5-2009

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Per G. Fredriksson
University of Louisville

Stephan Gohmann
University of Louisville

Khawaja Mamun
Sacred Heart University, mamunk@sacredheart.edu

Recommended Citation
Fredriksson, P.G., Gohmann, S. & Mamun, K. (2009). Taxing under the influence? Corruption and U.S. state beer taxes. Public Finance Review 37(3), 339-365. doi: 10.1177/1091142109332052

Public Finance Review
Volume 37 Number 3
May 2009 339-365

10.1177/1091142109332052
http://pfr.sagepub.com
hosted at
http://online.sagepub.com

Taxing Under the Influence?

Corruption and U.S. State Beer Taxes

Per G. Fredriksson
Stephan Gohmann
University of Louisville, Louisville, Kentucky
Khawaja Mamun
Sacred Heart University, Fairfield, Connecticut

This article examines the effect of state level corruption on state beer taxes in the United States. Our lobby group model predicts that corruption reduces the beer tax, but this effect is conditional on the level of alcohol-related vehicle deaths. Using a panel of state level data from 1982 to 2001, we find that increased corruption is associated with lower state beer tax rates. The magnitude of the effect, however, declines with increases in alcohol-related traffic deaths. Our findings suggest that future empirical work estimating the effect of alcohol taxes on alcohol-related traffic fatalities should treat alcohol taxes as endogenous.

Keywords: *alcohol taxes; corruption; political economy; traffic accidents*

I. Introduction

One of the main social costs of alcohol consumption is the number of lives lost to alcohol-related motor vehicle accidents. For example, in year 2004, the total number of alcohol-related traffic deaths was 14,409

Authors' Note: Please address correspondence to Per G. Fredriksson, College of Business, Louisville, KY 40292; per.fredriksson@louisville.edu. The authors would like to thank the helpful referees, Jim Alm, Meherun Ahmed, Suchandra Basu, Sören Blomquist, Vera Brusenteva, Paul Coomes, Nirupama Devaraj, Don Freeman, Barry Haworth, Dennis Jansen, Angeliki Kourelis, Arif Mamun, Dan Polsky, Laura Razzolini, Jay Vahaly, and participants at presentations at Sacred Heart University and at the IAE conference in Philadelphia for useful comments and discussions, and Dhaval Dave, Don Freeman, and Robert Kaestner for kindly providing parts of the data. The usual disclaimers apply.

(NHTSA, 2006).[1] A debate continues in the literature on the effectiveness of alcohol taxes in reducing the frequency of such deaths in the United States. According to Kenkel (1993), a 10 percent price increase would reduce the probability of drinking and driving by 7.4 percent and 8.1 percent for males and females, respectively; Young and Bielinska-Kwapisz (2006) find road fatalities to be negatively affected by alcohol prices, whereas alcohol consumption is positively correlated with fatalities.[2,3] Simultaneously, the beer industry pours considerable funds into the political process determining beer taxes. For example, in North Carolina, the beer industry spent US$565,000 in the 2004 state level election.[4]

Both the federal and the state governments levy alcohol taxes. However, state alcohol taxes vary tremendously. On January 1, 2006, the median state beer tax equaled 18.8 cents per gallon, and ranged from 2 cents per gallon in Wyoming to US$1.07 in Alaska. In this article, we seek to explain why the beer tax varies so widely among U.S. states. Our particular focus is state-level differences in corruption.[5]

The effect of corruption on U.S. public policy outcomes has received relatively scant attention in the literature; exceptions include Goel and Nelson (1998) who explore the effect of corruption on government size, and Glaeser and Saks (2006) who find negative effects of corruption on employment and income growth.[6] In particular, the literature lacks an analysis of the impact of corruption on state beer taxes (and on other alcohol taxes). We seek to remedy this deficiency.

Our theoretical model of endogenous alcohol tax policy determination builds on Grossman and Helpman (1994) and Dixit, Grossman, and Helpman (1997). In our model, a state government may reduce alcohol consumption by raising the beer tax, which in turn affects the incidence of alcohol-related traffic deaths. However, a lobby representing beer producers opposes higher beer taxes; it offers the state government a bribe (campaign contribution) in exchange for lower beer taxes. Thus, we seek to model (high-level) political corruption rather than bureaucratic (low-level) or overall corruption.[7] The state government values bribes and aggregates social welfare, and their relative importance is used as a measure of the degree of state government corruption (following, e.g., Schulze and Ursprung 2001; Fredriksson and Svensson 2003).[8] Our theory predicts that an increase in corruption reduces the beer tax, and the effect is *conditional* on the incidence of alcohol-related traffic fatalities. Although other authors have investigated the role of corruption on policymaking, the present article is to our knowledge the first to investigate the interaction effect of corruption and traffic fatalities on beer (alcohol) taxes using the Grossman and Helpman (1994; or Dixit, Grossman, and Helpman 1997) framework.[9]

We evaluate the implications of our theory using state level data for years 1982 to 2001. We use conviction rates of public officials as our corruption measure (as in Goel and Nelson 1998; Fredriksson, Millimet, and List 2003; Glaeser and Saks, 2006). The empirical findings support the theory. States with higher levels of corruption set lower beer taxes. Moreover, the effect is conditional on the frequency of the state's alcohol-related traffic deaths. In particular, corruption has a smaller negative effect on the beer tax when this fatality rate is high. Thus, the beer producer lobby has relatively less influence on state governments' tax rate decisions when the alcohol-related traffic fatality rate increases.

Our results allow us to estimate a corruption elasticity of the beer tax by state. The average (unweighted) value of this elasticity in 2001 over all U.S. states equals −0.24. Our estimates suggest that in Pennsylvania, for example, a 1 percent reduction in corruption would lead to 1.02 percent increase in the beer tax.[10]

What are the implications of our findings? First, we believe our results may have implications for future empirical investigations of the effects of beer (and other alcohol) taxes on alcohol-related traffic fatalities. Many studies to date have found few robust negative effects of beer taxes on alcohol-related vehicle fatalities.[11] This may be attributable to the fact that this literature has treated beer taxes as exogenous. If alcohol-related vehicle fatalities affect beer tax rates, any empirical model seeking to estimate the effect of beer taxes on such fatalities should take into account that both variables are endogenous.[12,13]

Second, our findings suggest that corruption has potentially serious spillover effects, which previously have not received attention in the literature. In fact, it appears lethal. Assuming that state beer taxes affect beer consumption and alcohol-related traffic fatalities (as reported by Young and Bielinska-Kwapisz 2006 and others), corruption claims lives every year in the United States by causing lower state beer taxes.[14]

The article is organized as follows. Section II sets up a theoretical model, which guides our empirical work. Section III discusses the data and our empirical approach, and Section IV reports our empirical results. Section V concludes.

II. Model

In this section, we set up a simple theoretical model that guides our empirical work. A state is inhabited by a population normalized to unity.

They are (for simplicity) all consumers of a numeraire good, z, as well as of alcohol, x.[15] The price of the numeraire good is normalized to unity and the price of alcohol equals p.

All individuals are assumed to (costlessly) drive a fixed distance per year, normalized to one mile.[16] Alcohol consumption is associated with driving-under-the-influence (DUI) and thus alcohol-related traffic deaths. Alcohol is taxed by the state government at a rate t. The resulting tax revenue is used to provide a state level public good, M, consumed by the state's entire population. We assume that each individual disregards their own consumption's impact on alcohol-related traffic deaths. Each individual has a quasi-linear utility function

$$U = z^c + u(x^c) + M^c - \beta R, \tag{1}$$

where z^c, x^c, and M^c are consumption of the numeraire good, alcohol, and the public good, respectively, and u is a concave subutility function. β is an (average) cost-of-accident coefficient, and R is the expected driver alcohol-related accident involvement rate, which equals the share of drivers involved in alcohol-related traffic fatalities (per time period). R is a function of the DUI offense rate, D, and a vector of vehicle-, driver-, and traffic-safety measures, T, that is, $R = R(D, T)$, where $R_D > 0, R_{DD} < 0$, $R_T < 0, R_{TT} > 0$, and $R_{DT} < 0$, following Benson, Rasmussen, and Mast (1999). DUI offenses are assumed to be a function of aggregate alcohol consumption, Q, and the expected punishment from a DUI offense, E, that is, $D = D(Q, E)$, where $D_Q > 0, D_{QQ} < 0, D_E < 0$, and $D_{EE} > 0$.[17]

Every individual is endowed with a unit of labor. The numeraire sector requires labor input only. Assuming an input-output coefficient equal to one in the numeraire sector, the wage rate is fixed at unity. Alcohol is assumed to be produced by symmetric duopoly firms using labor and a sector-specific factor. Duopoly firm k, $k \neq i$, has an output level equal to q^k, and a cost function given by $c(q^k)$, where $c' > 0$, and $c'' > 0$. Industry output equals $q^k + q^i = Q$. Disregarding all political expenditures (see below), the profit function of firm k equals

$$\pi^k = [p(Q) - t]q^k - c(q^k), \tag{2}$$

where $P(Q) - t$ reflects the market price net of the alcohol tax. We assume $P' < 0$, such that the demand function is negatively sloped, and that $P' + q^k P'' < 0$, such that a one-shot stable Cournot-Nash equilibrium exists (see Shapiro 1990). The FOCs equal

$$\frac{\partial \pi^k}{\partial q^k} = P - t + P'q^k - c' = 0,\ k, i, ; k \neq i. \tag{3}$$

The SOCs require $\partial^2\pi^k/\partial q^{k^2} < 0$, and $|\partial^2\pi^k/\partial q^{k^2}| > |\partial^2\pi^k/(\partial q^k \partial q^i)|, k \neq i$. Requiring $\partial\pi^k/\partial q^i < 0, k \neq i$, ensures stability (see Shapiro 1990). In addition, by symmetry of firm k and i, $\partial^2\pi^k/(\partial q^k \partial q^i) = \partial^2\pi^i/(\partial q^i \partial q^k)$. Totally differentiating the FOCs yields

$$\begin{bmatrix} \dfrac{\partial^2\pi^k}{\partial q^{k^2}} & \dfrac{\partial^2\pi^k}{\partial q^k \partial q^i} \\ \dfrac{\partial^2\pi^i}{\partial q^i \partial q^k} & \dfrac{\partial^2\pi^i}{\partial q^{i^2}} \end{bmatrix} \begin{bmatrix} dq^k \\ dq^i \end{bmatrix} = \begin{bmatrix} -\dfrac{\partial^2\pi^k}{\partial q^k \partial t} \\ -\frac{\partial^2\pi^i}{\partial q^i \partial t} \end{bmatrix} dt \tag{4}$$

Denote the determinant of this system by $|D|$; the SOCs imply $|D| > 0$. Note that $\partial^2\pi^k/(\partial q^k \partial t) = -1$. We find

$$\frac{dq^k}{dt} = \frac{\frac{\partial^2\pi^i}{\partial q^i \partial t}\ \frac{\partial^2\pi^k}{\partial q^k \partial q^i} - \frac{\partial^2\pi^k}{\partial q^k \partial t}\ \frac{\partial^2\pi^i}{\partial q^{i^2}}}{|D|} < 0; \tag{5.1}$$

$$\frac{dq^i}{dt} = \frac{\frac{\partial^2\pi^k}{\partial q^k \partial t}\ \frac{\partial^2\pi^i}{\partial q^i \partial q^k 0} - \frac{\partial^2\pi^i}{\partial q^i \partial t}\ \frac{\partial^2\pi^k}{\partial q^{k^2}}}{|D|} < 0, \tag{5.2}$$

where the signs of (5.1) and (5.2) follow from symmetry and the restrictions on terms from the SOCs. It follows that we can write $Q(t)$, where $Q' < 0$. Finally, note that the provision of the public good is determined by the amount of tax revenues raised, that is, $M = Qt$.

Lobbying and the Game

We follow much of the lobbying literature and abstract from free-riding problems discussed by Olson (1965); we assume that an alcohol producer lobby group is formed (exogenously) in each state and is joined by all industry firms. Each alcohol producing firm contributes equally to the lobby's attempt to influence the government's alcohol tax policy decision (consistent with the assumption that firms are identical). Our focus on one policy instrument alone is consistent with much of the literature (see Grossman and Helpman 2001).

The alcohol tax is determined by a two-stage game between the incumbent government and the lobby group (see Dixit, Grossman, and Helpman 1997). In the first stage, the firm lobby offers the government a prospective bribe (political contribution) schedule, $C(t)$, that is, a function that relates the size of the bribe to the size of the alcohol tax. In the second stage, the government selects its optimal tax policy, t^*, and receives the bribe associated with the tax selected. We assume that all promises are kept (i.e., the lobby group does not renege on its promise in the second stage). Given t^*, firms set their output levels.

The lobby's gross (of bribes) objective function, $L(t)$, depends on aggregate profits:

$$L(t) \equiv \sum_k \pi^k. \tag{6}$$

The government's objective function, $G(t)$, is the weighted sum of the bribe and aggregate social welfare:

$$G(t) = C(t) + \alpha \Omega^A(t), \tag{7}$$

where $\Omega^A(t)$ aggregates consumer surplus, firm profits, labor income, tax revenues, and the disutility from expected fatalities because of drunk driving, and is given by

$$\Omega^A(t) = \int_0^Q P(x)dx - P(Q)Q(t) + \sum_k \pi^k(t) + l + Qt - \beta R(D, T). \tag{8}$$

Finally, the parameter $\alpha \geq 0$ in equation (7) measures the government's exogenous weight on welfare relative to bribes (campaign contributions). Following Schulze and Ursprung (2001) and Fredriksson and Svensson (2003), we interpret α as a measure of the degree of government honesty (absence of corruption). It ranges from close to zero honesty to perfect honesty $(\alpha \to \infty)$.[18]

The Political Equilibrium

Because the equilibrium characterization in the common agency game by Bernheim and Whinston (1986; see also Grossman and Helpman 1994; Dixit, Grossman, and Helpman 1997) is standard in the literature, we omit the derivation here to conserve space (available on request). It can be shown that the subgame perfect Nash equilibrium, $(C^*(t^*), t^*)$, is implicitly given by the following equilibrium characterization:

$$\frac{\partial L(t^*)}{\partial t} + \alpha \frac{\partial \Omega^A(t^*)}{\partial t} = 0. \tag{9}$$

Taking the partial derivatives of equations (6) and (8), and substituting the result into equation (9) yields (after cancellations):

$$\underbrace{-Q}_{A} + \alpha \underbrace{\left(-\tfrac{\partial P}{\partial Q}\tfrac{\partial Q}{\partial t} Q + t\frac{\partial Q}{\partial t} - \beta \tfrac{\partial R}{\partial D}\tfrac{\partial D}{\partial Q}\tfrac{\partial Q}{\partial t} \right) = 0}_{B}\,. \tag{10}$$

Term A in expression (10) reflects the downward pressure on the alcohol tax because of producer lobbying. Term B mirrors the state government's welfare considerations such as firm profits, consumer surplus, tax revenues, and expected DUI offenses, respectively. Because term A is negative, term B must be positive. This suggests that because of lobbying the alcohol tax is set suboptimally low (welfare is increasing in the tax rate), and thus the costs associated with the expected number of DUI offenses are suboptimally high (unless the government is purely welfare maximizing, $\alpha \to \infty$). Note also that because expression (10) reflects the political equilibrium characterization, it implicitly depicts the equilibrium tax set because of lobbying aimed at avoiding an even higher tax. Below, we use a number of elasticities, ε_{jl}, where $j, l = R, D, Q, t$.

Proposition 1: In equilibrium, the alcohol tax satisfies

$$t^{*} = \underbrace{\left(\frac{\alpha\varepsilon_{Qt}}{\alpha\varepsilon_{Qt} - 1} \right)}_{A} \underbrace{\left(\frac{R\beta\varepsilon_{RD}\varepsilon_{DQ}}{Q} + \varepsilon_{PQ}P \right)}_{B}. \tag{11}$$

Proof: Rearrangements of equation (10) yield equation (11). *Q.E.D.*

Expression (11) reveals that the equilibrium tax rate is positive, because terms A and B in equation (11) are both positive (this follows because term B in equation (10) must be negative). Thus, a higher equilibrium accident involvement rate, R, and a higher cost per accident, β, both raise the equilibrium tax rate, *ceteris paribus*. Moreover, increases in the (absolute value of the) tax elasticity of alcohol consumption, ε_{Qt}, the consumption elasticity of DUI offenses, ε_{DQ}, and the DUI elasticity of accident involvement, ε_{RD}, all raise the equilibrium alcohol tax, *ceteris paribus*.[20]

In essence, this is because the greater is the eventual impact of the tax on accidents, the greater the alcohol tax. It becomes more difficult, *ceteris paribus*, for the government to give in to the alcohol lobby's pressure, the greater the effect of the tax on accidents. However, the greater is the absolute value of the quantity elasticity of price, ε_{PQ}, the lower is the alcohol tax. If a reduction in the quantity sold (because of the tax) raises price sharply, consumer surplus suffers.

Proposition 2: In equilibrium, corruption reduces the alcohol tax.

Proof: Taking the total derivative of equation (10) yields

$$\frac{dt}{d\alpha} = \frac{-\frac{\partial P}{\partial Q}\frac{\partial Q}{\partial t}Q + t\frac{\partial Q}{\partial t} - \beta\frac{\partial R}{\partial D}\frac{\partial D}{\partial Q}\frac{\partial Q}{\partial t}}{-H}, \tag{12}$$

where the denominator, H (expression available on request) is the negative of the SOC of the government's maximization in equation (10). H is required to be negative for a maximum, which we assume, and thus the denominator is positive. From equation (10), the numerator is positive, and thus (12) is positive. Thus, a reduction in corruption (a higher α) raises the alcohol tax. *Q.E.D.*

Although *Proposition 2* suggests that corruption lowers the alcohol tax, *Proposition 1* indicates that the effect of corruption also depends on several variables that influence the accident rate. Note that term A in equation (11) is multiplied by term B. In particular, the absolute value of the tax elasticity of alcohol consumption, ε_{Qt}, the DUI elasticity of accident involvement, ε_{RD}, and the consumption elasticity of DUI offenses, ε_{DQ}, all influence how changes in corruption influence the alcohol tax. These variables are however endogenously determined, and without resorting to the use of a specific functional form, a clear-cut direction of the interaction effect of corruptibility and the frequency of alcohol-related traffic accidents on the alcohol tax can therefore not be established. We can, however, establish that the effect of corruption is *conditional* on the frequency of such accidents. Our empirical work below aims to clarify the empirical relationship between these variables.

III. Empirical Approach and Data

Our theoretical framework yields the hypothesis that the effect of corruption on the alcohol tax rate is negative. Moreover, this impact is conditional on the costs associated with alcohol-related traffic accidents. In this section, we attempt to empirically evaluate these implications of the theory. The following model is estimated:

$$\begin{aligned} &BEER\quad TAX_{it} = \gamma_i + \lambda_t + CORRUPTION_{it}\delta_1 + FATALITIES_{it}\delta_2 + \\ &\quad CORRUPTION_{it} \times FATALITIES_{it}\delta_3 + X_{it}\beta + \varepsilon_{it}, \end{aligned} \tag{13}$$

where CORRUPTION_{it} is a measure of the level of corruption in state i at time t, FATALITIES_{it} is the number of alcohol-related traffic deaths per 100 million vehicle miles traveled in state i at time t, X_{it} represents the vector of controls, γ_i is a time-invariant state fixed effect, and λ_t is the location-invariant time fixed effects.[21] These fixed effects should capture, for example, differences in religious practices across states and time, which may influence the determination of beer taxes. We follow much of the related literature on the effects of corruption in the United States and treat CORRUPTION_{it} as exogenous (see Fisman and Gatti 2002; Fredriksson, Millimet, and List 2003).

The vector of control variables in our base model includes per capita personal income and the per capita budget deficit. We expect that higher income states generate higher income tax receipts and are therefore able to set lower beer taxes, whereas higher per capita state budget deficits would induce states to raise beer taxes. The ability and willingness to change tax rates may also be influenced by the amount of power either political party has in the state legislature. We include two dummy variables indicating whether the government is strongly democratic or strongly republican; this occurs if a particular party controls both legislatures with a 66 percent majority.[22] Reed (2006) suggests that the total tax burden tends to be larger when democrats run state governments. We also include spirits consumption per capita for population older than 21 years (lagged one year) and sale of spirits (lagged one year). States with larger per capita sales of spirits may require lower beer taxes to reach a given revenue target. A measure that may affect the amount of DUI is the legal level of intoxication ($\text{BAC} = 0.1$ or $\text{BAC} = 0.08$), which we include in a few models. Legislation determining the legal level of intoxication may reflect an overall state policy toward reducing drunk driving, as discussed by Freeman (2007).

According to our theory, the costs associated with alcohol-related traffic accidents and state beer tax rates are endogenously determined. Our measure of the costs of alcohol-related traffic fatalities is FATALITIES described above. We deal with the endogeneity problem by adopting an instrumental variable approach. We seek to select an instrument that reflects risky behavior that may influence traffic fatalities but is independent of factors that affect the beer tax rate. We instrument alcohol-related deaths with either one or two instruments, depending on model (tables 1 and 2, respectively). *Per Capita Vehicle Miles Traveled* (from NHTSA) is included as an instrument in all models. A greater number of per capita vehicle miles traveled increases the probability of an alcohol-related accident for a given number of drunk drivers. In addition, using cars (instead of public transportation) leads to more alcohol-related road deaths, *ceteris paribus*. A second

Table 1
Summary Statistics

Variables	Mean	SD	Min	Max
BEER TAX (US$)	0.15	0.12	0.01	0.80
CORRUPTION	0.04	0.04	0.00	0.23
FATALITIES	1.01	0.45	0.29	3.16
Vehicle miles traveled (per capita)	0.91×10^{-02}	0.16×10^{-02}	0.46×10^{-02}	1.81×10^{-02}
Per capita cigarette revenue (US$1000s)	2.26×10^{-02}	1.16×10^{-02}	0.21×10^{-02}	7.38×10^{-02}
Per capita personal income	14.12	2.44	9.19	24.23
Per capita budget deficit (US$1000s)	0.20×10^{-02}	0.21×10^{-02}	-0.63×10^{-02}	3.75×10^{-02}
Republican strong (in Senate and House)	0.08	0.27	0	1
Democrats strong (in Senate and House)	0.20	0.40	0	1
Spirits sold per capita (population over 21)	0.92	0.37	0.37	3.18
Legal level of intoxication (BAC = .10)	0.70	0.45	0	1
Legal level of intoxication (BAC = .08)	0.16	0.36	0	1
Gallons of spirits_{-1} (100 millions)	0.07	0.08	0.007	0.57

Note: Values are in 1983 U.S. dollars.

Table 2
Beer Tax Equations: 2SLS with 2 IVs and 4 IVs

BEER TAX Model	I	II	III	IV
CORRUPTION	-1.36^{***} (-2.57)	-1.44^{***} (-2.59)	-1.31^{***} (-4.22)	-1.23^{***} (-4.04)
FATALITIES	0.09^{*} (1.83)	0.11^{**} (2.30)	0.09^{**} (1.98)	0.10^{**} (2.31)
FATALITIES × CORRUPTION	1.27^{***} (2.59)	1.32^{**} (2.53)	1.22^{***} (4.25)	1.13^{***} (4.07)
Observations	855	855	855	855
Pagan and Hall (1983) heteroskedasticity test	0.98	0.99	0.97	0.98
Hansen's J statistic overidentification test			[p = 0.89]	[p = 0.85]
F test of joint significance of instrument set				
(FATALITIES)	17.83 (p = .00)	17.99 [p = .00]	10.07 [p = .00]	9.59 [p = .00]
(FATALITIES × CORRUPTION)	10.85 [p = .00]	10.63 [p = .00]	30.48 [p = .00]	30.46 [p = .00]
Shea's (1997) partial R^2				
(FATALITIES)	0.06	0.06	0.07	0.07
(FATALITIES × CORRUPTION)	0.12	0.12	0.31	0.32
Underidentification tests				
Kleibergen-Paap rk LM statistic [$\chi^2()$]	$\chi^2(1) = 56.11$ [p = .05]	$\chi^2(1) = 73.20$ [p = .00]	$\chi^2(1) = 59.84$ [p = .00]	$\chi^2(1) = 75.06$ [p = .00]
Kleibergen-Paap rk Wald statistic [$\chi^2()$]	$\chi^2(1) = 98.46$ [p = .05]	$\chi^2(1) = 120.47$ [p = .00]	$\chi^2(1) = 121.04$ [p = .00]	$\chi^2(1) = 134.60$ [p = .00]

(continued)

Table 2. (continued)

BEER TAX Model	I	II	III	IV
Weak identification test				
Kleibergen-Paap Wald rk F statistic	47.58	57.92	29.17	32.27
Test of joint significance of endogenous				
	20.09 [$p = .00$]	26.36 [$p = .00$]	39.67 [$p = .00$]	43.29 [$p = .00$]
Regressors Anderson–Rubin Wald Test [$\chi^2()$]				
Stock-Wright LM S statistic [$\chi^2()$]	18.72 [$p = .00$]	25.74 [$p = .00$]	42.76 [$p = .00$]	46.72 [$p = .00$]
Average VIF Score	3.89	3.83	3.38	3.87

Notes: VIF = variance inflation factor.

a. All models include state and time fixed effects. Robust z statistics in parenthesis.
*** indicates significant at 1 percent level; ** indicates significant at 5 percent level; * indicates significant at 10 percent level.

b. Models I and II present IV-2SLS results with 2 IVs (per capita vehicle miles traveled and the interaction with corruption) for FATALITIES and models III and IV present IV-2SLS results with 4 IVs (per capita vehicle miles traveled, per capita cigarette revenue and their interaction with corruption) for FATALITIES and FATALITIES × CORRUPTION, respectively.

c. Model I and III include per capita personal income, per capita state budget deficit, strength of Republicans in politics, strength of Democrats in politics, spirits consumption per capita for population aged over 21 (lagged) and sale of spirits (lagged).

d. Model II and IV include measures of the legal level of intoxication (BAC) plus variables from models I and III, respectively.

set of regressions includes a second instrument, *Per Capita Cigarette Revenue* from Orzechowski and Walker (2003), which is likely to reflect risky behavior but not to influence the beer tax. It follows that we must also instrument for the interaction FATALITIES × CORRUPTION, given that we instrument for FATALITIES. Thus, as a consequence of using one and two instruments for FATALITIES in the models reported in tables 1 and 2, respectively, we are required to use two and four instruments in these models, respectively. In the next section, we provide a range of tests of the validity of these instruments.

Data

We use state level data for years 1982 to 2001. Descriptive statistics are provided in table 3, and all data sources are provided in appendix B. We denote our dependent variable by BEER TAX. The beer excise tax rate data come from World Tax Data Base (2006); this data is converted into real 1982 dollars. In year 2001, the nominal tax rate ranged between US$0.02 per gallon in Wyoming and US$0.768 per gallon in South Carolina.

CORRUPTION reflects the level of government corruption and is measured by the number of convictions of public officials on corruption charges per 1000 public sector employees. CORRUPTION serves as a proxy for the inverse of the weight α included in the theory, which measures the government's exogenous weight on welfare relative to bribes. The data come from reports from the U.S. Department of Justice. These reports provide annual state-level data on the number of public officials convicted of corruption-related activities; we use a three-year moving average of this proxy variable. These data have been used also by Goel and Nelson (1998), Fisman and Gatti (2002), Fredriksson, Millimet, and List (2003), and Glaeser and Saks (2006). Despite a number of possible caveats, it remains the best available panel data measure of corruption in the United States, to our knowledge. One caveat is that it includes all forms of corruption convictions, not only convictions for political corruption.[23] In 2001, CORRUPTION ranged from zero in Maine, Wyoming, and Vermont, to 0.16 in Montana.[24] We note that high beer taxes may induce bribery aimed at lower the tax.[25] However, with a three-year moving average of corruption (which itself is lagged by the delay of convictions), the timing of our measure ensures that corrupt activities occurred before the tax year observation.

Data on the number of alcohol-related traffic deaths per 100 million vehicle miles traveled (FATALITIES) and vehicle miles traveled come

Table 3
Beer Tax Equations: Robustness Analysis

BEER TAX Model	I	II	III	IV	V
CORRUPTION	−1.10 (−1.52)	−0.72** (−2.14)	−1.33*** (−2.62)	−1.88** (−2.02)	−1.01** (2.56)
FATALITIES	0.12* (1.94)	0.02 (0.60)	0.08* (1.89)	0.09* (1.71)	0.11** (2.48)
FATALITIES × CORRUPTION	1.03 (1.61)	0.65** (2.04)	1.23*** (2.64)	1.75** (2.01)	0.94** (2.56)
Observations	760	855	817	641	899
Pagan–Hall heteroskedasticity test	0.95	0.98	0.98	0.97	0.99
Hansen's J statistic overidentification test		(p = .40)			
F test of joint significance of instrument set					
(FATALITIES)	14.98 (p = .00)	14.04 (p = .00)	22.50 (p = .00)	17.19 (p = .00)	18.52 (p = .00)
(FATALITIES × CORRUPTION)	8.79 (p = .00)	8.82 (p = .00)	10.87 (p = .00)	10.01 (p = .00)	16.39 (p = .00)
(NEIGHBOR TAX)		44.75 (p = .00)			
Shea's (1997) partial R^2					
(FATALITIES)	0.06	0.12	0.09	0.05	0.07
(FATALITIES × CORRUPTION)	0.10	0.14	0.13	0.05	0.19
(NEIGHBOR TAX)		0.28			
Underidentification tests					
Kleibergen-Paap rk LM statistic [χ^2()]	50.96 (p = .00)	76.51 (p = .00)	57.28 (p = .00)	58.85 (p = .00)	90.44 (p = .00)
Kleibergen-Paap rk Wald statistic [χ^2()]	14.02 (p = .00)	143.14 (p = .00)	105.47 (p = .00)	109.80 (p = .00)	178.09 (p = .00)

(continued)

Table 3. (continued)

BEER TAX Model	I	II	III	IV	V
Weak identification test					
Kleibergen-Paap Wald rk F statistic	45.36	27.56	50.89	52.46	86.12
Joint significance of endogenous regressors					
Anderson–Rubin Wald test [$\chi^2()$]	6.69 ($p = .02$)	86.71 ($p = .00$)	20.21 ($p = .00$)	14.33 ($p = .00$)	25.81 ($p = .00$)
Stock-Wright LM S statistic [$\chi^2()$]	6.62 ($p = .02$)	72.16 ($p = .00$)	18.90 ($p = .00$)	10.83 ($p = .00$)	23.27 ($p = .00$)
Average VIF score	3.53	3.13	3.36	3.39	3.03

Notes: VIF = variance inflation factor.

a. All models include state and time fixed effects. Robust z–statistics in parenthesis.

*** indicates significant at 1 percent level; ** indicates significant at 5 percent level; * indicates significant at 10 percent level.

b. All models present IV–2SLS results with 2 IVs (per capita vehicle miles traveled and the interaction with CORRUPTION)

c. All models include per capita personal income, per capita state budget deficit, strength of Republicans in politics, strength of Democrats in politics, spirits consumption per capita for population aged over 21 (lagged) and sale of spirits (lagged).

d. Model I uses alternative 1982–1999 beer tax data from Dave and Kaestner (2002).

e. Model II incorporates population-weighted neighboring states beer tax rates (NEIGHBOR TAX).

f. Model III uses states with nominal changes during 1980-2001.

g. Model IV excludes states where BEER TAX Granger causes CORRUPTION.

h. Model V uses a one-year lag of CORRUPTION.

from NHTSA. In 2001, Utah had the lowest alcohol-related traffic fatality rate per 100 million miles traveled at 0.30, and South Carolina had the highest at 1.25. To smooth out any fluctuations in the fatality rates, we use a three-year moving average of FATALITIES.

Next, we turn to our set of control variables. Data on state personal incomes and state budget deficits come from the Bureau of Economics Analysis and the Statistical Abstract of United States, respectively. To control for political party dominance, we use two dummy variables that measure republican and democratic party strength in state government.[26] The dummy is equal to one if a party has a 66 percent majority in both the state House and the state Senate. Using a 66 percent majority allows for veto overrides. The proportions of democrats and republicans in the Senate and House in each state are calculated from various editions of the Statistical Abstract of the United States. The spirits consumption data comes from National Institute of Alcohol Abuse and Alcoholism (NIAAA 2004). Data on legislation determining maximum blood alcohol content levels (BAC; i.e., the legal level of intoxication) comes from Freeman (2007). All data sources are listed in appendix B.

IV. Empirical Results

Table 1 reports our main results, and table 2 provides a robustness analysis. All models include state and time fixed effects.[27] Several diagnostic tests are conducted to assess the reliability and the efficiency of the IV estimations. First, we use the Pagan and Hall (1983) test of heteroskedasticity of the errors. Baum, Schaffer, and Stillman (2003) showed that standard IV estimation is more reliable than the GMM approach in finite samples if the errors are homoskedastic. Second, we present the results of Hansen's J statistic. This is an over-identification test for the validity of the instruments for models with the number of instruments exceeding the number of endogenous regressors. Third, we report the F test of joint significance of the instruments in each first-stage regression (see Staiger and Stock 1997). Fourth, we report Shea's (1997) partial R^2. It is well known that when multiple endogenous regressors are used, the F statistics and partial R^2 measures from the first-stage regressions will not reveal weakness of the instruments. Shea's (1997) partial R^2 measure takes into account the intercorrelations among the instruments.[28] Fifth, we present two under-identification tests, namely the Kleibergen-Paap LM and Wald tests (Kleibergen and Paap 2006). The test of under-identification is a test of whether the equation is identified. Sixth, we perform a weak identification test by reporting Kleibergen-Paap Wald *F* statistic (Kleibergen and Paap 2006). The *F* statistic should be compared with the critical values for the Cragg-Donald weak id test (Cragg and Donald 1993).[29] We also include two statistic that provide weak-instrument-robust inference for testing the significance of the endogenous regressors in the structural equation being estimated. The first statistic is the Anderson-Rubin test whether the endogenous variables are jointly statistically significant (Anderson and Rubin 1949). The second is the (closely) related Stock and Wright (2000) LM test. The null hypothesis tested in both cases is that the coefficients of the endogenous regressors in the structural equation are jointly equal to zero, and, in addition, that the over-identifying restrictions are valid. Both tests are robust to the presence of weak instruments. Finally, we present the average variance inflation factor (VIF) for each model. As a rule of thumb, a VIF value greater than 10 may merit further investigation to find whether multicollinearity exists (Marquardt 1970).[30]

Our results hold up to the full battery of diagnostic tests, and this is consistent across models in tables 1 and 2. The Pagan and Hall (1983) tests fail to reject the null of homoskedasticity in all specifications, indicating reliability of the standard IV method. Hansen's J statistic is reported in the last two models of table 1 and passes the Hansen's over-identification test.[31] Furthermore, in all models reported in tables 1 and 2, the *F* test shows joint significance for the instruments. Moreover, Shea's R^2 is in the range 0.06 to 0.32 and passes the instrument relevance test. In addition, the Kleibergen-Paap LM and Wald tests reject the null hypothesis that the equation is underidentified in all models of tables 1 and 2. Also, the Kleibergen-Paap Wald *F* statistic always passes the weak identification Craig-Donald critical values calculated by Stock and Yogo (2005). Finally, the Anderson-Rubin Wald and Stock-Wright LM tests easily reject the joint significance of endogenous regressors (i.e., weak instrument tests) in all models in tables 1 and 2. Finally, all models have an average VIF score well below 10.

In table 1, models I and II present IV-2SLS results with 2 IVs, whereas Models III and IV report IV-2SLS results using 4 IVs. Models II and IV include BAC legislation data in addition to the base models. The results reported in table 1 appear to tell a story consistent with our theory. Although corruption lowers the level of state beer taxes, the effect is conditional on the incidence of alcohol-related vehicle accident deaths. In particular, the negative impact of CORRUPTION on BEER TAX becomes smaller (in absolute value) as FATALITIES rises. Both the direct effects of CORRUPTION, as well as its interaction with FATALITIES, are significant at conventional levels in all models.[32] Thus, the beer lobby has a more difficult time influencing beer tax policy when alcohol-related traffic fatalities are more frequent.[33] To our knowledge, this finding has not previously been shown in the literature.

The (unreported but available on request) control variables largely exhibit coefficients consistent with expectations. Moreover, the magnitudes and signs are insensitive to the inclusion of additional control variables and instruments. A higher per capita personal income has a negative effect on BEER TAX. Consistent with Reed's (2006) study of the total tax burden, states with democrats in control of the legislature set a higher BEER TAX. States with a legal BAC level of 0.10 have higher BEER TAX levels.

Robustness Analysis

Table 2 presents a robustness analysis using model I from table 1 with 2 IVs. Model I uses alternative beer tax data from Dave and Kaestner (2002) for years 1982-1999. This evaluates whether our choice of data source drives our results (although the shorter time period may hinder the analysis somewhat). Model II seeks to adjust for possible strategic interaction in policy making among states (see, e.g., Hunter and Nelson 1992; Nelson 2002; Brueckner 2003 provides a useful survey of the literature on horizontal tax externalities). We follow Fredriksson and Mamun (2008) using the population-weighted tax (denoted NEIGHBOR TAX in Table 2) set by the neighboring states (instrumented by the population-weighted state unemployment rate, the percentage of children and old in the population). Model III includes data from the forty-six states that changed the nominal beer tax during 1980-2001.[34] However, we note that it is not inconsistent with the focus on corruption that no nominal change takes place (in particular, if special interests have a sufficiently large influence). In model IV, we use data only from states that pass an individual Granger causality test (at the 1 percent level), suggesting that CORRUPTION Granger causes BEER TAX (rather than the causality primarily going in the opposite direction) (Granger 1969). This resulted in 13 states being dropped. Moreover, we also estimated models with a one-year lag of the moving average of CORRUPTION in model V. The data set expands to 1982-2002 in this model, as a consequence.

The relevant coefficients are significant in all models except model I, where the sample ends in 1999. In addition, the negative impact of CORRUPTION on BEER TAX becomes smaller (in absolute value) as FATALITIES rises. The model I results are perhaps because of fewer observations and less variation in the data. Close observation of the 2000-2001 data reveals a higher degree of variation in the data in 2000-2001 relative to the rest of the time period of study.[35] In conclusion, our results appear reasonably robust.

Implications and Discussion

In this section, we discuss the implications of our findings. First, we examine the effect of corruption on the beer tax. Using model I in table 1, the marginal effect of corruption on the real beer tax equals $-1.36 + 1.27 \times$ FATALITIES. At the means of all variables, using the full sample, the marginal effect of corruption equals -0.08. The marginal effect of corruption is greater when alcohol-related traffic fatalities are less common. In particular, at one standard deviation (=0.45) below the mean of FATALITIES, the marginal effect is -0.79. These results suggest that in states with low alcohol-related traffic death rates, the corruption yields lower beer tax rates. However, as the fatality rate increases, the impact of corruption is muted.

Next, we calculate a corruption elasticity of the real beer tax at the state level (by multiplying the marginal effect by CORRUPTION/BEER TAX). Appendix A shows the corruption elasticity of the beer tax across states for 2001. These values show great variation, with Pennsylvania and Kentucky having large (in absolute value) negative elasticities (-1.02), suggesting different potential results of corruption reform across states. The mean elasticity for the states is -0.24, and the median equals -0.16.

Is corruption lethal? To the extent that corruption reduces alcohol taxes and higher alcohol taxes reduce alcohol-related traffic deaths, corruption kills. In the literature, an ongoing debate exists regarding the effects of beer taxes on both beer consumption and alcohol-related vehicle fatalities. Pacula (1998) finds that a doubling of the beer tax would reduce youth alcohol consumption by between 3 percent and 6 percent.[36] However, other studies find that the effect of the alcohol taxes on alcohol consumption is small (Gius 2005) or that there is no effect of alcohol prices on motor vehicle accidents (Whetten-Goldstein et al. 2000; Cohen, Mason, and Scribner 2001). In our view, one possible problem with the estimates reported in the literature is the failure to endogenize the alcohol tax.[37]

V. Conclusion

This article shows that beer producers are more successful in their political activities in states where corruption is more widespread. Moreover, this effect of corruption is conditional on the rate of alcohol-related traffic fatalities. In particular, the effect of corruption on the beer tax rate is less negative where these traffic fatalities are more frequent. We believe this is the first evidence of this nature in the literature.

Our results also raise some possible questions regarding the previous empirical literature, which seeks to estimate the effect of beer taxes on alcohol-related traffic fatalities. This literature has omitted the possibility that beer taxes are endogenously determined. In particular, it has not incorporated the effects of corruption and alcohol-related traffic fatalities on beer taxes. Our analysis may therefore provide some guidance for future empirical undertakings in this area.

Appendix A

Table A1
Corruption Elasticity of the Beer Tax by State (Year 2001)

State	Elasticity	State	Elasticity
Pennsylvania	−1.02	Vermont	−0.15
Kentucky	−1.02	Oregon	−0.14
Rhode Island	−0.77	New Hampshire	−0.13
Illinois	−0.70	Kansas	−0.12
New Jersey	−0.58	Florida	−0.12
North Dakota	−0.53	Washington	−0.12
New York	−0.53	Maine	−0.11
Delaware	−0.51	Alabama	−0.10
Wisconsin	−0.45	Utah	−0.09
Ohio	−0.44	West Virginia	−0.09
Colorado	−0.40	Oklahoma	−0.09
Missouri	−0.31	Texas	−0.09
Massachusetts	−0.31	Georgia	−0.08
Nevada	−0.30	Mississippi	−0.07
Idaho	−0.25	Arkansas	−0.06
Indiana	−0.24	North Carolina	−0.04
Virginia	−0.23	Iowa	−0.03
Connecticut	−0.23	Arizona	−0.02
Maryland	−0.22	South Dakota	−0.02
Tennessee	−0.21	Louisiana	−0.01
Wyoming	−0.19	New Mexico	−0.01

(continued)

Table A1. (continued)

State	Elasticity	State	Elasticity
Michigan	−0.19	Nebraska	−0.01
California	−0.19	South Carolina	0.01
Minnesota	−0.16	Montana	0.15

Appendix B

Table A2
Data Sources

Variables	Source
BEER TAX	World Tax Data Base (2006); http://www.bus.umich.edu/OTPR/otpr/introduction.htm
CORRUPTION	U.S. Department of Justice (various years); www.usdoj.gov/criminal/pin/AnnReport_04.pdf
FATALITIES; Vehicle miles traveled	NHTSA (various years); http://www-nrd.nhtsa.dot.gov
Per capita cigarette revenue (US$1000s)	Orzechowski and Walker (2003)
Per capita personal income; Per capita budget deficit (US$1000s); republican strong; democrats strong	Statistical abstract of the United States; http://www.census.gov/compendia/statab/past_years.html
Gallons of Spirits$_{-1}$	NIAAA (2004); http://www.niaaa.nih.gov/publications/surveillance66/pcyr1970-2003.txt
Legal intoxication (BAC = .10); legal intoxication (BAC = .08)	Freeman (2007)

Notes

1. Alcohol-related traffic deaths are deaths where at least one driver or nonoccupant (pedestrian or bicyclist) involved in the accident had a BAC over 0.08 grams per deciliter. For drivers aged 16 to 24 years, the number of alcohol-related traffic deaths with BAC greater than 0.01 gram per deciliter was 4,121 (NHTSA 2006; the stricter alcohol limit is used for youths under the minimum legal drinking age).

2. The impact of a 10-percent price increase on drunk driving of male and female *underage* drinkers would be 12.6 percent and 21.1 percent, respectively (Kenkel 1993; see also Chaloupka, Grossman, and Saffer 1993; Grossman et al. 1994). Levitt and Porter (2001) find that legally drunk drivers pose a risk 13 times greater than other drivers (see also Kenkel 1996).

3. Motor vehicle accidents are the leading cause of deaths among 6 to 27 year olds in America, and result in approximately 40,000 deaths per year. According to Grossman et al. (1994), had the 1991 increase in the federal beer tax from 16 cents to 32 cents per six-pack been enacted nine years earlier at least 611 young people's lives would have been saved from alcohol-related deadly traffic accidents.

4. The main issue was a proposed tax hike on beer supported by state Senate leaders, but which the beer industry has repeatedly defeated (see http://www.democracy-nc.org/moneyresearch/2005/rptcrd.html, accessed April 11, 2008).

5. By studying the effect of corruption on state beer taxes, we may potentially also gain an understanding of its (indirect) impact on alcohol-related traffic deaths.

6. See, for example, Jain (2001) and Aidt (2003) for surveys of the literature on corruption.

7. For discussions of bureaucratic, political, and overall corruption, see, for example, Rose-Ackerman (1978, 1999) and Ehrlich and Lui (1999).

8. Coate and Morris (1999), who build on Grossman and Helpman (1994), also view a firm's political gift as a bribe. Rose-Ackerman (1978) discusses several forms of high-and low-level corruption, one of which is the legal or illegal use of campaign contributions.

9. Fredriksson and Svensson (2003) study the interaction effects of corruption and political instability on environmental policy using the Grossman and Helpman (1994) theoretical framework, and test the predictions using cross-country data.

10. Appendix A reports estimates of the corruption elasticity of the beer tax for all states.

11. See, for example, Mast, Benson, and Rasmussen (1999) and Young and Likens (2000).

12. See, for example, Levitt (1997) and Besley and Case (2000) for studies examining endogenous policy changes and the biases in the estimated effect of the policy intervention when the endogeneity is ignored.

13. While the previous literature has not connected corruption, alcohol-related traffic fatalities, and beer taxes, Brown, Jewell, and Richer (1996) accounted for the endogeneity of alcohol prohibition policies (wet/dry status) at the county level. When the policy was endogenously determined, the estimated effect of a county being wet on alcohol-related traffic deaths was four times larger relative to when the policy was not treated as endogenous. Kubik and Moran (2003) find that fixed effects models that estimate the elasticity of demand for beer and cigarettes have large biases when policy endogeneity is ignored. Young and Bielinska-Kwapisz (2006) use alcohol taxes as instrumental variables and find that alcohol-related traffic fatalities are negatively affected by alcohol prices; they also report that alcohol consumption is strongly positively related to traffic fatalities.

14. Estimating the size of the corruption elasticity on alcohol-related traffic deaths is an interesting topic for future research, but beyond the scope of this article.

15. We believe our model does not only apply to beer (our empirical focus), and thus we opt keep the wording more general (i.e., "alcohol").

16. The effect of alcohol taxes on driving behavior is not the focus of this paper, and we therefore hold mileage driven constant.

17. With the population normalized to unity, Q is equivalent to per-capita alcohol consumption.

18. Schulze and Ursprung (2001) argue that "the portrayed interaction between the organized interest groups and the government meets the circumstances of corruption" (p. 68). This is consistent with Shleifer and Vishny's (1993, p. 599) view of corruption as "the sale by government officials of government property for personal gain," where government property refers to government policies.

19. The derivation is available from the authors upon request.

20. Using meta analysis, Gallet (2007) report a price elasticity of beer demand equal to -0.83 for year 1992.

21. We estimated both a fixed effects and a random effects model. The estimates for these models were similar. We present the fixed effect results because this estimation procedure allows us to estimate robust standard errors.

22. Nebraska is unicameral; these dummies indicate whether the government is strongly democratic or strongly republican in this single legislature.

23. Fredriksson, Millimet, and List (2003) noted several additional potential problems with this measure of corruption. First, convictions are only recorded if the corrupt bureaucrats are caught. Second, the data treat all corruption convictions homogenously, independent of the severity of the crime. Third, the date of convictions does not provide the actual timing of the corrupt activity.

24. Boylan and Long (2003) surveyed 293 state house reporters in 1999 to measure corruption within the states. The correlation between their survey-based measure and a 3-year average (1998-2000) of our measure is 0.39 (significant at the 1 percent level).

25. Goel and Nelson (1998) found that government size, in particular spending by state governments, has a positive influence on corruption.

26. Nelson (2000) reports that during years 1946-1993, 30.4 percent (18.4 percent) of all increases in alcohol taxes occurred when both the state governor and the majority of the state legislature were democratic (republican).

27. We also estimated a model that included a continuous time variable. The results were indistinguishable from those reported in tables 1 and 2.

28. See Godfrey (1999) for a detailed discussion.

29. See Stock and Yogo (2005) for detailed discussion of the Craig-Donald critical values.

30. Individual VIF scores are available upon request.

31. Hansen's J statistic is not reported in the first two models of table 1 or in table 2, since only one instrument is included and the models are exactly identified.

32. Since convictions are often handed down several years after the actual corrupt activities occurred, we also used the number of convictions in year $t + 1$ as an alternative proxy for corruption in year t, following Fredriksson, Millimet, and List (2003). This yielded results comparable to those reported in tables 1 and 2. We also used a one-year lag of FATALITIES; the results are similar to the ones reported in tables 1 and 2, but the relevant coefficients exhibit a lower level of significance (and the IVs become weaker in some models). This may perhaps indicate that the state legislatures take several years of road fatality data into consideration in their decision making.

33. We also used *Cigarette Revenues Per Capita* as a single instrument. Although the results are similar to the ones reported in tables 1 and 2, the coefficient on FATALITIES is always insignificant. In addition, we replaced FATALITIES with total alcohol-related traffic fatalities. The results are very similar to the results in table 1 for alcohol-related fatalities per 100 million vehicle miles traveled. However, instruments fail to hold up to the weakness tests. Other instruments, including motorcycle registrations and teen pregnancies per capita, resulted in insignificant coefficients on FATALITIES.

34. We used two extra years to account for the tendency to change taxes (in the sense that we are interested in those states which did change the nominal tax rate, or had a tendency to change it). Maryland and Missouri were dropped in these models.

35. The SD of BEER TAX was 0.009 in 2000-2001, compared to 0.004 during 1982-1999; the SD of CORRUPT was 0.003 in 2000-2001, compared to 0.001 during 1982-1999.

36. See also, for example, Chaloupka, Grossman, and Saffer (1993).
37. See, for example, Trefler (1993) for a discussion of this issue (applied to import tariffs).

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Per G. Fredriksson is an associate professor of economics at the University of Louisville, Louisville, Kentucky.

Stephan Gohmann is the BB&T professor of free enterprise at the University of Louisville, Louisville, Kentucky.

Khawaja Mamun is an assistant professor of economics at Sacred Heart University, Fairfield, Connecticut.