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Alcohol regulation and auto fatalities

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Abstract

We examine the relationship between motor-vehicle fatalities and alcohol taxes, prices, and various drinking laws. Estimates are based on data from 48 states over 9 years and consider total, youth, and alcohol-involved fatalities. None of the beer tax or price coefficients is significantly different from 0. The magnitudes of the estimated effects are much smaller than those reported in some previous studies. Seatbelt laws, the minimum legal drinking age, and dram-shop laws typically have statistically significant, negative relationships with fatalities. Other variables—including preliminary breath tests and various mandatory penalties for driving under the influence—are imprecisely estimated, sometimes have incorrect signs, and are usually not statistically significant.

Keywords: Alcohol; Auto fatalities; Drunk driving; Taxes

1. Introduction

Several research reports have concluded that raising alcohol taxes will result in a direct and significant reduction in automobile traffic fatalities. For example, the 1988 Surgeon General's Workshop suggests that, "[r]esearch evidence shows that an increase in the excise tax could have the largest long-term effect on alcohol-impaired driving of all policy and program options available" (U.S. Department of Health and Human Services, 1988). More

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recently, a *policy watch* report on alcohol and cigarette taxes by Grossman et al. (1993), states that:

> "If the federal excise tax on beer had been indexed to the rate of inflation since 1951, the lives of about 1,022 youths aged 18 to 20 who died in motor-vehicle accidents would have been saved in a typical year in the 1975–1981 period (Saffer & Grossman, 1987). Chaloupka et al. (1993) report that the beer tax policy would have had an even larger effect in the 1980s, saving about 1,660 lives [of 18- to 20-year-olds] per year in the 1982–88 period. The same policy would have prevented over 5,000 people of all ages from being killed annually in fatal motor crashes[1]."

The potential reduction in youth fatalities reported by Chaloupka et al. (1993) is based on an estimate that increasing beer taxes by 16 cents per six pack would reduce youth fatalities by almost 12%. Since alcohol is involved in only about one third of youth traffic fatalities, alcohol-involved fatalities would have to fall by 36%. This is an extraordinarily large response to a tax increase amounting to less than 6% of the retail price of beer.[2]

This study reexamines the relationship between motor-vehicle fatalities on the one hand, and taxes, prices, and a variety of laws governing alcohol on the other. We use the Chaloupka et al. (1993) study as a point of departure. We extend the time frame and correct for several statistical problems in the original research. We also examine the sensitivity of the results to various weighting schemes and functional forms. The findings lend little support for the claim that raising beer taxes will reduce highway fatality rates. As with some other recent research, we find small, negative and statistically insignificant relationships between taxes and total fatalities.

Because the tax-fatality linkage largely fails, we then examine whether a statistically meaningful relationship can be found between alcohol prices and auto fatalities. Because the hypothesized relationship is that higher taxes will result in higher prices that will, in turn, reduce abusive drinking and lead to fewer drunk-driving deaths, it seems plausible that where the tax-based models failed, price-based models might show a stronger set of results. Here again, however, the results fail to show a strong relationship between beer prices and fatalities. While they tend to carry negative signs, the coefficients on the price variables are not statistically significant at even the 0.10 level in any of the models.

Other variables, however, such as the legal drinking age, dram-shop laws, and seatbelt laws demonstrate much more consistent signs and significance levels throughout the analysis. We conclude with a discussion of directions for future research.

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[1] Similar statements have recently been published in other federally supported publications. See, for example, Chaloupka (1993). Other studies finding significant negative relationships between taxes and fatalities include Cook (1981) and Evans (1991).

[2] The average retail price of beer in the 1982–1990 period (in 1982–1984 dollars) was $2.80 per six-pack. See Table 1 and the data discussion below. Somewhat less dramatic, but still extraordinarily large, Ruhm (1996) concludes that raising the tax on beer by 1.5 cents per can (about 3% of the retail price) would result in a 7–8% reduction in total vehicle fatalities.

2. Methods

2.1. Functional forms

We estimate regression models that express fatality rates as functions of beer taxes or prices, as socioeconomic characteristics, and as a set of variables describing the legal environment. These models take the following form:

$$y_{it} = x_{it}\beta + w_{it}; \quad i = 1, 2, \ldots 48; \quad t = 1982, 1983, \ldots 1990, \tag{1}$$

where y_{it} is the (possibly transformed) fatality rate for state i in year t, x_{it} is the vector of right-hand side variables, β is a vector of coefficients to be estimated, and w_{it} is an unobserved disturbance term representing unmeasured factors affecting fatalities.

A common specification for the dependent variable employs the logistic transformation of the death rates. That is, if r_{it} is the fatality rate (i.e., deaths divided by population), then the dependent variable in the regression is defined by

$$y_{it} = \ln \frac{r_{it}}{1 - r_{it}} \quad \text{(Logistic Model)}$$

where ln is the natural logarithm function. An advantage of the logistic form is that it restricts predicted fatality rates to their natural range: 0–1. However, this study's measures of the fatality rates also include 0s for some states in some years. There is nothing untoward about these 0s in and of themselves; they simply indicate that there were no fatalities of a particular type in a particular state in a particular year. (For example, in North Dakota in 1982, no 18–20-year-old dead drivers were tested for alcohol.) Unfortunately, the logistic transformation cannot be applied when the fatality rate is 0, because the natural logarithm of 0 is minus infinity. Thus, this dependent variable cannot be computed for some of the observations.

This study has adopted two approaches to this problem. One is simply to assume that at least one person of each type died in each state-year. When the data are adjusted accordingly, the death rates are always >0 and the logistic transformation can be computed. As an alternative, this study also estimates regression models in which the dependent variable is simply the fatality rate, rather than its logistic transformation. The regressions using untransformed fatality rates are referred to as linear models.

$$y_{it} = r_{it} \quad \text{(Linear Model)}$$

The linear models also provide a check on whether estimated results depend on the somewhat arbitrary assumptions about functional form.[3]

The use of two functional forms somewhat complicates the interpretation of the results

[3] The linear model has the potential disadvantage that predicted values could fall outside the 0–1 range, but, in fact, this never occurs in the first-stage regressions (see the discussion of weighting below). Because the outcomes of interest (fatalities) are actually count data, still another approach would be to estimate a Poisson model.

since the exact meanings of the coefficients differ. In the *linear* models, the coefficient on the beer tax or price is the estimate of the *absolute* change in fatalities per 1,000 population from a \$1 increase in the tax. For example, a coefficient of −0.1 would indicate that a \$1 increase in the tax on a case of beer would reduce fatalities 0.1 per 1000, or about 1 per 10,000 people.

In the *logistic* models, the coefficient on the beer tax indicates the approximate *proportional* change in fatalities from a \$1 increase in the tax. For example, a coefficient of −0.1 would imply that fatalities would be reduced by approximately 10% if the tax were increased by \$1 per case. This approximation, while very useful in most instances, is less useful if the coefficient exceeds about 0.2 in absolute value.[4]

2.2. Weighting

The linear and logistic forms imply that some observations are more reliable (have smaller variances) than others. Let p_{it} be the population of a state in a particular year, and $r*_{it}$ be the probability of dying in a motor-vehicle accident. Then the variances of the disturbances for the two functional forms are given by the following[5]:

$$\text{(Logistic)} \quad \mathrm{Var}(w_{it}) = \frac{1}{p_{it}[r*_{it}(1 - r*_{it})]},$$

and

$$\text{(Linear)} \quad \mathrm{Var}(w_{it}) = \frac{[r*_{it}(1 - r*_{it})]}{p_{it}}.$$

Efficient estimation procedures weight the observations *inversely* with the variances given immediately above. Thus, both functional forms weight the data from more populous states more heavily than the data from less populous states. The two functional forms differ, however, in how the probability of a fatality affects the weighting. In the logistic model, state-years with higher probabilities receive more weight, while in the linear model state-years with higher probabilities receive less weight.[6] In practice, the differences in population levels across states are the dominant influences on the weights.

Operationally, the models are first estimated using just population for the weights, and then the predicted values for fatality rates from these first-round estimates, say, are used to construct the weights defined above. These constructed weights are used in computing the second-round estimates reported in this article.[7]

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[4] A closer approximation can be obtained for large negative coefficients: The percent change approximately equals (exp{b} − 1)*100 where b is the coefficient and exp denotes exponentiation. For example, if b = −0.2, the approximate reduction is 18%.

[5] See William H. Greene (1990), Chapter 14 and especially Section 3.1b of Chapter 20.

[6] Actually, the weights are symmetric about a fatality rate of 0.5, but because all the fatality rates are very close to 0, the text statement is true within the range of the data.

[7] Amemiya (1981), pp. 1498–1501. Greene (1990) also recommends this procedure.

2.3. State-specific effects

We assume that there may be unmeasured factors affecting fatalities that are unique to each state but that are constant over time within states. Examples might be the percentages of driving that are done on various types of roads such as mountainous, curving, two-lane, or gravel roads, or the percentage of driving that is done during daylight hours. Effects of this type are easily incorporated into models that utilize pooled time-series cross-section data.

The disturbance term for a model with state-specific effects, α_i, i = 1,2, . . . 48, may be written as

$$w_{it} = \alpha_i + \epsilon_{it}.$$

Thus, the α's represent factors that are unmeasured (i.e., not in x) and are constant over time, although they vary across states. Operationally, the state-specific effects are accounted for by including one dummy variable for each of the states.

In summary, we estimate the relationships between motor-vehicle fatality rates and beer taxes, prices, and other explanatory variables using data across states and over time in the 1980s. Our specification is very similar to that of Chaloupka et al. (1993) and several other studies, with the following differences: 1) we estimate state-specific fixed effects, while several other studies use ordinary least squares; 2) we estimate both logistic and linear functional forms—in part because the logistic form cannot be computed for some observations and, in part, to determine whether the estimates are robust to functional form; and 3) we employ technically superior weights computed from the fitted values of first-stage regressions.[8]

2.4. Control variables

This study employs a large number of socioeconomic and legal variables in addition to beer prices and taxes.[9] There are two reasons to include many "control" variables. First, estimators of the tax and/or price coefficients may be biased if adequate controls are not included. For example, if states with high taxes on alcohol are also states with populations that eschew alcohol in the first place, then the deterrent effect of taxes will be overestimated. A similar bias occurs if states that have increased taxes also have implemented other policies that deter drunken driving, but these other policies are not accounted for in the model specification. On the other hand, the effectiveness of taxes may be understated if states levy high taxes in response to unmeasured factors that result in high fatalities. These kinds of biases are minimized by including a large number of control variables.[10] The second reason for including measures of other policies toward drunken driving is because they are of interest themselves. Although this article focuses primarily on taxes

[8] Our specification is also very close to Ruhm (1996) whose data cover the 1982–88 period.

[9] The variable list is nearly identical to the "limited specification" of Chaloupka et al. (1993) to make comparisons of our findings easy. However, we were not able to fully reproduce the results of Chaloupka et al. (1993). See our companion piece (Young & Likens, 1994). Details of sources are provided in the Appendix.

[10] Of course, the number of control variables is limited by the number of degrees of freedom available, and including too many controls can result in intractable multicollinearity problems. A still better approach would be to treat the laws as endogenous in a simultaneous equations framework, if such a model could be identified.

and prices, the drinking age, breath tests, fines for driving under the influence (DUI), and other policies are also examined.

2.5. Data

Table 1 provides descriptive statistics on the variables used in this study.[11] The first four lines refer to the fatality rates. The first of these, *DALLPOP*, is the total number of motor-vehicle fatalities per 1,000 population. The national average of slightly less than 2 fatalities per 10,000 people displayed little trend over the sample period, but there is considerable variation across state-years.

The next variable, *DDALCPOP*, is the number of "alcohol-involved" driver deaths per 1,000 population. Alcohol involvement is estimated in the following way.[12] For each state and year, the following totals are counted: dead drivers; dead drivers who were tested and for whom the result of a blood alcohol content (BAC) result is known; and dead drivers tested whose BAC is ≥0.05%. (Only a fraction of dead drivers are tested, and this fraction varies from state to state, especially in the early years of the study.) The number of dead drivers in alcohol-involved accidents is then computed as the fraction of tested drivers with BACs≥0.05% times the total number of dead drivers. For example, if 1,000 drivers died, 500 were tested, and 300 of those tested had BACs of at least 0.05%, then the estimated number of dead drivers in alcohol-involved accidents would be 600 (=1,000*300/500).

This method for estimating alcohol involvement may be biased. Particularly in the early years of the study, testing was neither random nor complete. Tests were probably more likely to be performed on drivers whom the police suspected were, in fact, drunk. For example, alcohol odor or the presence of alcoholic beverage containers may well have triggered testing. If this is the case, our estimates of alcohol involvement are likely to be biased upward. But no clearly superior alternative exists.

The remaining fatality rates in Table 1 refer to the 18–20-year-old population. *DALL1820* is the total number of motor-vehicle fatalities for drivers aged 18–20 divided by the number of persons in the population aged 18–20. *DDALC18* is the corresponding fatality rate based on estimated alcohol involvement. Fatality rates for this age group are more than twice those of the general population, and a number of policies have been specifically aimed at reducing teenage fatalities.

The first variable in Table 1 after the fatality rates is *RTAXB*, the beer tax calculated by summing federal and state excise taxes. The tax is measured in dollars of 1982–1984 purchasing power per *case* of 24 12-ounce cans.[13] The price of beer, *RPRICEB*, is measured

[11] The means are weighted by total population, except that the youth fatality rates are weighted by the population aged 18–20. There are 432 observations (48 states times 9 years: 1982–1990), except that price data were only available for 397 state-years.

[12] This is the method used by Chaloupka et al. (1993).

[13] Dollars of 1982–1984 purchasing power are the basis for the Consumer Price Index of the U.S. Bureau of Labor Statistics. To convert to current (1998) dollars, multiply by about 1.65 to account for inflation since the 1982–1984 period.

Table 1
Variable definitions and descriptive statistics[a]

Variable	Definition	Mean	SD	Min	Max
DALLPOP	Total motor vehicle fatalities per 1,000 population	0.19	0.05	0.08	0.43
DDALCPOP	Estimated alcohol-involved driver deaths per 1,000 population	0.06	0.02	0.02	0.18
DALL1820	Total motor vehicle fatalities of 18–20-year-olds per 1,000 population aged 18–20	0.44	0.12	0.20	1.13
DDALC18	Estimated alcohol-involved deaths of 18–20 year old drivers per 1,000 population aged 18–20	0.15	0.06	0.00	0.52
RTAXB	Sum of federal and state excise taxes on beer, in 1882–1984 dollars per 24 can case, divided by state cost of living index	1.01	0.47	0.49	3.24
RPRICEB	Retail price of beer, in 1982–1984 dollars per six-pack, divided by state cost of living index.				
REALINC	*Per capita* personal income in thousands of 1982–1984 dollars, divided by state cost of living index	13.21	1.33	8.85	16.16
SPEED65	Percentage of vehicles exceeding 65 MPH in 55-MPH zones	10.48	3.65	2.70	27.30
VMTLIC	Vehicle miles traveled in thousands per licensed driver	11.70	1.61	7.75	17.50
PLIC25	Percent of licensed drivers under age 25	17.70	2.36	7.60	28.20
SEATBELT	Dummy variable equals 1 if mandatory seatbelt use law	0.46	0.49	0.00	1.00
UNEM	Unemployment rate	7.06	2.32	2.20	18.00
PCTDRY	Percent of population residing in dry counties	4.78	9.02	0.00	45.97
PMOR	Mormon population as percent of total	1.21	5.44	0.10	65.82
PSBA	Southern Baptist population as percent of total	6.80	9.15	0.00	30.36
PCAT	Catholic population as percent of total	21.00	12.60	1.64	63.81
PPRO	Other Protestant population as percent of total	20.17	8.29	1.46	46.14
DRINKAGE	Minimum legal age for purchase and consumption of beer $>3.2\%$	20.57	0.89	18.00	21.00
BREATH	Dummy variable equals 1 if police are authorized to administer a preliminary breath test	0.43	0.39	0.00	1.00
DRAMSHOP	Dummy variable equals 1 if state law permits lawsuits against servers of alcohol	0.81	0.39	0.00	1.00
ADMINPS	Dummy variable equals 1 if state requires administrative driver's license suspension or revocation after first arrest for DUI	0.18	0.39	0.00	1.00
ADMINPEN	Mandatory minimum administrative driver's license action, days	14.33	51.00	0.00	365.00
DUIFINE	Dummy variable equals 1 if a fine is required on first conviction for DUI	0.35	0.48	0.00	1.00
RDUIFINE	Mandatory minimum fine upon first conviction for DUI, in 1982–1984 dollars	91.75	135.90	0.00	721.85
DUILIC	Dummy variable equals 1 if state requires license suspension or revocation upon first conviction for DUI	0.32	0.47	0.00	1.00
DUILICD	Mandatory minimum license suspension or revocation upon first conviction for DUI, days	30.50	74.30	0.00	365.00

[a] Sample consists of the 48 contiguous United States from 1982 through 1990 (432 observations), except that the price of beer (*RPRICEB*) is missing for 35 cases. Sample means are weighted by population in each state-year, except for youth fatality rates, which are weighted by the youth (ages 18–20) population. See text and Appendix for details, SD, standard deviation.

in 1982–1984 dollars per *six-pack*.[14] Both the tax and price variables are divided by a cost-of-living index that is specific to each state (McMahon et al., 1991). Thus, the beer tax and price variables are each expressed relative to the overall cost of living in each state and year.

The price data are from surveys of a wide variety of consumer items conducted by the American Chamber of Commerce Research Association (ACCRA). The correlation between the tax and price variables is 0.40.[15] Consequently, the tax variable and the price variable convey somewhat different information about the prices people actually pay. Taxes may not be a good indicator of actual transaction prices, because they represent $<$10% of price; thus, variations in other factors that affect price could “swamp” variations due to taxes. On the other hand, the ACCRA data are also imperfect measures of price. While the price data consistently refer to a particular brand and size across states and over time, and the establishments from which prices are gathered are (mostly) constant over time within states, there is considerable variation in the types of establishments sampled across states.

The control variables include real *per capita* income, the percentage of vehicles that exceed 65 miles per hour (MPH) in 55-MPH zones, vehicle miles traveled per licensed driver, the percentage of licensed drivers under age 25, a dummy variable for mandatory seatbelt usage, the unemployment rate, the percentage of population residing in “dry” counties, and the percentages of the population who are, respectively, Mormon, Southern Baptist, Catholic, and other Protestant.

Other policies are aimed particularly at drinking and driving. These include the minimum legal drinking age for beer, a dummy variable indicating that police can administer preliminary breath tests, and a dummy variable if servers of alcohol can be sued for damages resulting from motor-vehicle accidents (a “dram-shop” law). Three legal penalties for driving and drinking are represented by pairs of variables. The first variable is a dummy for the existence of a mandatory minimum penalty, and the second variable indicates the magnitude of the penalty, if it exists. Pairs are defined for mandatory administrative license suspension or revocation after first arrest for DUI and for mandatory fines and license suspension upon a first conviction for DUI.

3. Results

Tables 2 report coefficient estimates from a full specification that includes all of the explanatory variables, including dummies for each state and year. The left-hand portion of each table reports estimates from the logistic functional form, while the right-hand portion pertains to the linear model. Separate estimates using both beer tax and price data are

[14] The brand is Budweiser or Miller Lite, and the size is a six-pack of 12-ounce bottles.

[15] A regression of the price variable (in dollars per six-pack) on the tax variable (in dollars per case) and state and year dummies yields a tax coefficient of 0.305 with a standard error of 0.12. Thus, the null hypothesis that the tax is fully passed on to consumers cannot be rejected. The R^2

[15] is 0.82.

Table 2
Total fatalities[a]

Independent variable	Logistic				Linear			
Real beer tax	−0.030	(0.8)			−0.0053	(0.6)		
Real beer price			−0.011	(0.6)			−0.0018	(0.5)
Real income	0.065**	(7.4)	0.068**	(7.6)	0.0129**	(7.1)	0.013**	(6.9)
Speed over 65 MPH (%)	0.002	(1.7)	0.002	(1.7)	0.0004	(1.7)	0.0004	(1.7)
Vehicle miles traveled per driver	0.021**	(3.6)	0.021**	(3.5)	0.0043**	(3.5)	0.0043**	(3.3)
Young drivers (%)	−0.002	(0.8)	−0.002	(0.6)	−0.0004	(0.6)	−0.0003	(0.3)
Seatbelt law	−0.044**	(4.1)	−0.047**	(4.2)	−0.0095**	(4.5)	−0.0099**	(4.5)
Unemployment rate	−0.029**	(9.0)	−0.028**	(8.5)	−0.0055**	(8.4)	−0.0054**	(8.0)
Dry state (%)	0.562**	(2.6)	0.582**	(2.7)	0.1090**	(2.6)	0.1117**	(2.7)
Mormon	0.002	(0.1)	0.002	(0.2)	−0.007	(0.2)	−0.0006	(0.2)
Southern Baptist	0.017	(1.6)	0.019*	(1.8)	0.0056*	(2.4)	0.0055*	(2.4)
Catholic	0.013*	(1.8)	0.015**	(2.1)	0.0020	(1.5)	0.0027	(1.9)
Other Protestant	0.008*	(1.8)	0.006	(1.4)	0.0022*	(2.3)	0.0018	(1.8)
Legal drinking age	−0.005	(0.9)	−0.006	(1.3)	−0.0006	(0.7)	−0.0007	(0.8)
Preliminary breath test	−0.006	(1.3)	−0.002	(0.1)	0.0004	(0.2)	0.0003	(0.1)
Dram Shop	−0.22	(1.6)	−0.018	(1.3)	−0.0047	(1.6)	−0.0040	(1.3)
Administrative *per se*	0.0004	(0.0)	−0.0004	(0.0)	0.0000	(0.0)	−0.0003	(0.1)
Minimum administrative penalty	−0.0001	(0.6)	−0.0000	(0.6)	−0.00001	(0.6)	−0.00001	(0.6)
DUI fine	0.15	(0.7)	0.014	(0.6)	0.0016	(0.4)	0.0014	(0.3)
Real minimum DUI fine	−0.0000	(0.0)	−0.0000	(0.0)	0.0000	(0.5)	0.0000	(0.5)
DUI license action	−0.0006	(0.0)	−0.002	(0.1)	−0.0011	(0.4)	−0.001	(0.4)
Minimum license action	−0.0001	(0.5)	−0.0000	(0.5)	0.0000	(0.4)	0.0000	(0.4)
R^2	0.97		0.97		0.96		0.96	

* 5% significance level. ** 1% significance level.

[a] Absolute values of *t*-ratios are indicated in parentheses. Each equation also includes a constant term and dummy variables for each year, 1982–1989, and for each state.

reported in each table. Thus, the first column of estimates is for the logistic model using the beer tax, the second column reports estimates of the logistic model with the price variable in place of the beer tax, and the last two columns use the beer tax and price, respectively, in the linear model.

3.1. Beer taxes and prices

Five of the eight beer tax coefficients are negative, and three are positive. None are significantly different from 0 at even the 10% level. The price variable is negative in all specifications, but it too is never significantly different from 0.

The magnitudes of the estimated coefficients are also smaller than those reported in some previous studies. For example, the point estimate from the logistic form for total fatalities implies that increasing the beer tax by 16 cents per six-pack would reduce fatalities by about 2%. The logistic equation using the price variable implies that if the tax were fully passed on to consumers, total fatalities would decline $<$0.2 of 1%. Among youth, the logistic

Table 3
Alcohol-involved driver fatalities[a]

Independent variable	Logistic				Linear			
Real beer tax	0.031	(0.4)			0.0018	(0.3)		
Real beer price			−0.061	(1.3)			−0.0024	(0.9)
Real income	0.047*	(2.1)	0.047*	(2.1)	0.0045**	(3.2)	0.0044**	(2.9)
Speed over 65 MPH (%)	0.002	(0.8)	0.004	(1.1)	0.0003	(1.4)	0.0003	(1.5)
Vehicle miles traveled per driver	0.036*	(2.5)	0.041**	(2.7)	0.0010	(1.1)	0.0013	(1.2)
Young drivers (%)	0.002	(0.3)	0.003	(0.4)	0.0004	(0.7)	0.0005	(0.9)
Seatbelt law	−0.142**	(5.3)	−0.148**	(5.3)	−0.0059**	(3.7)	−0.0062**	(3.6)
Unemployment rate	−0.032**	(4.2)	−0.31**	(3.9)	−0.0021**	(4.0)	−0.0021**	(3.8)
Dry state (%)	−0.257	(0.5)	−0.326	(0.6)	−0.101	(0.3)	−0.0079	(0.2)
Mormon	−0.0023	(0.6)	0.025	(0.6)	0.0002	(0.1)	0.0003	(0.2)
Southern Baptist	−0.001	(0.0)	0.010	(0.4)	0.0042*	(2.2)	0.0045*	(2.4)
Catholic	−0.011	(0.7)	−0.007	(0.4)	−0.0007	(0.7)	−0.0006	(0.5)
Other Protestant	0.010	(1.0)	0.008	(0.8)	0.0004	(0.5)	0.0003	(0.3)
Legal drinking age	−0.026*	(2.4)	−0.029**	(2.6)	−0.0018*	(2.5)	−0.0019*	(2.4)
Preliminary breath test	−0.019	(0.5)	−0.018	(0.5)	−0.0016	(0.7)	−0.0015	(0.7)
Dram shop	−0.120**	(3.6)	−0.117**	(3.5)	−0.0098**	(4.0)	−0.0096**	(3.7)
Administrative *per se*	0.020	(0.7)	0.013	(0.5)	0.0027	(1.5)	0.0024	(1.3)
Minimum administrative penalty	−0.000	(1.4)	−0.0003	(1.4)	−0.00002	(1.4)	−0.00002	(1.4)
DUI fine	0.185**	(3.6)	0.181**	(3.5)	0.0051	(1.6)	0.0053	(1.5)
Real minimum DUI fine	−0.0005*	(2.2)	−0.0005*	(2.3)	−0.00001	(0.7)	−0.00001	(0.7)
DUI License Action	−0.005	(0.2)	0.002	(0.1)	−0.0006	(0.3)	−0.0003	(0.1)
Minimum license action	0.002	(1.7)	0.0002	(1.5)	0.00001	(1.6)	0.00001	(1.3)
R^2	0.91		0.91		0.90		0.89	

[a] See Table 2 footnote for explanation of symbols.

estimate for the beer tax implies a reduction in fatalities of about of 0.5 of 1%, and the logistic estimate from the price equation implies a reduction of <0.3 of 1%. Of course, the lack of large standard errors of these estimates implies that little confidence can be placed in the precise predictions. Results from the linear functional forms are very similar.

3.2. Control variables

Real income is positively and significantly related to fatalities, except for alcohol-involved youth fatalities. The percentage of highway drivers who are speeding is positively related to fatalities but is significant at the 10% level in the total fatality equation. Somewhat more strongly, vehicle miles traveled per licensed driver is positive in all specifications and is significant at the 10% level or better in more than half. The percentage of drivers who are under age 25 displays an inconsistent relationship with fatalities, with half of the coefficients unexpectedly negative. None are significant at even the 10% level.

A mandatory seatbelt law is negative and significant in all specifications. The unemployment rate is negative in all cases and is significant except for alcohol-involved youth. The percentage of the population living in dry counties is positive and is significant for total fatalities. One explanation would be that people drive further to drink, resulting in more

Table 4
Total fatalities, ages 18–20[a]

Independent variable	Logistic				Linear			
Real beer tax	−0.009	(0.1)			0.0154	(0.4)		
Real beer price			−.017	(0.4)			−0.106	(0.6)
Real income	0.056**	(2.9)	0.058**	(2.9)	0.0209*	(2.4)	0.0214*	(2.4)
Speed over 65 MPH (%)	0.002	(0.8)	0.003	(0.9)	0.0010	(0.9)	0.0012	(1.0)
Vehicle miles traveled per driver	0.024	(1.9)	0.025	(1.9)	0.106	(1.7)	0.0118	(1.8)
Young drivers (%)	−0.005	(0.8)	−0.004	(0.7)	−0.0021	(0.7)	−0.0015	(0.5)
Seatbelt law	−0.049*	(2.0)	−0.061*	(2.4)	−0.0235*	(2.3)	−0.0284**	(2.7)
Unemployment rate	−0.026**	(3.6)	−0.024**	(3.2)	−0.0115**	(3.6)	−0.0105**	(3.2)
Dry state (%)	0.036	(0.1)	0.000	(0.0)	0.0819	(0.4)	0.0585	(0.3)
Mormon	−0.030	(1.0)	−0.029	(1.0)	−0.0136	(1.0)	−0.0132	(1.0)
Southern Baptist	−0.018	(0.8)	−0.015	(0.5)	−0.0030	(0.3)	−0.0010	(0.1)
Catholic	0.027	(1.8)	−0.031	(1.9)	−0.0089	(1.4)	−0.0016	(1.6)
Other Protestant	0.003	(0.3)	−0.000	(0.0)	−0.0031	(0.7)	−0.0015	(0.3)
Legal drinking age	−0.024*	(2.4)	−0.025*	(2.5)	−0.0085	(1.9)	−0.0095	(2.1)
Preliminary breath test	0.038	(1.2)	0.035	(1.1)	0.0152	(1.1)	0.0133	(1.0)
Dram shop	−0.001	(0.0)	−0.001	(0.0)	−0.0000	(0.0)	−0.0002	(0.0)
Administrative *per se*	−0.041	(1.6)	−0.042	(1.7)	−0.0213	(1.9)	−0.0237*	(2.1)
Minimum administrative penalty	0.0002	(1.1)	0.0002	(1.1)	0.0001	(1.1)	0.0001	(1.1)
DUI fine	−0.023	(0.5)	−0.028	(0.6)	−0.0118	(0.6)	−0.0143	(0.7)
Real minimum DUI fine	0.0002	(1.1)	0.0002	(1.2)	0.0001	(1.4)	0.0001	(1.5)
DUI license action	−0.035	(1.3)	−0.033	(1.2)	−0.0216	(1.8)	−0.0186	(1.5)
Minimum license action	−0.001	(0.4)	−0.001	(0.4)	−0.0000	(0.6)	−0.0000	(0.6)
R^2	0.84		0.84		0.85		0.85	

[a] See Table 2 footnote for explanation of symbols.

fatalities (Giacopassi & Winn, 1995). But the coefficients are negative in some other specifications. None of the religion variables displays a consistent, significant relationship with fatalities.

3.3. Alcohol, driving and the law

The legal drinking age is negative in all cases and is significantly so for half of the total cases. The preliminary breath-test coefficients are more often positive than negative and are never statistically significant. In contrast, the dram-shop coefficients are consistently negative and are always significant for alcohol-involved fatalities.

The various mandatory penalty coefficients display inconsistent signs and are generally insignificant. These results may reflect the difficulties inherent in concisely measuring mandatory penalties, inconsistencies in their actual implementation, multicollinearity, or that they, in fact, have little impact on fatalities.

3.4. A limited specification

One possible explanation for the lack of statistical significance for the beer tax and price variables is that they are so highly correlated with other included variables that precise

Table 5
Alcohol-involved driver fatalities, ages 18–20[a]

Independent variable	Logistic				Linear			
Real beer tax	−0.033	(0.2)			0.0039	(0.1)		
Real beer price			−0.067	(0.6)			−0.0007	(0.1)
Real income	0.016	(0.3)	0.000	(0.4)	0.0024	(0.4)	0.0000	(0.5)
Speed over 65 MPH (%)	0.002	(0.3)	0.003	(0.5)	0.0010	(1.2)	0.0009	(1.0)
Vehicle miles traveled per driver	0.056	(1.7)	0.066*	(2.0)	0.0029	(0.7)	0.0039	(0.9)
Young drivers (%)	0.006	(0.4)	0.007	(0.4)	0.0029	(1.2)	0.0034	(1.5)
Seatbelt law	−0.195**	(3.2)	−0.216**	(3.6)	−0.0171*	(2.4)	−0.0203**	(2.7)
Unemployment rate	−0.021	(1.2)	−0.019	(1.1)	−0.0044	(1.9)	−0.0040	(1.7)
Percent dry	−0.470	(0.4)	0.501	(0.5)	−0.0076	(0.0)	−0.0045	(0.0)
Mormon	−0.195*	(2.2)	0.210*	(2.4)	0.0125	(1.5)	0.0137	(1.6)
Southern Baptist	−0.060	(1.0)	−0.053	(1.0)	−0.0033	(0.4)	−0.0033	(0.4)
Catholic	0.037	(1.0)	0.054	(1.4)	0.0022	(0.4)	0.0038	(0.8)
Other Protestant	−0.005	(0.2)	−0.013	(0.6)	−0.0029	(0.9)	−0.0041	(1.2)
Legal drinking age	−0.018	(0.8)	−0.028	(1.2)	−0.0061	(1.9)	−0.0068*	(2.1)
Preliminary breath test	0.81	(1.0)	0.081	(1.0)	0.0106	(1.2)	0.0101	(1.1)
Dram shop	−0.138	(1.9)	−0.133	(1.9)	−0.0292**	(2.8)	−0.0280**	(2.6)
Administrative *per se*	−0.031	(0.5)	−0.040	(.7)	−0.0012	(0.2)	−0.0022	(0.3)
Minimum administrative penalty	−0.000	(0.0)	−0.000	(0.0)	−0.00002	(0.4)	−0.00002	(0.4)
DUI fine	0.304**	(2.8)	0.289**	(2.7)	0.0258	(1.8)	0.0248	(1.7)
Real minimum DUI fine	−0.001*	(2.0)	−0.001*	(2.0)	−0.00005	(0.9)	−0.00005	(0.9)
DUI license action	−0.061	(1.0	−0.059	(0.9)	−0.0154	(1.7)	−0.0158	(1.8)
Minimum license action	−0.0004	(1.3)	−0.0004	(1.4)	−0.00006	(1.5)	−0.00005	(1.3)
R^2	0.66		0.066		0.74		0.73	

[a] See Table 2 footnote for explanation of symbols.

estimates cannot be obtained. To minimize the potential multicollinearity problem, the fatality models were re-estimated after dropping the variables that displayed inconsistent signs in the full specification. Results are reported in Tables 6.

Table 6
Total fatalities[a]

Independent variable	Logistic				Linear			
Real beer tax	−0.035	(1.0)			−0.0033	(0.4)		
Real beer price			−0.008	(0.4)			−0.0004	(0.1)
Seatbelt law	−0.045**	(4.2)	−0.046**	(4.3)	−0.0092**	(4.4)	−0.0099**	(4.5)
Legal drinking age	−0.008	(1.8)	−0.008	(1.9)	−0.0012	(1.3)	−0.001	(1.4)
Dram shop	−0.025	(1.9)	−0.023	(1.7)	−0.0060*	(2.1)	−0.0050	(1.7)
Speed over 65 MPH (%)	0.002	(1.7)	0.002	(1.5)	0.0005*	(2.3)	0.0006*	(2.2)
Vehicle miles traveled per driver	0.018**	(3.3)	0.016**	(3.0)	0.0034**	(3.1)	0.0031**	(2.6)
Unemployment rate	−0.031**	(10.3)	−0.030**	(9.8)	−0.0062**	(10.0)	−0.0062**	(9.5)
Real income	0.067**	(7.9)	0.069**	(8.1)	0.0129**	(7.6)	0.0133**	(7.4)
R^2	0.96		0.97		0.96		0.96	

[a] See Table 2 footnote for explanation of symbols.

Table 7
Alcohol-involved driver fatalities[a]

Independent variable	Logistic		Linear	
Real beer tax	−0.001 (0.0)		0.0057 (0.8)	
Real beer price		−0.065 (1.4)		−0.0024 (0.9)
Seatbelt law	−0.130** (5.0)	−0.131** (4.9)	−0.0057** (3.5)	−0.061** (3.4)
Legal drinking age	−0.021* (2.0)	−0.024* (2.4)	−0.0023** (3.2)	−0.0024** (3.1)
Dram shop	−0.128** (4.1)	−0.123** (3.9)	−0.0118** (5.0)	−0.0118** (4.7)
Speed over 65 MPH (%)	0.003 (0.9)	−0.003 (1.0)	−0.003 (1.4)	−0.0003 (1.5)
Vehicle miles traveled per driver	0.037** (2.8)	0.040** (3.0)	0.0014 (1.6)	0.0015 (1.6)
Unemployment rate	−0.034** (4.7)	−0.035** (4.7)	−0.0027** (5.3)	−0.0026** (4.9)
Real income	0.050* (2.4)	0.051* (2.4)	0.0037** (2.8)	0.0036* (2.5)
R^2	0.91	0.91	0.89	0.89

[a] See Table 2 footnote for explanation of symbols.

The limited specification did not yield dramatic changes in the estimates. The beer tax and price coefficients remain insignificant—indeed, only two of 16 coefficients have *t*-statistics as large as unity—and two of the estimates remain positive. In most cases, the point estimates continue to imply modest effects on fatalities from increasing beer taxes or prices. An exception is the beer tax coefficient in the logistic form for alcohol-involved youth fatalities, which implies that an increase in the tax of 16 cents per six-pack would reduce fatalities by about 15%. But the logistic form of the price equation implies a reduction of only about 0.5 of 1%, the beer tax coefficient in the linear form implies a reduction of 2.5%, and the price coefficient in the linear form is positive. As noted previously, however, little confidence can be placed in these estimates because of the large standard errors.

Most of the results for the other variables are also consistent in both the limited and full specifications. Seatbelt laws, the legal drinking age, and dram-shop laws are negatively, and often significantly, related to fatalities. Speeding and vehicle miles traveled per driver display consistently positive coefficients, although they are never statistically significant for youth

Table 8
Total fatalities, ages 18–20[a]

Independent variable	Logistic		Linear	
Real beer tax	−0.058 (0.8)		−0.0025 (0.1)	
Real beer price		−0.013 (0.3)		−0.0020 (0.1)
Seatbelt law	−0.049* (2.1)	−0.060* (2.5)	−0.0222* (2.2)	−0.0280** (2.7)
Legal drinking age	−0.027** (2.9)	−0.029** (3.0)	−0.0104* (2.4)	−0.0115** (2.6)
Dram shop	0.006 (0.2)	0.005 (0.2)	0.0053 (0.4)	0.0051 (0.4)
Speed over 65 MPH (%)	0.003 (1.2)	0.003 (1.1)	0.0015 (1.3)	0.0016 (1.3)
Vehicle miles traveled per driver	0.018 (1.6)	0.018 (1.5)	0.0081 (1.5)	0.0076 (1.3)
Unemployment rate	−0.021** (3.2)	−0.019** (2.9)	−0.0103** (3.5)	−0.0096** (3.1)
Real income	0.068** (3.6)	0.070** (3.7)	0.0258** (3.1)	−0.0268** (3.2)
R^2	0.83	0.84	0.84	0.84

[a] See Table 2 footnote for explanation of symbols.

Table 9
Alcohol-involved driver fatalities, ages 18–20[a]

Independent variable	Logitist				Linear			
Real beer tax	−0.237	(1.4)			−0.0165	(0.6)		
Real beer price			−0.035	(0.3)			0.0094	(0.8)
Seatbelt law	−0.182**	(3.1)	−0.205**	(3.4)	−0.0167*	(2.4)	−0.0198**	(2.7)
Legal drinking age	−0.007	(0.3)	−0.015	(0.6)	−0.0061*	(2.0)	−0.0069*	(2.2)
Dram shop	−0.116	(1.7)	−0.110	(1.6)	−0.0263**	(2.7)	−0.0260*	(2.6)
Speed over 65 MPH (%)	0.007	(1.1)	0.008	(1.1)	−0.0012	(1.6)	−0.0011	(1.4)
Vehicle miles traveled per driver	0.025	(0.8)	0.027	(0.9)	−0.0004	(0.1)	−0.0002	(0.0)
Unemployment rate	−0.016	(1.0)	−0.014	(0.8)	−0.0047*	(2.3)	−0.0044*	(2.0)
Real income	0.035	(0.7)	0.047	(1.0)	0.0029	(0.5)	0.0043	(0.8)
R^2	0.62		0.62		0.72		0.72	

[a] See Table 2 footnote for explanation of symbols.

fatalities. The unemployment rate and real income are significantly related to fatalities, except for alcohol-involved youth. One reason for the generally less satisfactory results for the alcohol-involved youth equation may be the relatively small number of fatalities used to form the dependent variable: the median is only about 25.

3.5. *State-specific effects*

Another possibility is that the state dummy variables result in multicollinearity and, hence, in insignificant tax and price coefficients. Indeed, if state effects are excluded, some of the coefficients are significant, but in every case they are significantly *positive* rather than negative. As Table 10 indicates, all 16 of the tax and price coefficients are positive when state dummies are excluded. Seven of these dummies are significant at the 5% level using the tax variables, and five are significant using the price variable. As already seen in Tables 6–9, the tax and price coefficients are mostly negative when state dummies are included, but none of them is statistically significant.[16] These results are consistent with those of Mast et al. (1999), who also found that including state fixed effects made the estimated tax effects more negative.

4. Discussion

Some of the existing literature on alcohol taxes concludes that they are a sure and effective means to reduce traffic fatalities. The findings of this study are inconsistent with that

[16] Similar results are obtained with the "long" specification (Tables 2–5). Eleven of the 16 tax and price coefficients are positive without state dummies, and 13 are negative when state effects are included. Fewer of these are statistically significant, however: Only three coefficients are significant without the state effects, and all are positive.

Table 10
Tax and price coefficients, "short" specification

	Tax		Price	
State effects?	No	Yes	No	Yes
Number >0	8	1	8	1
Number <0	0	7	0	7

interpretation. While most of the estimated tax and price coefficients are negative, none of them is statistically significant, and all are smaller in magnitude than those estimated in some frequently cited earlier studies.

Our findings are similar to those of some recent studies of alcohol-related motor-vehicle fatalities. Using fatal analysis reporting system (FARS) data for 1984–1992, Mast et al. (1999) find that beer taxes are statistically insignificant and often *positively* related to fatalities. The authors utilize a two-equation recursive model that first estimates the impact of taxes on alcohol consumption, and then analyzes the impact of consumption on alcohol-involved fatalities. Their analysis includes a broader range of enforcement/deterrence and alcohol regulatory variables than prior studies and finds that, once state fixed effects are included, the tax variables flip from positive to negative in sign but that neither are statistically significant. Dee (1999) uses a longer time period (1977–1992) for total teen fatalities (ages 18–20) and teen driver fatalities and uses a more limited specification of control variables. He finds that beer taxes are insignificant when state-specific time trends are included.

Mast et al. (1999), Dee (1999), and the current study approach the tax-fatality question from different time frames and utilize different control variables and methodological perspectives. Despite these differences, these studies share one basic result—that while a number of policy variables have stable and statistically significant effects on traffic fatalities, the effect of alcohol/beer taxes is quite small and statistically insignificant when state fixed-effects models are utilized. As to the effect of prices, Sloan et al. (1994a) also utilize an alcohol price variable constructed from ACCRA data for the years 1982–1988. They find a positive relationship between alcohol price and traffic fatalities for drivers aged 21–24 and a negative relationship for those aged 25–64, but they find that neither is significant. For youth aged 18–20, both the alcohol price and its interaction with the drinking age are included. The price variable is negative and significant by itself, but the interaction is positive. Sloan et al. (1994a) conclude that, "when the minimum drinking age is set at 18, the effect of alcohol prices is completely offset" (p. 67).

Exactly why the more recent studies do not find significant tax or price effects is not easy to determine. One explanation may be that as other policies have been implemented to deter drunken driving, the marginal effect of taxes and prices has diminished. Consistent with this interpretation, Laixuthai & Chaloupka (1993) find that beer tax coefficients in teen drinking equations decline between 1982 and 1989, possibly as a result of increases in the legal drinking age.

Besides employing somewhat more recent data, current studies virtually always include dummy variables for both states and years. Controls for state-specific effects were omitted from several of the earlier studies that obtained some of the largest and most significant estimates of beer tax effects.[17] However, our results indicate that including state-specific dummy variables causes estimated coefficients to become more negative, a result also obtained by Mast et al. (1999). Thus, inclusion of the state effects cannot account for the differences from previous results.

The results of this study also shed light on a number of other issues—some methodological and some substantive. With regard to the latter, this study has found that a number of other public policies besides taxes are significantly related to fatalities, and also that some are not. Our estimates generally indicate that the legal drinking age and laws regarding seatbelts and dram-shop liability are significantly related to fatality rates. On the other hand, no consistent relationships were found between fatalities and a number of mandatory minimum sanctions—administrative *per se* penalties, DUI fines, and DUI license actions. Benson et al. (1999) also find that "penalty" variables are less important than factors relating to the probability of arrest. That is, mandatory fines or license suspensions will only be effective if there are substantial efforts to arrest drunken drivers.

With regard to methodological issues, one of the most obvious conclusions is that ordinary least squares methods applied to data of this type may lead to highly misleading conclusions. Models that incorporate state-specific effects provide a much more natural framework for the analysis of pooled time series cross-section data. Furthermore, this study has demonstrated that panel data methods do in fact yield meaningful results in this context.

A second methodological point concerns the use of weights with fatality rate data. As Amemiya (1981) and Greene (1990) point out, weights are properly based on first-stage regressions that produce fitted-value estimates of the probabilities of fatalities. Use of fitted-value weights is particularly important in data such as these in which some of the fatality rates are 0 or nearly so. In this study, the use of fitted-value weights also resulted in greater consistency between the linear and logistic forms, thus increasing confidence in the robustness of the estimates.

Third, estimates based on the linear functional form were qualitatively similar to those based on the logistic form. While the estimates of the beer tax and price coefficients did sometimes differ even in sign, this appears to be a result of the large standard errors rather than the functional form. Coefficients with smaller standard errors—for example, seatbelt laws and the legal drinking age—varied much less between the linear and logistic forms.

Fourth, much work remains to be done on the connections between taxes and other alcohol regulation and consumption, abuse, and fatalities. Current work, which largely focuses on the "reduced-form" relationship between taxes and fatalities, would be greatly improved if efforts were made to verify other links in the theoretical chain—i.e., that taxes do indeed significantly affect prices, that prices affect consumption among alcohol abusers, and how

[17] Examples include Cook (1981), Saffer & Grossman (1987), and Chaloupka et al. (1993). On the other hand, Ruhm (1996) found negative and significant beer tax coefficients, even when state dummies were included, but his data extend only to 1988. Sloan et al. (1994b) find that alcohol price is negative and significant at the 10% level in one of three specifications, but that it is sensitive to the inclusion of dummy variables for years.

consumption is related to drunk-driving behavior. Some of the existing literature is reviewed in Grossman et al. (1993).[18]

Future studies also might attempt to control for a number of factors that were largely omitted from this study. The 1980s, in particular, was a decade in which awareness of alcohol abuse was on the rise. This increased concern about drunken driving and alcohol abuse was, in part, a response to the rise of numerous grass roots organizations (Mothers Against Drunk Driving, Students Against Driving Drunk, Remove Intoxicated Drivers, etc.) around the country. Surely their impact varied significantly across states and over time. Along with the rise of these groups, there occurred much tougher and more visible enforcement of existing laws on driving and drinking (and again, this must have occurred differentially across states and over time). Many states also increased drug and alcohol education in the schools. These factors, as well as changes in individual consumption behavior totally unrelated to drunken driving (e.g., the focus on individual health), all were very likely significant factors in the recent declines in alcohol-related fatalities. Unfortunately, data are not available to allow us to control for these factors except through the state effects and year dummies—which are, at best, only a partial solution to this problem. As a result, the estimates of the effects of the policy variables that have been included may well be biased. In particular, to the extent that states simultaneously took action to reduce alcohol abuse on a number of fronts—say, by increasing taxes, legislating stricter and more certain penalties for DUI, stepping up enforcement and educational efforts, and mobilizing citizen groups—then the estimated effects of the policy variables included in this study are likely to overstate their actual deterrent effects.[19]

Another methodological difficulty concerns the use of the beer tax as a proxy for all alcohol taxes. In principle, it would be desirable to include measures of wine and liquor taxes as well, but including all three beverage taxes may lead to intractable multicollinearity problems: Because states tend to change all three taxes together, it is very difficult to sort out the effect of one tax from another, and the estimators have such large standard errors that it is impossible to reject virtually any hypothesis. These difficulties notwithstanding, focusing only on beer taxes can lead to mistaken policy interpretations. In particular, the estimated coefficients will tend to overstate the impact that raising just beer taxes would have on fatalities. This is because the actual events on which the estimates are based tended to involve simultaneous changes in the taxes on all three types of beverages. If, instead, policy makers were to increase just beer taxes, the impact would be smaller both because there would be no direct effect on people who normally consume wine or liquor, and because beer drinkers will tend to substitute liquor or wine for beer. As a consequence, the total consumption of alcohol is likely to decline less if just beer taxes are increased.

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[18] More recently, Mast et al. (1999) found that beer consumption is significantly related to fatalities, but that beer consumption is not related to beer taxes when controls for other influences on consumption are included.

[19] Chaloupka & Wechsler (1996) found that an index of state policy developed by Mothers Against Drunk Driving is significantly related to drinking by youth and young adults.

For all of these reasons, it should be emphasized that none of the models presented in this analysis—or perhaps in any other—provides final and conclusive evidence on the issue of how beer taxes (or prices) impact various classes of auto fatalities. In contrast to some earlier findings of consistently large, negative, and statistically significant relationships between taxes and fatalities, this study finds smaller, sometimes positive, and mostly insignificant relationships. Thus, while earlier findings seemed to unambiguously suggest that the beer tax would be a powerful and certain tool for reducing fatalities, the results of this and some other recent studies suggest that such claims should be viewed with caution.

Appendix

Data sources

Fatalities

Counts of total and driver motor-vehicle fatalities by state, year, age, and time of accident and death were obtained directly from U.S. Department of Transportation's National Highway Traffic Safety Administration data tapes. These tapes provide extensive documentation on every motor-vehicle accident involving a fatality that occurs in the United States as part of the Fatal Accident Reporting System (U.S. Department of Transportation, 1991).

Population

State total populations are available on an annual basis from the U.S. Bureau of the Census, *Current Population Reports, Series P-25*. However, the population of persons aged 18–20 is not available for each state-year (except 1990), although the population of persons aged 18–24 is available, and population by individual years of age is available for the United States as a whole for each year. Thus, the following procedure was adopted. For each year 1982–1989, the U.S. population aged 18–20 as a fraction of U.S. population that is age 18–24 was computed. This fraction then was multiplied by the state population aged 18–24 for that year to obtain an estimate of state population aged 18–20.

The remaining variables are described briefly in Table A1.

Table A1
Description of variables

Variable	Definition	Source
RTAXB	Sum of Federal and state excise taxes on beer, in 1982–1984 dollars per 24-can case	Federal = $.64 (nominal). State: U.S. Brewers Association, various years. Deflated by CPI[a] from U.S. Council of Economic Advisors, 1992.
RPRICEB	Retail price of beer, in 1982–1984 dollars per six-pack	American Chamber of Commerce Research Association, various years
REALINC	*Per capita* personal income in thousands of 1982–1984 dollars	Floppy Disk, Regional Economic Information System, BEA, USDC (adjusted by CPI)
SPEED65	Percentage of vehicles exceeding 66 MPH in 55-MPH zones	USDOT, NHTSA, *Traffic Statistics*, various years
VMTLIC	Vehicle miles traveled in thousands per licensed driver	Same as for *SPEED65*
PLIC25	Percent of licensed drivers under age 25	Same as for *SPEED65*, missing data for various years interpolated
SEATBELT	Dummy variable equals 1 if mandatory seatbelt use law	USDOT, NHTSA, *Digest of Alcohol-Highway Safety Related Legislation*, Editions 1–9
UNEM	Unemployment rate	USDOL, BLS, *Geographic Profile of Employment and Unemployment*, annual.
PCTDRY	Percent of population residing in dry countries	U.S. Brewers Association
PMOR	Mormon population as percent of total	Extrapolated from national Council of Churches data for 1971 and 1980. See Johnson (1974) and Quinn (1982)
PSBA	Southern Baptist population as percent of total	Same as for *PMOR*
PCAT	Catholic population as percent of total	Same as for *PMOR*
PPRO	Other Protestant population as percent of total	Same as for *PMOR*
DRINKAGE	Minimum legal age for purchase and consumption of beer $>$ 3.2%	USDOT, NHTSA, *Digest of Alcohol-Highway Safety Related Legislation*, Editions 1–9
BREATH	Dummy variable equals 1 if police are authorized to administer a preliminary breath test	Same as for *DRINKAGE*
DRAMSHOP	Dummy variable equals 1 if state law permits lawsuits against servers of alcohol	Same as for *DRINKAGE*
ADMINPS	Dummy variable equals 1 if state requires administrative driver's license suspension or revocation after first arrest for DUI	Same as for *DRINKAGE*
ADMINPEN	Mandatory minimum administrative driver's license action, in days	Same as for *DRINKAGE*
DUIFINE	Dummy variable equals 1 if a fine is required upon first conviction for DUI	Same as for *DRINKAGE*
RDUIFINE	Mandatory minimum fine on first conviction for DUI, in 1982–1984 dollars	Same as for *DRINKAGE*
DUILIC	Dummy variable equals 1 if state requires license suspension or revocation upon first conviction for DUI	Same as for *DRINKAGE*
DUILICD	Mandatory minimum license suspension or revocation upon first conviction for DUI, in days	Same as for *DRINKAGE*

[a] CPI, consumer price index; USDOT, U.S. Department of Transportation; NHTSA, National Highway Traffic Safety Administration; BLS, Bureau of Labor Statistics.

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