drinking and consequences

Intoxication has long been considered an important cause of injury and crime. This connection has figured most prominently in shaping policies to prevent traffic fatalities, but drinking is also an important factor in homicide, other types of violent crime, suicide, and other injury.

The evidence for a causal effect of intoxication begins with what is known about the pharmacological and social effects. The pharmacological effects generally depend on the amount and duration of drinking relative to body mass, and a variety of other factors that make the effects quite heterogeneous. Generally speaking, when a drinking session is initiated, the increasing alcohol level is a stimulant, and may engender loss of inhibition and increased sociability. At higher levels of consumption, impairment of judgment, other cognitive processes, and coordination will occur. As alcohol in the blood is metabolized, the stimulant effect gives way to a depressant effect. Very high levels of intoxication may lead to coma or death due to overdose. Also relevant is that alcohol is an anesthetic (and in fact was used as such in medical procedures before modern anesthetics were introduced), which may change individual assessment of getting into a bar fight, say. In sum, the pharmacological effects are diverse. In some people under some circumstances, alcohol intoxication can lead to reckless driving, suicide, other injuries, or involvement in crime either as a perpetrator or a victim.

The social effects of drinking depend on the cultural context in which it occurs. In Western cultures, intoxication often serves as an excuse for bad behavior – the man who abuses his wife or gets in a fight or sexually assaults an acquaintance may have a better chance of forgiveness if he gets drunk first. Furthermore, drinking is linked to the nature of the social context, since much drinking occurs in bars and other public places. Crowds of impaired people provide opportunities for conflict and victimization.

The statistical characterization of these associations begins with the rather high prevalence of intoxication in injury deaths and crimes. Table 1 provides a consistent set of estimates for 2001 injury deaths, in which deaths are "alcohol-attributable" if "the decedent (or, as in the case of motor-vehicle traffic, a driver or non-occupant) had a BAC of>0.10 g/dL" (Midanik et al. 2004, p. 866). This standard is conservative in that it exceeds the nationwide *per se* limit for driving under the influence (0.08%). About 25% of the motor vehicle deaths meet that standard. Overall, 19% of injury deaths of all types were deemed alcohol-attributable based on the epidemiological evidence.

Table 1 about here

Statistics on the prevalence of alcohol involvement in criminal acts come from several sources. Occasional surveys of inmates include questions on whether they had been drinking at the time of their crime. The 1997 Survey of Inmates in State Correctional Facilities (conducted by the US Department of Justice), for example, found that 42 percent of inmates convicted of a violent crime had been drinking, compared with 34.5 percent of those convicted of a property crime (Table 2). Another source of information is the National Crime Victimization Survey (NCVS), which routinely asks respondents who report a violent crime whether they thought the perpetrator had been drinking or using drugs at the time of the crime. Excluding those who said that the perpetrator was using drugs but not drinking, 29 percent of the violent crimes involved or possibly involved drinking. The percentage so reported for rape is 41.5%, similar to the percentage from the inmate survey. (Note that neither the NCVS nor the National Prisoner Survey inquires whether the *victim* was drinking at the time of the crime.)

Table 2 here

Of course this association does not demonstrate the extent to which alcohol is a cause of injury or crime. People who drink to excess tend to have other personality traits that may explain why they engage in risky and criminal behavior: in the case of drunk driving, these traits include emotional instability, impulsiveness, hostility, and depression (Donovan, Marlett, and Salzberg 1983). Indeed, people who drive drunk from time to time are more likely to get into a crash even when sober (Levitt and Porter 2001). In principle this sort of confounding can be overcome through laboratory experiments, and there has been some research of this sort. Laboratory experiments with humans have demonstrated that drinking degrades driving ability, while experiments with both humans and animals have provided strong evidence that drinking leads to more aggressive behavior in some people (and monkeys). But the scope for such experiments is obviously limited.

A quite different approach to assessing the causal effect of drinking on injury and crime is to evaluate policies and events that affect the price and availability of alcoholic beverages.[1] The alcohol-control measures that have been most thoroughly evaluated are the minimum legal drinking age and alcohol excise taxes. State-level changes in the minimum drinking age were common in the 1970s and 1980s, and a number of studies (beginning with Cook and Tauchen 1984) utilized difference-in-difference panel-regression methods on state data to assess the effects on various outcomes including teen traffic fatalities and suicide rates. There have been

[1] Cook (2007) provides a review of this evidence for both injury and crime. Carpenter and Dobkin (2011b) review the evidence on drinking and crime.

no changes in minimum age since 1987, but a series of regression discontinuity studies focused on age 21 have given persuasive evidence of its effects on crime and other outcomes (Carpenter & Dobkin 2009; Carpenter & Dobkin 2011a).

The economic literature on the effects of alcohol-excise taxes has also made extensive use of panel regression studies of state-level data (beginning with Cook and Tauchen 1982). In this analysis, the use of the tax rate as the regressor is justified from a "reduced form" interpretation: the presumed mechanism is that a tax increase is passed on to consumers in the form of higher prices (confirmed by Young & Bielinska-Kwapisz 2002), and that the price increase reduces alcohol abuse related to the outcome in question. This literature helps establish the effects of alcohol sales on alcohol-related outcomes such as crime, traffic fatalities, and sexually transmitted diseases (Chesson et al 2004). Note that a finding that an increase in an excise tax affects outcome Y (crime, injury) is directly relevant as part of evaluation of such taxes, and also, indirectly, a confirmation of the causal effect of drinking on outcome Y. One possible challenge to this causal interpretation is that the decision by state legislatures to change taxes may be influenced by near-term patterns in alcohol use or abuse, and hence cannot be interpreted as completely exogenous (Young & Bielinska-Dwapisz 2006).

To illustrate the results from panel-regressions on state excise tax changes, Table 3 provides a consistent set of estimates for alcohol sales (measured as gallons of ethanol sales per capita) and four types of injury deaths – those resulting from crashes, falls, homicide, and suicide. In each case, the regression is based on annual state-level data for the period 1981-2000. The second column provides evidence that changes in state per capita alcohol sales are closely associated with the injury-death outcomes (with the exception of homicide). The last column reports that the effect of tax increases on sales is highly significant ($p<.01$), while the "reduced form" effect of excise taxes on motor-vehicle fatalities is marginally significant. The estimated effects on falls, homicide, and suicide are not significant, and the effect for homicide has the "wrong" sign. These rather weak results may well reflect the lack of statistical power in the quasi-experiment – nominal excise-tax rates are rarely changed, and the changes that occurred during this period were in most cases quite small.[2]

Table 3 about here

Several studies have assessed the effects of beer-excise taxes on crime rates (Carpenter and Dobkin 2011b). Cook and Moore (1993) used state-level panel data for the period 1979-1987 with two-way fixed effects, finding that increases in beer tax rates reduced rape and robbery rates. (See also, Chaloupka et al., 2002; Sloan et al., 1994). DeSimone (2001) conducted a similar study of 29 large cities for the period 1981-1995, finding a negative effect of beer taxes on rape, assault, larceny, and motor vehicle theft. A study of injury-producing violence in

[2] It should be noted that research evaluating the effect of tax changes on mortality is by no means limited to the economics literature. Much of this research utilizes time-series methods to evaluate changes in a single state. For example, Wagenaar et al. (2009) finds that two rather large changes in alcohol-excise taxes in Alaska at different times were associated with immediate and sustained reductions in alcohol-related disease mortality. A similar analysis for Florida had a similar result (Maldonado-Molina and Wagenaar 2010). There is also a related literature based on British and European experience (e.g., Purshouse et al., 2010; Babor et al., 2003).

England and Wales also found a negative effect for beer taxes (Matthews et al., 2006). Markowitz (2005) utilized panel data on individuals from three consecutive years of the NCVS, finding marginal evidence that the beer tax reduced physical assault victimization, but with null results for rape or robbery. She has also analyzed the effect of beer taxes on domestic violence in a series of studies, including several that utilize repeated cross sections (Markowitz and Grossman, 2000; Markowitz 2000) with mixed results.

One consistent finding of the "crime" literature is a null result for the effect of alcohol taxes on homicide rates. The most recent contribution is Durrance et al. (forthcoming), which utilizes a panel of state-level data, reporting a null effect of state alcohol excise tax rates on female homicide victimization.

3. The Federal tax increase of 1991

In 1990, federal legislation was signed by President George H.W. Bush that increased excise taxation on tobacco, gasoline, and alcohol. Taxes on beer increased from 29 cents to 58 cents per gallon, taxes on wine increased from 17 cents to $1.07 per gallon, and taxes on liquor increased from $12.50 to $13.50 per proof gallon (which is the volume of liquid that contains 64 ounces of ethanol). Using appropriate conversion figures, these tax increases amounted to approximately a 5.0 cent per ounce of ethanol increase in beer, a 5.5 cent per ounce of ethanol increase in wine, and a 1.5 cent per ounce of ethanol increase in liquor.[3]

It is of interest that Congress has not changed the alcohol tax rates since 1991, and the price effect of these increases has been substantially eroded by general inflation. At the time, however, the tax increases were associated with an abrupt departure from the trend in alcohol prices. Figure 1 depicts the ratio of the Consumer Price Index for alcoholic beverages to the overall CPI for the years around 1991. The increase of 6 percent (in real terms) between 1990 and 1991 began fading after 1992.

Figure 1 about here

Our window of analysis is the two-year period that brackets the federal tax increase. During that time there were four states that increased alcohol excise tax rates, three of them by more than a trivial amount. We return to this matter below.

4. Specification

One approach to justifying our regression specification builds on the assumption that injury deaths and crimes can be divided between those that are in some sense caused by drinking and those that are not. Epidemiologists estimate the "attributable portion" of deaths that are caused by drinking, as noted above. We do not attempt to specify an operational definition of the attributable portion in what follows, but only suppose that there is a subset of fatalities that are attributable to drinking, and that the proportion of such fatalities is closely related to how "wet" or "dry" the state is, as indicated by average consumption of ethanol. Thus we posit that the effect of the tax increase on each of our outcome variables (injury deaths, crimes) is moderated

[3] There is approximately 5.76 ounces of ethanol in a gallon of beer, 16.51 ounces of ethanol in a gallon of wine. A standard drink of beer, wine, or spirits includes about 0.5 ounces of ethanol.

by the proportion of the outcome that is attributable to alcohol – and that that proportion is directly linked to per capita consumption in the state.

In what follows, variables can be subscripted by state s and by period t.

D_{ts} = death rate in state s during a specified period t (t=0 for baseline period; t=1 for period following tax increase)

Θ_s = fraction of deaths due to alcohol in baseline

1-k = fraction of alcohol-related deaths prevented by the 1991 tax increase

C_s = per capita ethanol consumption

Ceteris paribus,

$$D_{1s} = [k\,\theta_s + (1-\theta_s)]\,D_{0s}$$

$$\Delta D_s/D_{0s} = (-1+k)\,\theta_s$$

Now suppose there is a uniform proportional change p in the state death rates between the two periods due to factors other than the tax increase:

$$\Delta D_s/D_{0s} = p + (-1+k)\,\theta_s$$

Finally, we postulate state-specific random variation in the proportional change between the two periods that is additive:

$$\Delta D_s/D_{0s} = p + (-1+k)\,\theta_s + \varepsilon_s$$

We assume a linear relationship between θ and C:

$$\theta_s = a + b\,C_s$$

Substituting, we have

$$\Delta D_s/D_{0s} = p + (-1+k)(a + bC_s) + \varepsilon_s = p + a(-1+k) + (-1+k)b\,C_s + \varepsilon_s$$

Thus the proportional change in the outcome is linear in C, as follows:

(1) $\Delta D_s/D_{0s} = \alpha + \beta C_s + \varepsilon_s$ where $\alpha = p + a(-1 + k)]$ and $\beta = (-1 + k)\,b$

An estimate of β then quantifies the range of effects of the 1991 tax increase on the proportional change in the outcome variable (crime or death rate). In particular, we can estimate how much more the tax increase affected alcohol-related outcomes in, say, Wisconsin, than in a relatively dry state such as Utah. However, without an estimate of p, it is not possible to estimate the absolute effect of the tax increase (as opposed to the effect relative to other states). It is logically possible to estimate p from knowledge of the parameters a, b, and β (which then provides an estimate of k), all of which we will estimate. However, in what follows we do not attempt that estimate, but rather report the results of a more conservative approach that sets a lower bound on the magnitudes of the effects.

The model assumes that in the absence of the federal tax increase, the states would have followed the same relative trajectory from 1990 to 1992 with respect to outcome variables, so that $p_s = p$ for all states. If that assumption is not correct, and in particular if the trajectories are correlated with C, then the OLS estimate of equation (1) will produce a biased estimate of β. There is some evidence, discussed below, that that assumption is incorrect for some outcome variables. For that reason, we experiment with a "momentum" model that assumes that p_s is linearly related to the recent trend:

$$p_s = \gamma + \varphi\,(\Delta D_s/D_{0s})_{-1}$$

where the independent variable is the proportional change over a previous period (such as 1989 to 1990, or 1985 to 1990).

We then estimate the following equation:

$$(2) \qquad \Delta D_s/D_{0s} = \alpha' + \beta' C_s + \varphi\,(\Delta D_s/D_{0s})_{-1} + \varepsilon_s$$

5. The relationship between alcohol consumption and alcohol involvement in traffic fatalities

The explicit assumption for specifications 1 and 2 is that C is linearly related to the proportion of deaths or crimes that are alcohol-related. While there are some data on alcohol involvement in crime and injury (summarized in the previous section), a systematic state-by-state tabulation is lacking. Fortunately, more comprehensive data are available for traffic fatalities.

As it turns out, the relative importance of drinking in fatal accidents is indeed highly correlated with *per capita* alcohol consumption across states. To demonstrate this relationship, we use data from the Fatality Analysis Reporting System (FARS). FARS publishes data by state and by year on fatal crashes according to various characteristics. These compilations are based on administrative reports from state agencies. The year 1994 is the first one for which the data are reasonably complete, and we analyze data from that year and also from 2005 (which is generally considered of higher quality). Our measure of alcohol involvement is *Alc%,* the percentage of drivers killed in fatal crashes in which at least one of the drivers in the crash had blood alcohol content exceeding the legal limit of 0.08%.[4]

Per capita ethanol consumption data are from the National Institute of Alcohol Abuse and Alcoholism (NIAAA) and identified as "apparent consumption" by that agency. The data are based on alcohol sales measured (as part of the excise-tax collection system) as withdrawals from the distributors' warehouses. The unit of measurement for consumption is gallons of ethanol per year, *C*. Ethanol, the "active ingredient" of alcoholic beverages, is measured and taxed directly for spirits; for beer and wine, it can be estimated from market averages as 4.5% of

[4] In other models (not reported), we use the percentage of drivers *involved* in fatal crashes where alcohol was involved. The results are similar.

gallons of beer, and 12.9% of gallons of wine. In most states the assumption that sales are about equal to consumption is reasonably accurate.[5]

As shown in Figure 2, the cross-section scatterplot between the two variables appears to have a linear axis over the observed range, despite the fact that the dependent variable is bounded.

Figure 2 about here

For the two years that we consider (1994 and 2005), the slope coefficients are almost identical. The correlation coefficients are 0.56 in 1994 and 0.70 in 2005. Table 4 provides additional details.

Table 4 about here

While there is no guarantee that per capita consumption is also highly correlated across states with alcohol involvement in other types of injury deaths, or with crime, we believe that the "proxy" interpretation is plausible.

6. The effect of the 1991 tax increase on injury deaths and crime

Here we present and discuss the regression results using the specifications (1) and (2). In every case, the dependent variable is the percent change in the outcome variable between the year following the federal tax increase (1991) and the year preceding the tax increase (1990). The regressions are estimated from 47 states. Excluded are the District of Columbia, Nevada, and New Hampshire. For these jurisdictions a large proportion of sales are to non-residents in these jurisdictions, so that the sales figure is a poor representation of consumption (Cook 2007). We also exclude Alaska, due to problems with the crime data. The independent variable in all these regressions is the *per capita* ethanol consumption (C) for 1989. We did not use 1990 data since they would be affected by inventory adjustments in anticipation of the federal tax increase. The regressions are weighted by state population in 1990.

First results for injury deaths

Fatal injury data are drawn from the Web-Based Injury Statistics Query and Reporting System (WISQARS), compiled by the National Center for Health Statistics as part of the Vital Statistics program. We use non-age-adjusted crude death rates (CDRs), where the population data used to create the rates are available through WISQARS but originally drawn from the US Census Bureau. These rates are calculated per 100,000 state residents. Specifically, we use CDRs for motor-vehicle traffic deaths. Further information on these, and other variables used in the subsequent analysis, is presented in Tables 5 and 6.

Tables 5 and 6

The data columns of Table 7 report the regression estimates for model (1) on all injury, homicide, suicide, and traffic fatalities. The coefficients on 1989 ethanol consumption are negative in every case. The coefficients for all injuries and motor vehicle traffic fatalities are

[5] Wastage, inventory changes, interstate sales, and home production are among the sources of difference.

statistically significantly different from zero by the usual standards. Interestingly, the null result with respect to homicide is a recurrent finding in the literature (Durrance, et al.2011).

Table 7

The magnitudes of the point estimates are of interest. Combined with the 1989 values of C (per capita ethanol sales), they provide the basis for computing the relative effects of the tax increase across states. C ranges from 1.39 gallons in Utah, up to 3.07 in Wisconsin (Table A1), with a median of 2.42 gallons (Michigan). With respect to the reductions in "all injury" death rate, the difference between Utah and Michigan is -4.598 (2.42 –1.39) = - 4.7 %. Thus if we make the conservative assumption that the tax increase had *no* effect on outcomes in Utah, the 6% increase in alcohol prices induced by the federal tax increase resulted in a reduction of 4.7% in injury deaths for the median state. Under this assumption of zero effect in Utah, the elasticity of injury deaths with respect to alcohol prices is then -0.8 for the median, ranging up to -1.3 for Wisconsin.

Results for crime

We now consider the effect of the drinking on the effect of the alcohol tax increase on crime. Crime data are taken from the Uniform Crime Reports (UCR) compiled from crimes known to law enforcement agencies and submitted to the Federal Bureau of Investigation (FBI). These data are available from the Bureau of Justice Statistics.[6]Rates are calculated by using population data available from the Census and are per 100,000 people. We employ violent crime rates (murder and non-negligent manslaughter, aggravated assault, forcible rape, robbery) and property crime rates (burglary, larceny theft, motor vehicle theft). It should be noted that the "murder and non-negligent manslaughter" rates are similar but not identical to the "homicide" rates compiled by the NCHS Vital Statistics program; the two variables are compiled by different agencies from different sources.

Table 8

The regression estimates indicate that both violent and property crime were affected by an increase in the federal tax rates. As expected (see the discussion above), the effect on violent crime appears to be more sensitive to state "wetness" than is property crime. Within the category of violent crime, robbery, aggravated assault, and rape are the most sensitive, and once again murder appears largely immune (although the sign is negative). Within the category of property crime, the effect of the tax increase on burglary and motor vehicle theft rates are the most sensitive to state "wetness," although the coefficient for larceny is also statistically significant. Employing the same assumptions as before, the price elasticities for the median state are -1.3, violent crime and -0.7 (property crime).

[6]http://bjs.ojp.usdoj.gov/dataonline/Search/Crime/State/StateCrime.cfm

7. Alternative specifications

The findings from specification (1) could be biased if consumption in the baseline year (1989) is correlated with state trends in mortality and crime near the time of the 1991 tax increase. To test for this possibility we first conduct a simple graphical analysis of the data.[7] We divide the states into three groups according to per capita sales in 1989: "low" (the 10 states with sales of 2.0 gallons or less), "medium" (the 27 states with sales between 2.0 to 2.6 gallons), and "high" (the 10 states with sales above 2.6). Our theory predicts that the trajectory of the "high" states will drop in 1991 by more than the "medium," and the "medium" by more than the "low." Figure 6 depicts the relevant trends for traffic fatalities. Panel A demonstrates that the three groups of states differ widely in traffic safety. To adjust for those permanent differences, Panel B indexes all three groups to their level in 1990. What then becomes clear is that the post-tax trends are as predicted (with dryer states having a post-tax trajectory above the wetter states). This picture is not entirely reassuring, however, since pre-tax trends are somewhat different across the three groups, as is also clear from Panel B – although the difference is more constrained.

Figure 3

We made similar plots for the other outcomes. Of all the outcomes, robbery comes closest to having similar pre-tax trends for the three groups of states, as shown in Figure 7. Note that the robbery results confirm our basic results. Other outcomes follow somewhat different trends both pre- and post-tax.

Figure 4

One way to account for differences in pre-tax trends more systematically is to expand our basic regression specification to include a covariate that measures the previous trend in the outcome variable; in one specification check, the trend is measured as the change in the outcome variable between 1989 and 1990, and in a second check as the change in the outcome variable between 1985 and 1990.

Table 9 presents the results of these two related specification tests. The results using either covariate suggest little evidence of so-called momentum (or anti-momentum) effects. In fact, the coefficients on consumption in 1989 are little changed, even in those cases for which the trend measure is statistically significant. The one exception appears to be suicide, where inclusion of the pre-tax trends generates stronger, statistically significant results than our original model.

Table 9

Changes in state excise taxes and other concerns

While the 1991 tax increase occurred at the federal level, four of the 47 states in our analysis sample opted to change their own alcohol tax levels during the 1990-1991period. Table 10 reports these state tax changes (in cents per ounce of ethanol) and averages them using as weights the proportion of ethanol consumed (in 1990) for each type of beverage. The change in Colorado was trivial. When we drop the other three states from the analysis, we obtain the results presented in Tables 11 and 12. The results are quite similar to those of all 47 states.

[7] We are indebted to Jens Ludwig for suggesting this test.

Table 10, 11, and 12

We also conducted our analysis using two-year periods both pre- and post-change in tax. In other words, we estimated the effects of consumption per capita in 1989 on changes in mortality or crime rates for 1991-1992 relative to 1989-1990. The empirical results were quantitatively similar to those presented here. We chose ultimately to present the results using 1990-1991 data to avoid the handful of additional state tax changes that occurred in 1989 and 1992.

8. Conclusions

The federal increase in alcohol excise tax rates of 1991 provides a relatively high-powered intervention, exogenous to the individual states, that helps establish the causal effect of higher prices on alcohol abuse and a variety of costly consequences.

Our analysis offers several innovations:

- Establish that the state-level prevalence of DUI in fatal crashes is directly related to average ethanol consumption;
- Demonstrate that ethanol consumption levels moderate the effect of alcohol prices on the rates of injury fatality and crime;
- Develop and implement a statistical method for utilizing this heterogeneity to estimate the aggregate effects of a federal tax increase on rates of injury fatality and both property and violent crime.

The empirical findings provide consistent support for a conclusion that the alcohol-price elasticity for several outcomes is closely related to average alcohol consumption. For injury, we find strong and consistent results for the predicted gradient between consumption and the price elasticity of traffic fatalities and overall fatalities. Under the conservative consumption that the driest state (Utah) experienced no benefit from the tax increase, our national point estimate is that it reduced the number of injury deaths by 6,824, or 4.7%, in the first year (1991). For our crime categories, we find strong and consistent results for overall violent crime, aggravated assault, robbery, overall property crime, burglary, and motor-vehicle theft. The gradient relating drinking to price elasticity is about twice as steep for violent crime and for property crime.

Alcohol tax policy is a powerful tool for reducing alcohol-attributable deaths and crime. But in the two decades since this tax increase, Congress has not changed the nominal rates, with the result that the inflation-adjusted rates have been substantially eroded.

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Table 1.
Alcohol-attributable injury deaths, 2001

	Deaths[a]	**Alcohol-attributable deaths**[b]	**Percent alcohol-attributable**
Homicide	20,704	5,963	28.8
Suicide	30,622	5,638	18.4
Motor vehicle – traffic	42,443	10,674	25.1
All injury	**157,078**	**30,399**	**19.4**

[a]Source: http://webappa.cdc.gov/sasweb/ncipc/mortrate10_sy.html
[b]Source: Midanik et al. (2004)

Table 2.
Prevalence of alcohol use by offenders at the time of crime

	Surveys of prisoners[a]	**As reported by victims 1991 NCVS[b]**
Murder	44.6	
Rape	40.0	41.5
Robbery	37.4	16.4
Aggravated assault	45.1	36.1
Violent crime, total	**41.7**	**29.0**
Property crime, total	**34.5**	

[a]Source: 1997 Survey of Inmates in State Correctional Facilities, reported in Greenfield and Henneberg (2001) p. 25.
[b]Source: Bureau of Justice Statistics (1992), *Criminal Victimization in the United States, 1991* NCJ-139563. Table 42, p. 58. The statistics are the percent of victimizations for which the victim reported that the offender was under the influence of drugs or alcohol, less those that were under the influence of drugs.

Table 3.
Regression estimates:
effects of per capita ethanol sales and excise taxes on sales and injury deaths, 1981-2000

	Elasticity with respect to p.c. ethanol sales	Percentage change associated with tax increase (10 cents/oz)
Ethanol sales p.c.		-12[a]
Motor vehicle fatality rate	+0.92[a]	-7[c]
Fatality rate from falls	+0.96[a]	-9
Homicide rate	+0.51	+11
Suicide rate	+0.51[b]	-6

[a]p<.01; [b]p<.05; [c] p<.10
Source: Cook (2007) pp 104-5
Notes: Each entry is from a different regression. All regressions include fixed effects for state and year, and two covariates reflecting economic conditions.

Table 4.
Regression estimates:
effect of per capita ethanol consumption on alcohol involvement in fatal crashes

	1994	2005
Regression Coefficient (SE)	11.50 (2.51)	11.15 (1.68)
Intercept (SE)	9.80 (5.52)	6.43 (3.85)
Correlation coefficient	0.56	0.70

Note: Ordinary least squares regression results. N=48 (50 states excluding DC, NV, NH)

Table 5. Data sources

Variable	Definition	Source
Cons	Gallons of ethanol contained in alcoholic beverages sold in the state divided by population aged 14 and over, 1989, by state.	NIAAA, Per Capita Ethanol Consumption for States, Census Regions, and the US, 1970-2007. Original Source: Alcohol Epidemiologic Data System. LaVallee, R.A.; Williams, G.D.; and Yi, H. Surveillance Report #87: Apparent Per Capita Alcohol Consumption: National, State, and Regional Trends, 1970–2007. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism, Division of Epidemiology and Prevention Research (September 2009).
CDR	Crude death rate per 100,000 population, by state and year, for the years 1989-1992, for the following circumstances: All injury Homicide Suicide Motor vehicle traffic	Centers for Disease Control, WISQARS, Fatal Injury Data, Injury Mortality Reports, 1981-1998, drawn from death certificate data from the National Vital Statistics System.
Crime	Crime rate per 100,000 population, by state and year, for the years 1989-1992, including: Violent Crime Criminal homicide Rape Aggravated assault Robbery Property Crime Burglary Larceny Motor vehicle theft	FBI Uniform Crime Reports, obtained through Bureau of Justice Statistics.
Alcohol %	The percentage of drivers killed where alcohol was involved (BAC = 0.08+), by state, for 1994 and 2005.	Fatal Accident Reporting System, National Highway Traffic Safety Administration, Drivers Killed in Fatal Crashes, by State and Blood Alcohol Concentration of the Driver.

Table 6. Summary statistics for key variables

Variable	Median	Inter-decile range	Minimum	Maximum
Cons. (gals./cap) in 1989	2.38	(1.77, 2.84)	1.42 (UT)	2.96 (WI)
Alcohol Involvement in Fatal Crashes				
1994	34	(26, 45)	22 (UT)	49 (MT)
2005	31.5	(25.5, 39)	12 (UT)	43 (MT)
$(D_{1s}–D_{0s})/D_{0s}*100$ for mortality				
All injury	-2.4	(-7.5, 4.7)	-10.1 (ID)	7.2 (KS)
Homicide	6.2	(-8.7, 32.6)	-26.3 (ID)	48.9 (IA)
Suicide	-1.0	(-13.0, 9.2)	-35.8 (RI)	13.7 (ME)
Motor vehicle	-8.1	(-15.1, 1.6)	-27.7 (DE)	12.5 (WY)
$(D_{1s}–D_{0s})/D_{0s}*100$ for crime				
Violent Crime	4.4	(-7.8, 11.9)	-13.9 (HI)	19.1 (AL)
Criminal homicide	1.9	(-8.8, 9.6)	-22.9 (ME)	23.8 (KS)
Rape	3.7	(-6.3, 17.8)	-21.1 (GA)	25.1 (RI)
Aggravated assault	4.8	(-22.9, 21.0)	-50.0 (HI)	52.5 (AL)
Robbery	8.2	(-4.4, 20.3)	-14.3 (MT)	51.6 (SD)
Property Crime	2.1	(-4.2, 7.0)	-19.2 (MT)	9.6 (DE)
Burglary	1.6	(-6.5, 11.8)	-26.2 (MT)	17.6 (MO)
Larceny	1.5	(-2.3, 6.3)	-18.1 (MT)	11.0 (DE)
Motor vehicle theft	1.9	(-11.7, 8.9)	-30.5 (VT)	37.9 (MS)

Notes: Summary statistics are calculated for N= 47 states for 1989 ethanol consumption per capita and log changes in rates for mortality and crime. Summary statistics are reported for N=48 states for FARS reports of alcohol related traffic fatalities. State abbreviations identify the state that has the minimum or maximum change in crime or mortality rate for the period studied.

Table 7. Regression estimates:
effect of per capita ethanol sales on proportional change in death rates, 1990-1991

	Coefficient (SE)	Intercept (SE)
All injury	-4.598[a] (1.354)	9.041[a] (3.282)
Homicide	-5.685 (4.672)	19.040[c] (11.323)
Suicide	-3.842 (2.505)	7.539 (6.071)
Traffic	-5.036[b] (1.971)	3.795 (4.777)

Notes: Weighted least squares using state resident population. Regression results for N=47 states (excluding AK, NV, & NH).

Table 8.
Regression estimates:
effect of per capita ethanol sales on change in crime rates, 1990-1991

	Coefficient (SE)	Intercept (SE)
Violent Crime	-7.601 [a] (2.083)	22.415 [a] (5.048)
Aggravated Assault	-7.476 [a] (2.395)	20.292 [a] (5.805)
Rape	-6.352 [c] (3.518)	18.144 [b] (8.527)
Murder	-5.138 (5.362)	16.571 (12.997)
Robbery	-10.401 [a] (3.377)	32.875 [a] (8.185)
Property Crime	-4.049 [a] (1.376)	10.983 [a] (3.334)
Burglary	-5.919 [b] (2.435)	15.959 [a] (5.901)
Larceny	-3.331 [b] (1.302)	9.261 [a] (3.155)
Motor Vehicle	-5.649 [b] (2.784)	14.503 [b] (6.748)

[a]p < 1% ; [b] p < 5%; [c] p < 10%
Note: Weighted least squares using state resident population. Regression results for N=47 states (excluding AK, NV, & NH)

Table 9.
Specification Tests: Inclusion of State Pre-1990 Trend in Outcomes as Co-Variate

	Specification Test 1: Prior Change 1989-90			Specification Test 2: Prior Change, 1985-90		
	Per Cap. Sales (SE)	Prior Change (SE)	Intercept (SE)	Per Cap. Sales (SE)	Prior Change (SE)	Intercept (SE)
All Injury	-4.587 [a] (1.408)	0.005 (0.143)	9.021 [b] (3.372)	-4.863 [a] (1.528)	-0.033 (0.085)	9.623 [b] (3.635)
Homicide	-5.300 (4.616)	-0.217 (0.145)	19.717 [c] (11.181)	-4.991 (4.483)	-0.195 [b] (0.086)	20.009 [c] (10.850)
Suicide	-6.207 [a] (2.141)	-0.559 [a] (0.121)	14.000 [b] (5.230)	-5.206 [b] (2.571)	-0.127* (0.073)	10.905 [c] (6.241)
Traffic	-6.162 [a] (2.043)	-0.203 [c] (0.120)	5.923 (4.847)	-5.829 [b] (2.228)	-0.057 (0.073)	5.563 (5.313)
Violent Crime	-6.546 [a] (2.044)	0.310 [b] (0.136)	16.523 [a] (5.472)	-7.299 [a] (2.050)	0.086 (0.051)	19.072 [a] (5.336)
Aggravated Assault	-6.030 [b] (2.501)	0.200 (0.119)	14.635 [b] (6.614)	-7.611 [a] (2.362)	0.065 (0.043)	18.093 [a] (5.898)
Rape	-7.023 [c] (3.899)	-0.071 (0.171)	20.339 [b] (10.090)	-3.682 (4.325)	0.081 (0.077)	10.699 (11.044)
Murder	-5.375 (5.299)	-0.218 (0.150)	18.907 (12.937)	-5.867 (5.356)	-0.112 (0.088)	20.263 (13.228)
Robbery	-11.679 [a] (3.454)	0.175 (0.121)	34.215 [a] (8.143)	-10.316 [a] (3.408)	0.025 (0.048)	32.074 [a] (8.390)
Property Crime	-3.129 [b] (1.471)	0.203 (0.127)	8.648 [b] (3.592)	-4.519 [a] (1.494)	-0.041 (0.050)	12.509 [a] (3.825)
Burglary	-5.882 [b] (2.472)	0.027 (0.167)	15.940 [b] (5.967)	-6.673 [b] (2.606)	-0.052 (0.063)	17.581 [a] (6.234)
Larceny	-1.838 (1.425)	0.237 [b] (0.109)	5.410 (3.505)	-3.951 [b] (1.523)	-0.041 (0.051)	11.173 [a] (3.980)
Motor Vehicle	-5.570 [c] (2.828)	0.037 (0.134)	14.142 [b] (6.945)	-5.516 [c] (2.947)	-0.006 (0.037)	14.430 [b] (6.840)

[a] $p < 1\%$; [b] $p < 5\%$; [c] $p < 10\%$
Note**:** Weighted least squares using state resident population. N=47 states (excluding AK, NV, & NH).

Table 10. State Alcohol Tax Changes, 1990 and 1991

		Amt of Tax Increase (Cents/Oz Eth)			Proportion Consumption (1990)			Tax Change Index
State	**Year**	**Beer**	**Wine**	**Liquor**	**Beer**	**Wine**	**Liquor**	
California	1991	2.78	1.15	2.03	0.48	0.21	0.31	2.21
Colorado	1990		0.24			0.13		0.03
Delaware	1990	1.74	3.45	5.02	0.49	0.13	0.39	3.22
New Jersey	1990	1.22	0.12	2.19	0.45	0.19	0.37	1.37
FEDERAL	1991	5.03	5.45	1.56	0.55	0.14	0.31	4.00

Note: Year corresponds to the first full year of the effective tax increase. New Hampshire and District of Columbia also experienced tax changes during this period, but these observations were omitted from our study and therefore suppressed from this table.

Table 11. Regression estimates:
effect of per capita ethanol sales on proportional change in death rates , 1990-1991
(excluding states that raised excise taxes)

	Coefficient (SE)	Intercept (SE)
All injury	-4.671[a] (1.555)	9.237[b] (3.666)
Homicide	-7.985 (5.172)	24.108[c] (12.197)
Suicide	-4.205 (2.808)	8.431 (6.622)
Traffic	-5.080[b] (2.247)	3.866 (5.299)

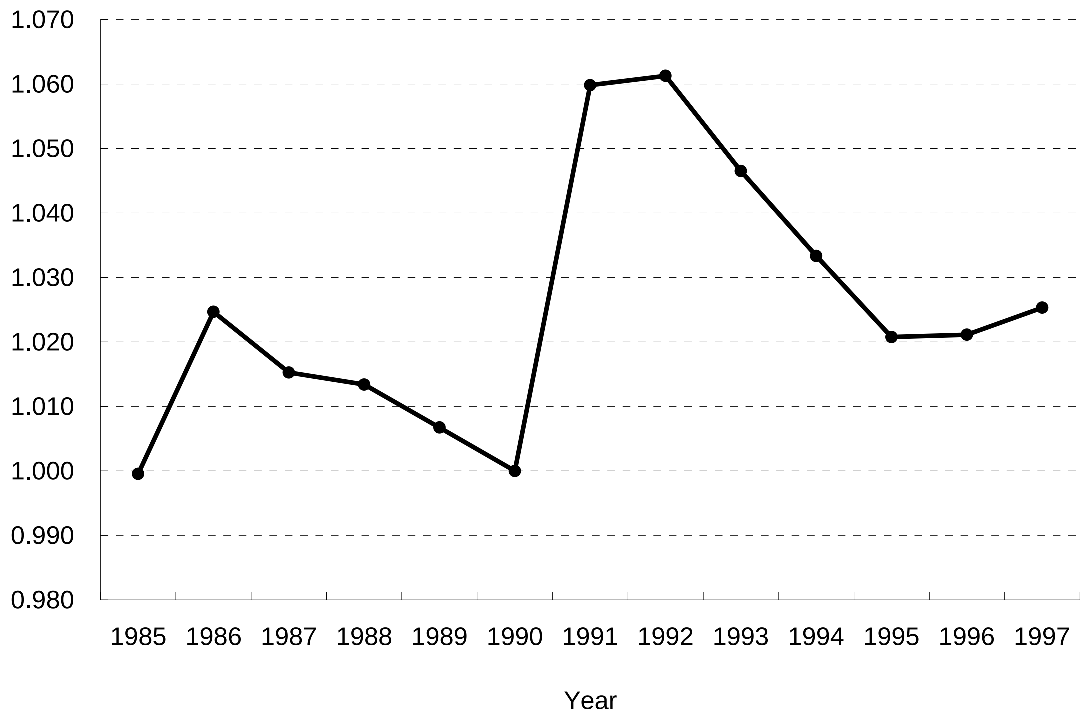
Notes: Weighted least squares using state resident population. Regression results for N=44 states (excluding AK, DC, NV, NH as well as CA, DE, and NJ whose state taxes changes significantly during the 1990-1991 period).

Table 12.
Regression estimates:
effect of per capita ethanol sales on change in crime rates, 1990-1991
(excluding states that raised excise taxes)

	Coefficient (SE)	Intercept (SE)
Violent Crime	-9.209 [a] (2.292)	25.878 [a] (5.406)
Aggravated Assault	-8.687 [a] (2.742)	22.875 [a] (6.466)
Rape	-5.423 (4.070)	16.256 [c] (9.597)
Murder	-7.067 (6.105)	20.798 (14.396)
Robbery	-13.324 [a] (3.626)	39.178 [a] (8.550)
Property Crime	-5.737 [a] (1.475)	14.547 [a] (3.479)
Burglary	-8.874 [a] (2.620)	22.193 [a] (6.178)
Larceny	-4.456 [a] (1.442)	11.638 [a] (3.401)
Motor Vehicle	-7.474 [b] (3.135)	18.348 [b] (7.393)

[a] $p < 1\%$; [b] $p < 5\%$; [c] $p < 10\%$
Note: Weighted least squares using state resident population. Regression results for N=44 states (excluding AK, DC, NV, NH as well as CA, DE, and NJ whose state taxes changes significantly during the 1990-1991 period).

Figure 1. Ratio of CPI-Alcohol to overall CPI (with 1990 value set to 1.0)



Source: Bureau of Labor Statistics

Figure 2.
Scatterplot: %Drivers killed in alcohol-related crashes vs. p.c. consumption

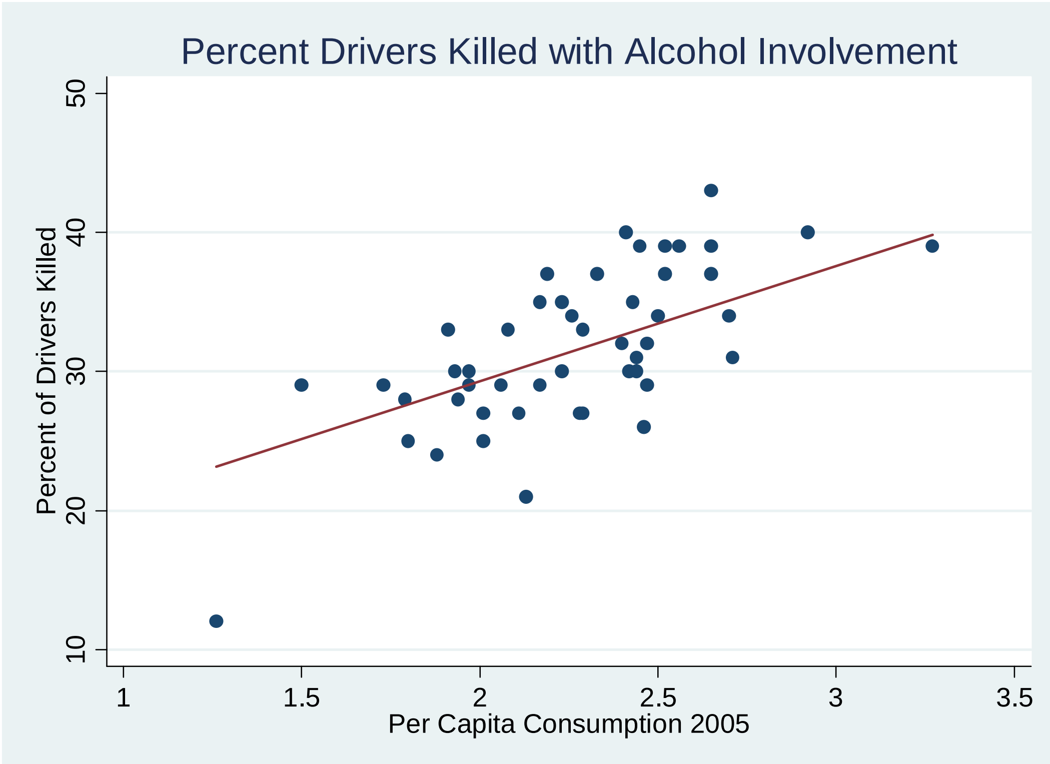
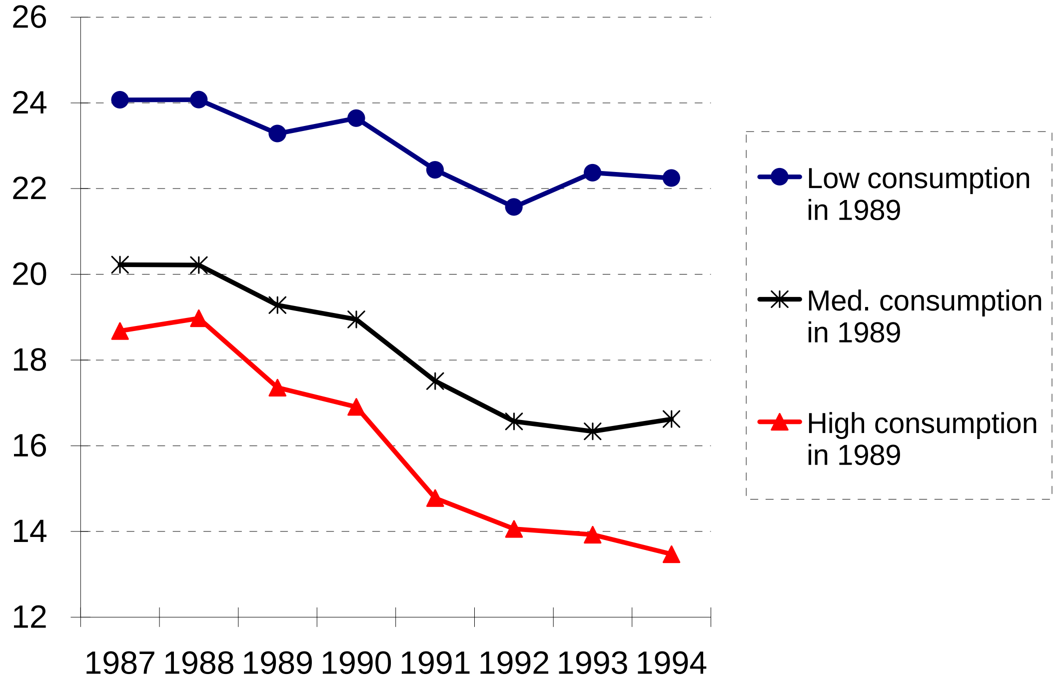


Figure 3. 8-year trend in traffic fatality rates for three groups of states

Panel A. Raw rates



Panel B. Rates (1990=100)

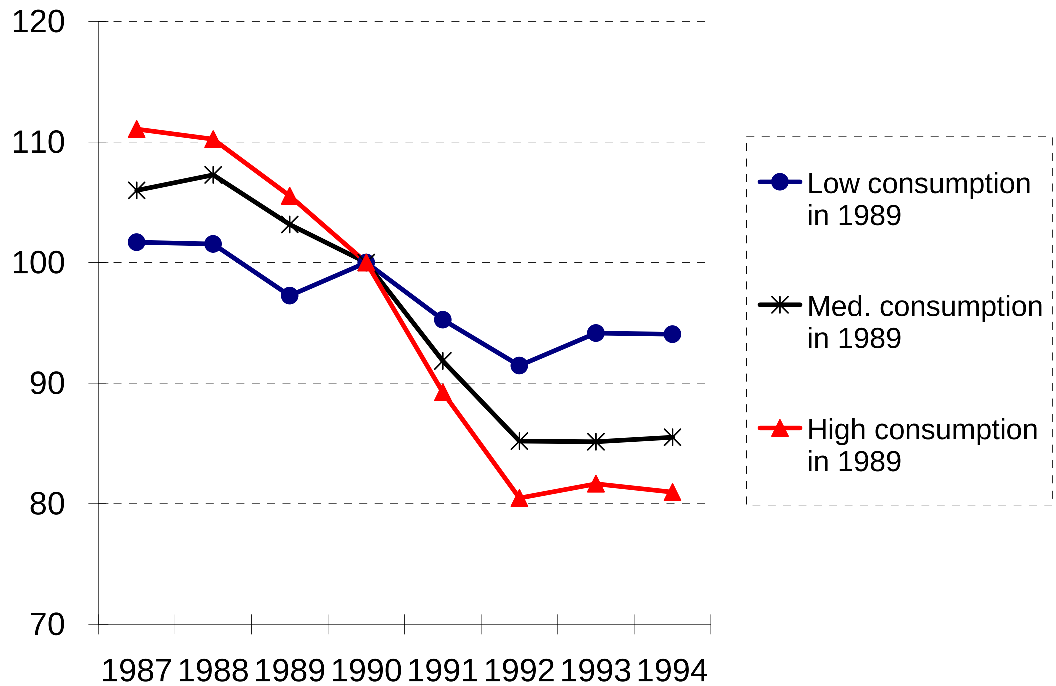
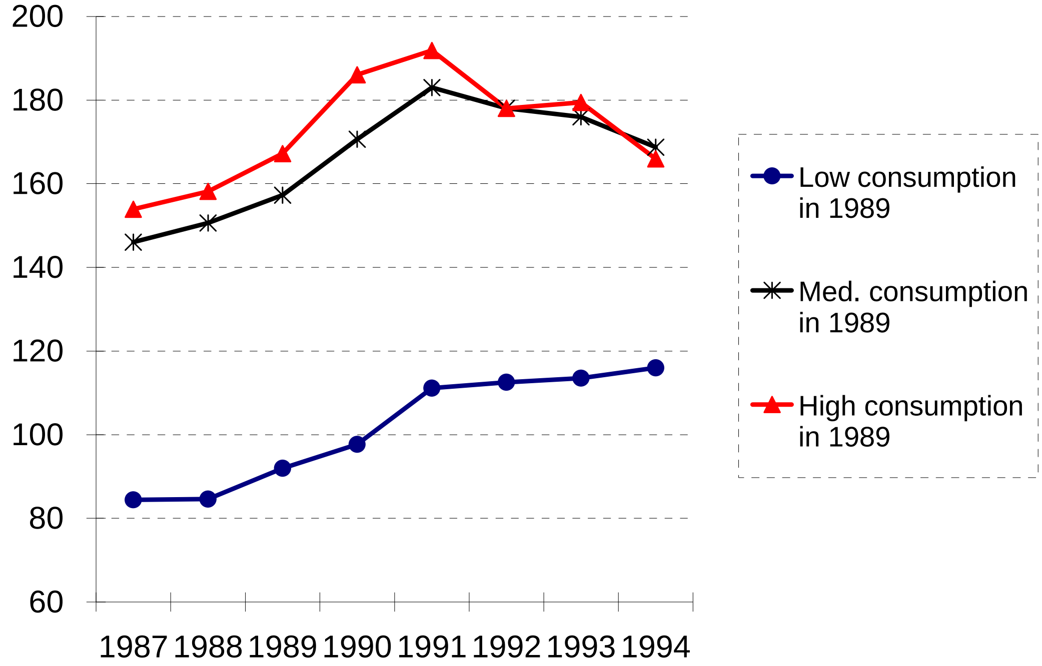


Figure 4. 8-year trend in robbery fatality rates for three groups of states

Panel A. Raw rates



Panel B. Rates (1990=100)

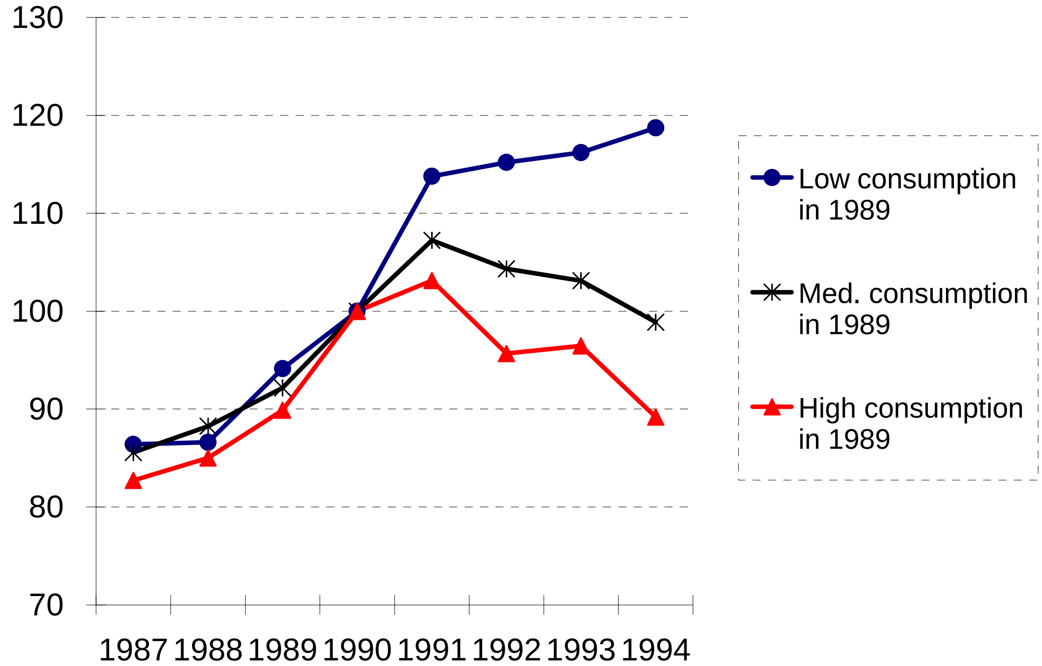


Table A1. "Extra" Reduction in injury deaths, 1991

State	Per capita consumption of ethanol in 1990	#deaths in 1990	% reduction in deaths caused by tax increase in comparison with Utah	Lives saved in 1991 in comparison with Utah
Utah	1.39	890	0.00	0.00
West Virginia	1.72	1,176	1.52	17.84
Kansas	1.79	1,328	1.84	24.42
Oklahoma	1.81	2,006	1.93	38.74
Kentucky	1.83	2,470	2.02	49.97
Arkansas	1.86	1,722	2.16	37.21
Alabama	1.92	3,347	2.44	81.56
Tennessee	1.96	3,504	2.62	91.83
Iowa	2.06	1,416	3.08	43.62
Mississippi	2.08	2,152	3.17	68.27
North Carolina	2.08	4,546	3.17	144.23
Indiana	2.09	3,120	3.22	100.42
Ohio	2.09	5,452	3.22	175.48
Pennsylvania	2.15	6,322	3.49	220.92
Virginia	2.18	3,527	3.63	128.12
Nebraska	2.25	842	3.95	33.30
Idaho	2.27	689	4.05	27.88
Missouri	2.30	3,326	4.18	139.17
New York	2.30	9,160	4.18	383.27
Georgia	2.31	4,597	4.23	194.46
Maine	2.34	584	4.37	25.51
South Dakota	2.34	439	4.37	19.18
Colorado	2.39	1,856	4.60	85.34
Michigan	2.42	5,329	4.74	252.38
Connecticut	2.46	1,399	4.92	68.83
Texas	2.47	11,042	4.97	548.33
Washington	2.49	2,802	5.06	141.72
Maryland	2.51	2,506	5.15	129.05
Oregon	2.51	1,716	5.15	88.37
Louisiana	2.54	3,230	5.29	170.79
Rhode Island	2.54	447	5.29	23.64
Minnesota	2.55	2,139	5.33	114.09
North Dakota	2.56	310	5.38	16.68
New Jersey	2.58	3,108	5.47	170.06
South Carolina	2.61	2,536	5.61	142.26
Illinois	2.62	6,461	5.66	365.40
Massachusetts	2.63	2,454	5.70	139.92
Wyoming	2.63	302	5.70	17.22
New Mexico	2.64	1,227	5.75	70.52

Montana	2.67	609	5.89	35.84
Arizona	2.77	2,627	6.35	166.69
California	2.78	17,634	6.39	1127.03
Vermont	2.80	284	6.48	18.41
Hawaii	2.84	488	6.67	32.54
Delaware	2.95	357	7.17	25.61
Florida	2.96	8,840	7.22	638.15
Wisconsin	3.07	2,461	7.72	190.10
Alaska	3.33	496	8.92	44.24
District of Columbia	4.14	651	12.64	82.32
New Hampshire	4.30	500	13.38	66.90
Nevada	4.78	950	15.59	148.08
Total excluding AK, DC, NV,NH		144,779		6,824